

March 21, 1961

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2,975,902

MEANS FOR IMPROVING CLOTHES DISTRIBUTION IN A MACHINE
HAVING A CENTRIFUGAL LIQUID EXTRACTION STEP

Filed July 2, 1959

4 Sheets-Sheet 1

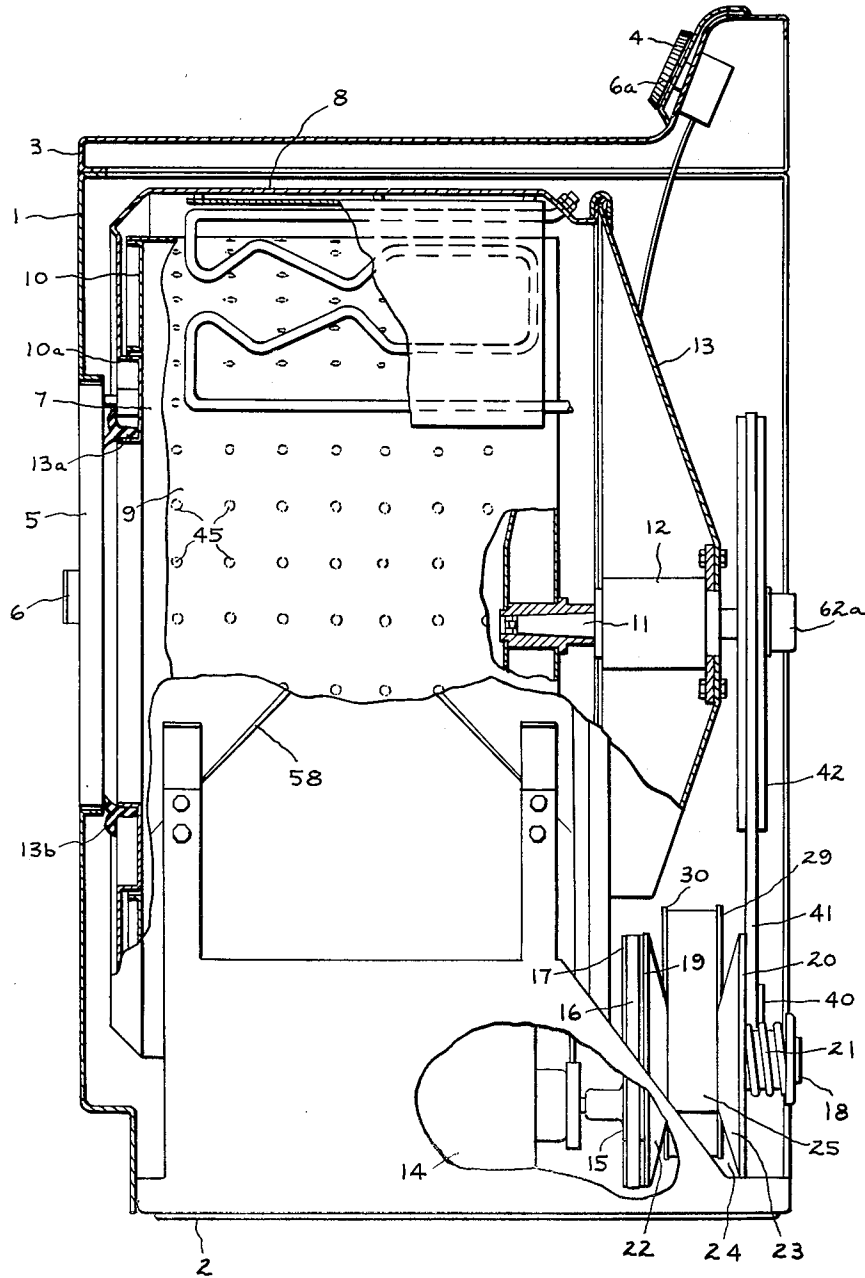


FIG. 1

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4 Sheets-Sheet 3

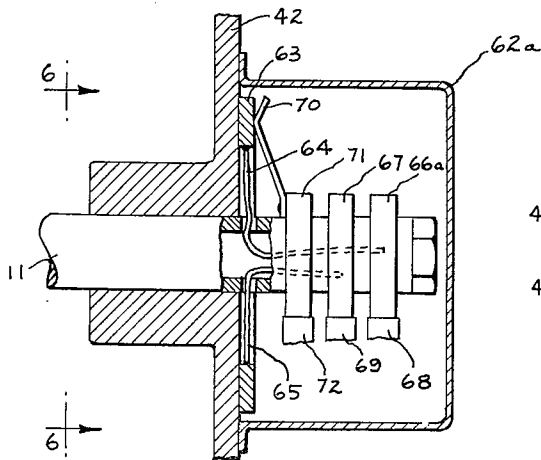
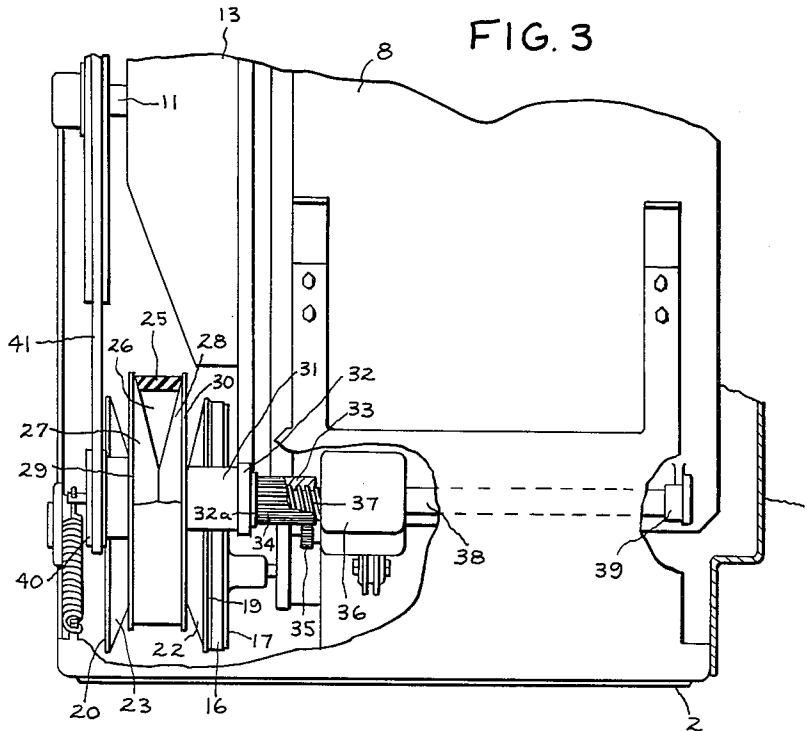
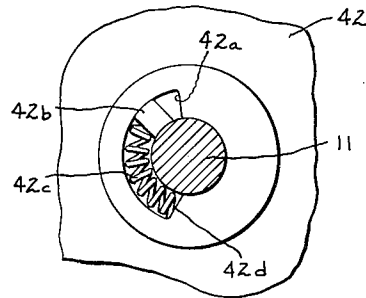


FIG. 6



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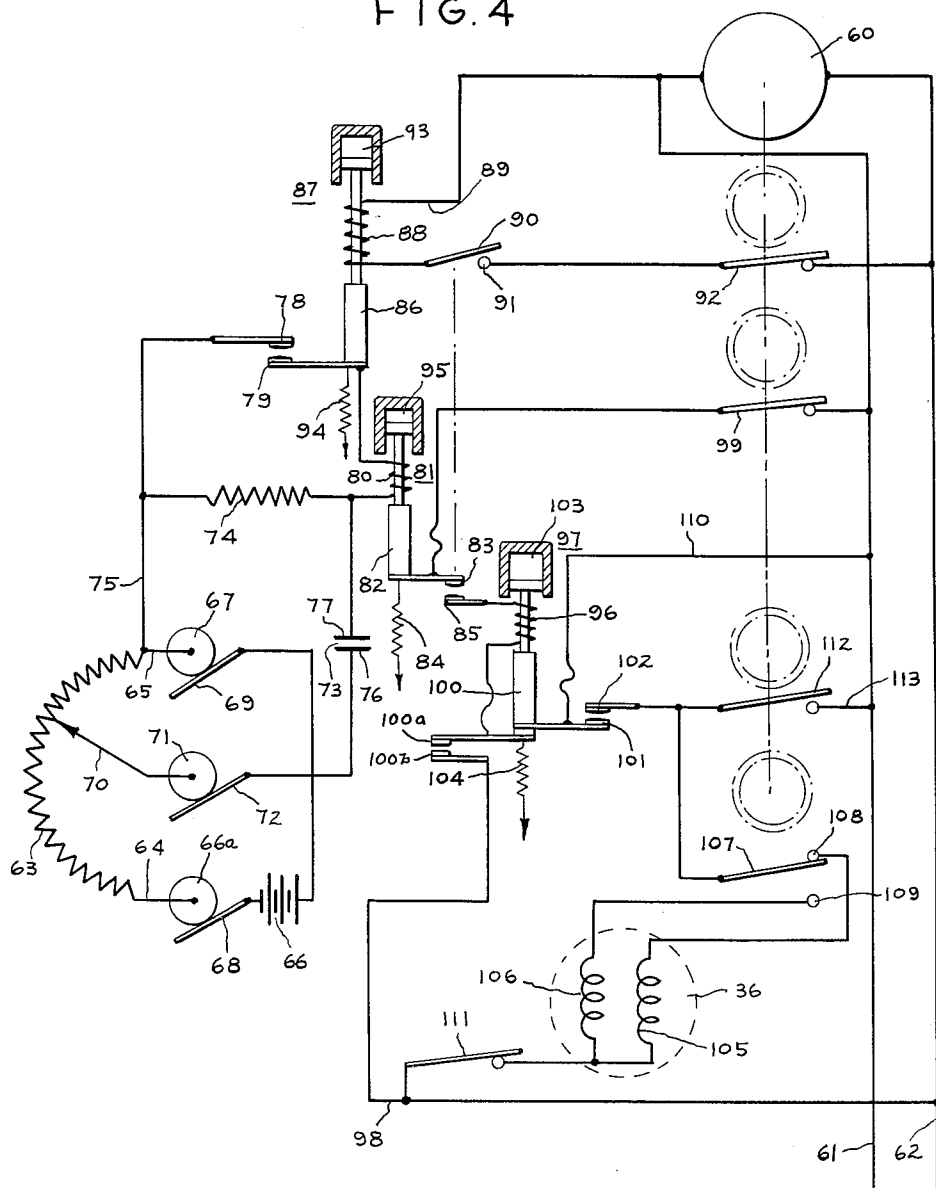
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4 Sheets-Sheet 4

FIG. 4



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MEANS FOR IMPROVING CLOTHES DISTRIBUTION IN A MACHINE HAVING A CENTRIFUGAL LIQUID EXTRACTION STEP

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10 Claims. (Cl. 210—144)

This invention relates to improved clothes distributing means for machines which centrifuge liquid out of the clothes by high speed rotation of the clothes container, and more particularly to such an arrangement wherein the rotational speed of the container is brought up to centrifuging speed by a specially programmed acceleration.

When an automatic laundry machine of the type having a rotating container, or basket, proceeds from a washing or rinsing step into a centrifugal extraction step, vibration of the basket and of its enclosing tub structure may become quite substantial unless the clothes distribute themselves evenly around the basket. If this even distribution does not occur, the basket is dynamically unbalanced and, to whatever degree this condition exists, the vibration will occur. Actual harm may result to the machine from such vibration; this is particularly so where, because of the increasing demand for machines which take up a relatively small amount of space without any decrease in the load capacity of the machine, the clearance between the parts has been cut down as much as possible.

In the type of machine having a basket rotatable on a substantially non-vertical axis, the clothes as they tumble about in the basket often approach a balanced state for an instant; of course if the clothes continue to tumble after that instant they depart from the balanced state. Thus, if, after the tumbling clothes have momentarily reached a balanced state, the rotational speed could quickly be increased to a point where the clothes were plastered about the basket by centrifugal force, the clothes would be "frozen," so to speak, into a balanced distribution.

However, the different types of clothes loads may become plastered at different speeds, even within a single clothes container of a given diameter. While the variation is not too great, in the case of a 26 inch diameter basket the "plaster" speed may be as low as 55 to 60 r.p.m. for some clothes but as high as 75 or 80 r.p.m. for certain other types of clothes. It is therefore virtually impossible to know at exactly what speed specific items of clothing will be plastered around the basket.

With these facts before me, I have conceived of programming the acceleration of the basket from the tumbling speed (approximately 47 r.p.m. for a 26 inch basket) by small increments, on the order of 3 or 4 r.p.m., up to centrifuging speed; this assures that, regardless of the clothes load, one of the steps, or increments, in the programmed acceleration will occur just prior to plastering of each article of clothing about the basket. If each increment of acceleration is permitted only when the clothes are substantially balanced for an instant, then some one of those incremental accelerations will bring the basket speed up to the point where the clothes are plastered; therefore, one of the increments will cause the instantaneous balanced distribution to be held and maintained for the centrifugal liquid extraction operation.

Various arrangements sensitive to unbalance at low speed have been devised for machines where the clothes basket is rotatable on a substantially non-vertical axis. In such machines, because of the gravity force, any un-

balance in the basket tends to make the rotational speed of the basket increase (i.e., to help the driving mechanism) when the unbalance is against the basket wall which is moving downwardly and to decelerate the basket, i.e., to oppose the driving mechanism, when the unbalance is against the wall which is moving upwardly. Different arrangements for utilizing this phenomenon are described and claimed in, for instance, application Serial No. 752,727 filed by John Bochan on August 4, 1958 and application Serial No. 788,398 filed by John W. Toma on January 22, 1959, now Patent No. 2,917,175, both applications being assigned to the General Electric Company, owner of the present invention. Any suitable system of this type may be used to determine the instant for providing each incremental acceleration in my programmed acceleration arrangement.

It is, accordingly, an object of this invention to utilize the gravitational unbalance phenomenon in containers rotating on a non-vertical axis to achieve a programmed acceleration which will provide in a clothes washing machine a balanced clothes distribution during the centrifugal extraction of liquid from the clothes.

A further object of the invention is to increase the speed of rotation of the clothes container in such a machine from tumble speed to a low centrifuging speed by relatively small increments whereby one of the increments falls just before the speed at which all the clothes are plastered about the basket by centrifugal force.

A further object of the invention is to determine the moment at which each of the steps of acceleration takes place by means of a gravitational unbalance sensitive device which will provide for each acceleration step in response to an instantaneous substantially balanced distribution of the clothes.

In one aspect of my invention I provide a laundry machine of the "tumbler" type, that is, where the clothes basket is rotatable on a substantially non-vertical axis. The basket is driven by multi-speed drive means which are arranged to drive the basket either at a relatively low speed for tumbling clothes in the basket, at a relatively high speed for extracting liquid from the clothes by centrifugal force, or at intermediate speeds. In order to improve the balanced distribution of the clothes during high speed rotation of the basket I provide means for sensing when the clothes are in substantially balanced distribution in the basket, together with means for increasing the basket speed in predetermined increments from the relatively low tumble speed to a speed where the clothes are all plastered about the basket by centrifugal force. When the sensing means determines that there is an instantaneous substantially balanced distribution of the clothes, the drive means is caused to increase its speed another increment. This continues until, during one of the brief incremental accelerations, the basket reaches a speed where all of the clothes are plastered. Since the sensing means has just previously determined that the clothes are instantaneously in balance, this balanced distribution of the clothes is held and retained for the centrifuging operation which is then provided by increasing the speed to a relatively high level.

The features of my invention which I believe to be novel are set forth with particularity in the appended claims. My invention itself, however, may best be understood by the following description taken in conjunction with the accompanying drawings.

In the drawings, Figure 1 is a side elevational view of a domestic laundry machine of the type which both washes and dries completely, partly in section and with certain surfaces broken away to show details;

Figure 2 is a rear elevational view of the machine of Figure 1 with the rear panel removed to show details;

Figure 3 is a fragmentary side elevational view of the

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other side of the machine from that shown in Figure 1, with certain surfaces broken away to show further details;

Figure 4 is a schematic illustration of the circuit which provides for controlled and programmed acceleration from tumble speed to spin speed;

Figure 5 is an enlarged fragmentary view, partly in cross section, of the driving connection between the driving mechanism and the clothes basket; and

Figure 6 is a fragmentary view partly in cross section along line 6—6 in Figure 5.

Referring now to Figures 1 and 2, there is shown a combination washer-dryer machine where the operating elements of the machine are included within an outer cabinet structure which has a wrap-around central section 1 supported on a base and toe-board assembly 2 and carrying a separate top 3 provided with an integral back-splash panel 4. Access to the interior of the machine is provided by a door 5 mounted on concealed hinges and opened by any suitable means such as, for instance, knee operated latch control 6. The machine is so constructed that when a load of soiled clothes is placed therein it proceeds through a sequence of operations, first washing the clothes and then drying them. In order to provide flexibility of operation of the machine, suitable operator controls may be included therein, the controls being mounted on the back-splash panel 4. Illustrative of these controls is a suitable dial 6a, shown on the back-splash panel, for convenient operator selection of any particular sequence of operations.

As shown in the figures, the machine is of the non-vertical axis type (horizontal in this particular instance), that is, it has a clothes basket or receptacle 7 mounted for rotation on a generally horizontal axis within an outer enclosing tub structure 8. Basket 7 includes a cylindrical shell or wall 9 and a front wall 10 which is formed so as to define an access or loading opening 10a to the basket. The basket is rotatably supported by a shaft 11 which is mounted in an elongated bearing 12 supported from rear wall 13 of the tub. The tub is provided with an opening 13a in the front wall thereof which is aligned with the access opening to the basket so that the clothes may be placed into and removed from the basket. Door 5 seals against a suitable gasket 13b to close the opening during operation of the machine.

During the operation of the machine, the basket 7 is driven from an electric motor 14 mounted to tub 8 by bracket 14a. Thus, the tub provides the base to which the drive including motor 14 is mounted. The drive from the motor to the basket includes a pulley 15 which is secured to the motor shaft so as to rotate therewith and over which passes an endless flexible belt 16 which drives a pulley 17. Pulley 17 is mounted on the same shaft 18 as two sheave plates 19 and 20 which are axially movable relative to each other. This is effected, in the present case, by making plate 20 axially slidable on shaft 18 as well as rotatable therewith. Plate 20 is biased toward plate 19 by a spring member 21 mounted on shaft 18, as shown in Figure 1.

Sheave plate 19 has a sloping surface 22, and plate 20 has a similar surface 23, so that between them surfaces 22 and 23 form a groove 24 of generally V-shaped cross section. Seated in groove 24 is an endless flexible belt 25 having a cross section substantially in the form of a truncated V whose sides engage the sides of the groove so that rotation of plates 19 and 20 drives the belt 25. Belt 25 also passes within a groove 26 formed by the surfaces 27 and 28 of a pair of sheave plates 29 and 30 which are secured to a rotatably mounted hollow shaft 31; plates 29 and 30, while rotatable together, are axially movable relative to each other. In the case of plates 29 and 30, the axially movable relationship is maintained by making plate 30 axially movable along shaft 31. This is achieved by providing a sleeve 32 over the shaft secured to plate 30 so that when sleeve 32 is moved axially it carries the plate with it. Separated from sleeve 32 by a thrust bear-

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ing 32a is a nut member 33 having an exterior surface 34 formed as a gear and positioned to be engaged by a pinion member 35 driven through a conventional motor and gear train assembly 36. The internal surface of the nut member 33 is threaded, and engages the mating end 37 of a shaft 38 non-rotatably secured in suitable fixtures (one of which is shown at 39 in Figure 3) fastened to tub wall 8. Shaft 38 provides the base on which hollow shaft 31 is rotatably mounted a fixed predetermined distance from shaft 18. Upon rotation of pinion 35 by motor 36, nut member 33 is caused to rotate and therefore, by its threaded engagement with end 37 of shaft 38, to move axially on the shaft in one direction or the other depending upon the direction of rotation of the pinion 35. The nut member in moving axially carries with it the sleeve 32 and the plate 30 so as to vary the width of groove 26. In addition, speed-reduction drive from motor 36 to plate 30 may include suitable conventional means, such as a worm gear (not shown), to provide enough friction when motor 36 is not energized to act as a brake and thus to hold plates 29 and 30 in the desired relationship.

Secured on shaft 31 so as to rotate the plates 29 and 30 is a pulley 40 which is in driving relationship to a belt 41. Belt 41 in turn drives a pulley 42 rotatably mounted about shaft 11 and provided with a slot 42a (Figure 6) into which projects a key-like member 42b of the shaft. Assuming the rotation of pulley 42 to be clockwise as viewed in Figure 6, a spring member 42c is provided between the end 42d of slot 42a and key member 42b. In this manner, rotation of pulley 42, by engagement of the end 42d of slot 42a through spring 42c with key 42b causes rotation of pulley 42 to rotate shaft 11. It will readily be seen that spring 42c will be compressed to a greater extent when the load represented by shaft 11 and basket 7 is greater, to a lesser extent when the load represented by the shaft and the basket is less, and to a varying extent when the load varies.

Thus, to recapitulate briefly, starting with motor 14 the drive proceeds through pulley 15, belt 16, pulley 17, sheave plates 19 and 20, belt 25, sheave plates 29 and 30, pulley 40, belt 41, pulley 42, spring 42c, shaft 11, and basket 7. A lower, or tumble speed, of about 47 r.p.m. for the construction shown, wherein a container having a diameter of about 26 inches is used, is obtained with the adjustable plates in the position shown, i.e., with plates 29 and 30 close to each other to force belt 25 outwardly in groove 26 and with the belt correspondingly pulled inwardly at plates 19 and 20 to widen groove 24. To increase the speed to effect a centrifugal spin operation, plate 30 is moved away from plate 29 to widen groove 26 and allow belt 25 to move radially inwardly toward the center of rotation of shaft 31. This permits spring 21 to push plate 20 toward plate 19 to force belt 25 outwardly in groove 24.

To heat the clothes during the drying portion of the cycle, there is provided in the machine a heater assembly including two heaters 43 and 44. These heaters are mounted within the upper portion of tub 8 so that when energized they heat the basket 7. The heating elements are preferably of the sheathed type in which resistance wire is maintained in spaced relation with an outer sheath by a highly compressed granulated heat-conducting electrically-insulating compound such as magnesium oxide. The heaters, when they are energized during the drying cycle, transfer heat to the clothes basket which is then passed on to the clothes to cause vapor migration out of the clothes. Since the outer cylindrical wall of the basket is perforated by a great many small spaced openings 45, some of the heat from the heating elements also passes directly to the clothes by radiation.

The means whereby water is admitted to and discharged from tub 15 during operation of the machine is particularly shown in Figure 2. The water supply means includes connections 46 and 47 through which hot and cold water is supplied to the machine for the washing opera-

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tion. A valve controlled by a solenoid 48 admits hot water to the machine and a valve controlled by an opposed solenoid 49 admits cold water to the machine. The hot and cold water valves under the control of the solenoids 48 and 49 discharge through a common outlet conduit 50, through a suitable air gap, and into a funnel 51 which discharges into a line 52 leading to the interior of tub 8 through a suitable connection 53. The air gap provided by the funnel 51 makes it impossible for water to be syphoned from the machine thereby to contaminate the incoming water supply line. In the illustrated machine a pressure actuated sensing device or water level control 54 controls both solenoids 48 and 49 to maintain the proper water level in the machine during the washing operation. This sensing device is connected to the interior of tub 8 by a suitable line 55.

The illustrated machine is of the type which uses cold water during the drying cycle for condensing the moisture extracted from the clothes. This condenser water is admitted to the machine through an additional solenoid actuated valve controlled by a solenoid 56 (Figure 2). Solenoid 56 is energized during the drying operation so that the valve passes water at a slow rate sufficient to condense from the air the moisture vaporized from the clothes. As shown, the condenser water valve discharges into funnel 52 through a separate conduit 57, with an air gap between conduit 57 and the funnel preventing supply line contamination as before. From the funnel the condenser water flows through the conduit 52 and connection 53 into the tub. The condenser water flowing slowly into the tub is spread over the side of the tub by an inverted V-shaped bead 58 (Figure 1) formed on the tub wall directly below the connection 53. The condenser water being so spread out cools a substantial portion of the area of the side wall whereby there is provided a large cool surface for condensing the moisture extracted from the clothes.

The wash and rinse water used during the washing portion of the operation, and the condenser water and the moisture extracted from the clothes during the drying operation are discharged from the machine through a sump 58a mounted at the bottom of the tub. A suitable discharge hose 59 leads from the sump to suitable drain means (not shown) which are normally arranged to discharge to the household drain.

With the apparatus above described and by the use of suitable well known control arrangements which do not form a part of this invention and are not further described except incidentally in connection with the invention, the machine of Figures 1, 2 and 3 may be made to proceed through suitable washing and drying operations, first washing the clothes and then rinsing them as the basket rotates at tumble speed, that is, 47 r.p.m., then centrifugally extracting liquid from the clothes by high speed rotation of the basket, and then, where so desired, returning to tumble speed for a heat drying operation to effect substantially complete drying of the clothes. When the time comes to increase the speed from tumble speed to full spin speed, the basket speed is brought up by a series of incremental accelerations, each increment being provided in response to an instantaneous substantially balanced distribution of the clothes. The result of this is that one of the incremental advances will bring the basket up to a speed where the clothes are plastered immediately after one of the instantaneous balanced clothes distributions so that the distribution of the clothes which caused the incremental acceleration is retained during high speed rotation of the basket.

In order to effect this, a suitable control arrangement in accordance with my invention is shown in Figure 4. As shown there is provided a control device, generally a timer motor 60, which is connected across lines 61 and 62 of a 110 volt power supply (not shown). While the location of the timing motor 60 within the machine is not im-

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portant, it is customarily provided within the back-splasher 4.

It will be understood that in addition to its connection in the circuit specifically shown in Figure 4 in connection with the invention, timer motor 60 is normally so arranged as to control the full sequence of operation of the machine, causing the water supply solenoids 48 and 49, the condenser solenoid 56, the motor 14, the drain means (not shown), and the heaters 43 and 44 to perform in the appropriate sequence to fill the tub to a proper level, to drain the tub, to heat the clothes subsequent to the centrifugal liquid extraction, and to condense the moisture extracted from the clothes. Such sequence control connections are well known to those skilled in the art and will not be further described herein.

Returning to Figure 4, in conjunction with Figures 5 and 6, there is provided a casing member 62a secured to pulley 42 over shaft 11. Within casing 62a, a resistor 63 having its ends connected by conductors 64 and 65 across a source of direct current power 66, such as a small storage battery. As shown in Figure 5, resistor 63 is secured to pulley 42 so as to be movable therewith. Conductors 64 and 65 extend from the ends of resistor 63 and are secured respectively to slip rings 66a and 67 rigidly mounted on shaft 11; the slip rings in turn are contacted respectively by stationary brushes 68 and 69. The connection of direct current power source 66 is directly across the brushes 68 and 69 so as to effect the circuitry shown in Figure 4. A contact member 70 is rigidly secured to shaft 11 so as to be movable therewith, and therefore, recalling the movable connection between shaft 11 and pulley 42, limited relative motion between contact member 70 and resistor 63 is provided for. Contact 70 is connected to a slip ring 71 which is engaged by a brush member 72 secured, as are brush members 68 and 69, to the stationary parts of the machine.

A capacitor member 73 is connected in series relation with contact member 70; a resistor 74 is connected between the capacitor and a conductor 75 which in turn is connected to the same end of resistor 63 as conductor 65. Capacitor 73 and resistor 74 constitute, together with power source 66 and resistor 63, a circuit sensitive to the balanced or unbalanced condition of the clothes in basket 7. When an unbalanced load is provided within the basket with the construction described, the voltage at plate 76 of capacitor 73 is constantly changing with the movement of contact member 70, and the voltage at plate 77 of capacitor 73 is constantly tracking the voltage at plate 76. When contact 70 remains stationary in any particular position, then after a given amount of time (which may be on the order of milliseconds with properly proportioned capacitor and resistance) the voltage at plate 77 equalizes itself with the voltage at plate 76 and there will be no potential drop across resistor 74. As will be understood from a recapitulation of Figures 4 and 5 as thus far explained, a stationary condition of contact member 70 indicates that the load is substantially balanced because the load on spring 42c is not varying; thus, a balanced load provides zero voltage drop across resistor 74, whereas a continually changing voltage at plate 76 will cause there to be a voltage drop across resistor 74. In other words, when the clothes load is unbalanced so that contact 70 is in movement, there is a voltage present across resistor 74.

It will be observed that when a pair of contacts 78 and 79 are closed, the coil 80 of a relay member generally indicated at 81 is in parallel with resistor 74. The division of impedances between resistor 74 and coil 80 is generally very uneven, with resistor 74 having a substantially greater impedance than coil 80. As a result, when there is a voltage drop across resistor 74, the main current in the system will flow through coil 80 to energize the coil and lift the movable armature 82 which carries a movable contact 83. When coil 80 is not energized, as occurs when the voltage drop across resistor 74 is zero, a spring

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member 84 pulls armature 82 down so that contact member 83 engages a contact 85. It will thus be seen that when contacts 78 and 79 are engaged, energization of coil 80 is dependent on whether an unbalance is causing movement of contact 70; the coil is energized when there is an unbalance and is de-energized when there is no substantial unbalance. Of course, when contacts 78 and 79 are separated coil 80 can not be energized, and consequently contacts 83 and 85 remain in engagement as a result of the action of spring 84 on plunger 82.

Contact 79 is secured to the end of an armature 86 of a relay member 87 having a coil 88. Coil 88 is connected at one end thereof through a conductor 89 to conductor 61; at its other end, coil 88 is connected through contacts 90 and 91 and timer actuated contact 92 to conductor 62. Contacts 90 and 91 are in series with timer switch 92 so that closing of both provides energization of coil 88. It should be noted at this point that relay 87 is of the type provided with suitable retarding means, schematically indicated by dashpot 93, which, once the coil 88 has been energized to close contacts 78 and 79, insures a one minute time delay after the deenergization of coil 88 and then, through the biasing action of spring 94, pulls contact 79 out of engagement with contact 78. Also at this point, it is to be noted that the relay 81 is also of the time delay type, as indicated by dashpot 95: de-energization of coil 80 must last on the order of one second before spring 84 can move contact 83 into engagement with contact 85.

When contacts 83 and 85 are closed, an energizing circuit for the coil 96 of a relay 97 is completed as follows: starting at conductor 62, the circuit proceeds through a conductor 98, coil 96, contacts 85 and 83, and a timer controlled switch member 99. Relay 97 is of the type which, upon energization of coil 96, raises the armature member 100 to separate contacts 100a and 100b and bring contact 101 into engagement with contact 102 for a brief period, preferably about $\frac{2}{10}$ of a second. This is achieved by the deenergization of coil 96 by separation of contacts 100a and 100b and by the provision of a suitable delaying type of mechanism, schematically indicated by dashpot 103. At the end of $\frac{2}{10}$ seconds, by the cooperation of dashpot 103 and a biasing spring 104 under tension, the plunger 100 is moved back to a position where contact 101 is separated from contact 102 by suitable means such as a biasing spring 104. It will be understood that the structure of relay 97, including coil 96, plunger 101 and contacts 100a and 100b, is intended to provide a typical illustration of the type of relay which, when its coil is energized, actuates contacts for a predetermined period of time from the moment of energization. Such relays are commercially available; they may be essentially as shown consisting of normally engaged contacts separable by energization of the relay coil, and a dashpot; or they may include a small timer device in order to effect the timed actuation of the contacts.

As stated earlier, accelerating motor 36 operates in reverse directions to speed up or slow down the rotation of the basket. Motor 36 is provided with appropriate windings 105 and 106 which are alternatively energized by engagement of a timer switch arm 107 with either a contact 108 or a contact 109 respectively. In the present case, the accelerating winding is winding 105, that is, the winding which causes the motor to rotate in the direction to cause acceleration of the basket; therefore, during the period from tumble speed to the time when the machine is rotating at full centrifuging speed, the timer mechanism will retain switch arm 107 in engagement with contact 108 as shown.

When contacts 101 and 102 are engaged, an energizing circuit for the winding 105 is completed as follows: starting at conductor 61, the circuit passes through a conductor 110 to contact 101, contact 102, switch arm 107, contact 108, winding 105, unbalance switch 111, and then back to conductor 62. The unbalance switch

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111 is of the conventional vibration-sensitive type commonly provided in machines of the type described hereinabove in order to prevent centrifuging speeds at which the unbalance is such as to cause damage to the machine, or "walking" of the machine across the floor; this function will be more fully explained in the complete description of the operation of the improved clothes distributing arrangement.

Timer motor 60 also controls a switch 112 which, when closed, completes a circuit from the windings 105 and 106 to conductor 61 through a conductor 113, thereby bypassing contacts 101 and 102 and conductor 110.

At the point in the sequence when it is desired to go from the tumbling speed of about 47 r.p.m. to a centrifuging speed to extract water from the clothes, timer motor 60 moves switches 92 and 99 from open to closed position, maintains switch 112 open, and provides for engagement of switch arm 107 with contact 108. This provides for energization of relay coil 88 and therefore closes contacts 78 and 79. These contacts were previously open because of the open position of switch 92, regardless of the closed position of contacts 90 and 91 (which are controlled by coil 80, in turn controlled by the contacts 78 and 79). The initial closing of timer switch 99 completes an energizing circuit for coil 96 of relay 97 since contacts 83 and 85 are in engagement until coil 80 is energized, and coil 80 cannot be energized unless coil 88 is energized by closure of contacts 90 and 91. However, once coil 88 has closed contacts 78 and 79, the energization of coil 96 is dependent upon engagement of contacts 83 and 85, and that in turn is dependent upon a balanced condition of the clothes. The open position of timer switch 112, and engagement of timer switch 107 with contact 108 places winding 105 of motor 36 under the control of contacts 101 and 102, assuming unbalance switch 111 to be closed as shown.

The closing of contacts 78 and 79 places relay coil 80 under the control of the sensing arrangement, with the coil being energized as long as contact 70 does not remain stationary for a period of about one second. As previously explained, contacts 78 and 79 remain in engagement for at least one full minute upon energization of coil 88. With switch 92 closed, renewed energization of coil 88 is thereafter entirely under the control of contacts 90 and 91, contact 90 being ganged to contact 83 so as to be controlled by the movement of plunger 82.

Let it be assumed that, after a few seconds, an instantaneous state of balance of the clothes is achieved in the basket for a period of one second and that consequently, as described, coil 80 is de-energized. When this occurs contacts 83 and 85 close to cause energization of relay coil 96 which then causes contact 101 to close with contact 102 for about $\frac{2}{10}$ of a second to provide energization of motor coil 105 for that period. This length of time is sufficient to provide for a basket acceleration of about 4 r.p.m. (each incremental acceleration is, preferably, in the 3-7 r.p.m. range) so that the basket speed then moves up to 51 r.p.m. from the original 47 r.p.m.. At this time (after $\frac{2}{10}$ second) spring 104 pulls contact 101 out of engagement with contact 102 and the motor 36 ceases to cause acceleration of the basket.

It will be observed that the de-energization of coil 80, in addition to closing contacts 83 and 85, also closes contacts 90 and 91 to cause renewed impulse of power across coil 88 of relay 87, thereby to continue to maintain contacts 78 and 79 closed for another minute. At this point the entire sequence is renewed, with coil 80 being sensitive to the movement of contact 70 and being de-energized when contact 70 ceases to move for a period of approximately 1 second. De-energization of coil 80 will again close contacts 83 and 85 which in turn energizes coil 96 to cause another four r.p.m. acceleration in the speed of the basket rotation, so that the speed rises to 55 r.p.m. This sequence continues until, at the time that de-energization of coil 80 causes another speed increase of 4 r.p.m., the

speed of the basket rises sufficiently to cause all the clothes in the basket to be plastered. Because of the very brief amount of time that this takes, the clothes are caught and held in their substantially balanced distribution. The clothes are thus appropriately distributed for a high speed centrifugal extraction operation to take place.

Once the clothes are plastered, then with a continually balanced load the speed rapidly increases even if timer switch 112 should remain open. However, the timer is set so that after a period of approximately two minutes after time switch 92 closed, switch 112 closes and switch 99 opens to cause completion of the circuit to accelerating motor 36 regardless of the sensing mechanism. The basket speed thus increases up to the maximum permissible by unbalance switch 111. When the basket speed reaches the maximum safe speed (if this should be lower than the maximum speed attainable) switch 111 opens to cause the acceleration to cease, and the spin then takes place at that speed for an appropriate amount of time as determined by the timer motor 60 in the conventional manner.

It will be observed that the arrangement described substantially increases the chances of a well balanced clothes distribution and thereby substantially increases the speed at which most extraction operations can be carried out. There will, however, be times when even though a full minute elapses the clothes do not during that period become balanced for a period of a second so as to permit an increase in speed. This may occur even though the clothes load is one which is capable of being well balanced; it is for this reason that relay 87 is included in the circuit. It will be observed that at the end of one full minute, if coil 80 has not become de-energized during that time by balanced clothes distribution, spring 94 will pull plunger 36 down to separate contacts 78 and 79. This opening of the circuit of course de-energizes coil 80 so that an acceleration takes place regardless of the fact that no suitable balance was attained at that particular speed. The operation then continues as before. It has been found expedient to provide for at least one (in addition to the initial increment) such possible acceleration increment without a balanced condition: a low number of such occurrences may often be without significance; several such occurrences generally indicates that the clothes load is of a type which is difficult to balance.

The single intermediate increment of acceleration without balance provided in the present case is provided by virtue of the fact that relay 87 keeps contacts 78 and 79 closed for one minute, and the total time allowed for acceleration from tumble speed is only two minutes. It will also be observed that when contacts 78 and 79 open to de-energize coil 80, this automatically causes closing of contacts 90 and 91 to re-energize coil 88, reclose contacts 78 and 79, and cause the programmed acceleration to continue as previously.

As stated, while the arrangement described is extremely useful in helping to balance clothes loads, there are certain clothes loads which are not susceptible of very good balancing, as for instance, a load of one or two shag rugs. When such a load is in the laundry machine, it may well occur that no acceleration of the basket is possible during the two minute sensing period except the accelerations provided by the opening of contacts 78 and 79 in response to the action of spring 94. In such a case, at the end of the two minute period, the closing of timer switch 112 will cause motor 36 to accelerate basket 7 even though the sensing mechanism has not indicated that there is an optimum distribution of the clothes. This acceleration continues to the extent permitted by unbalance switch 111; when the unbalance switch opens, the acceleration ceases and the centrifugal extraction operation takes place at the maximum speed permitted by the unbalance switch. While of course the centrifugal extraction in such a case will be at a speed lower than where the clothes were properly balanced by the unbalance sensing arrangement,

it will nonetheless extract the maximum amount of liquid possible from the load for the actual distribution.

Thus, the invention provides an arrangement where, for the great majority of loads, an optimum distribution of the clothes will be attained so that the rotational speed of the basket during the centrifugal extraction operation may be substantially higher than would otherwise be possible. The invention also accommodates special types of loads which are not susceptible of proper balancing and provides for it the same type of centrifugal extraction operation that is normally provided, that is, in such a type of clothes load, the sensing arrangement in effect does not operate and the extraction operation is conducted as though it did not exist except for the two minute interval of sensing. Such loads, however, represent a small minority of all those which are washed in domestic laundry machines, and most of the time an excellent clothes distribution will be achieved by means of the arrangement described.

It will be understood that, while the illustrated sensing structure provides speed increments which are all equal, the feature of importance is that the speed increases occur as a result of a substantially balanced condition; and thus, with other sensing arrangements, increments of differing magnitude, predetermined in a manner different from the specific one illustrated, may be provided, and such an arrangement will also be within the scope of my invention.

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

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

1. In a laundry machine, a clothes basket rotatable on a substantially non-vertical axis; multi-speed drive means rotatively engaging said basket, said drive means rotating said basket at a relatively low speed for tumbling clothes in said basket and at a relatively high speed for centrifugal extraction of liquid from the clothes; and means for improving the balanced distribution of the clothes for high speed rotation of said basket comprising means for sensing when the clothes are in substantially balanced distribution in said basket, and means for increasing the speed at which said drive means rotates said basket in predetermined increments from said relatively low tumble speed to the minimum speed at which the clothes are plastered around the basket, said sensing means controlling said speed increasing means and causing said speed increasing means to raise the basket speed one of said predetermined increments at the time said sensing means determines there is substantially balanced distribution of the clothes.

2. In a laundry machine, a clothes basket rotatable on a substantially non-vertical axis; multi-speed drive means rotatively engaging said basket, said drive means rotating said basket at a relatively low speed for tumbling clothes in said basket and at a relatively high speed for centrifugal extraction of liquid from the clothes; means for improving the balanced distribution of the clothes for high speed rotation of the basket comprising means for sensing when the clothes are in substantially balanced distribution in said basket, and means for increasing the speed at which said drive means rotates said basket in predetermined increments from said relatively low tumble speed to the minimum speed at which the clothes are plastered around the basket, said sensing means controlling said speed increasing means and causing said speed increasing means to raise the basket speed one of said predetermined increments at the time said sensing means determines there is substantially balanced distribution of the clothes; and sequence control means arranged to ter-

minate operation of said distribution improving means after a predetermined period of time and thereafter raise the speed of rotation of said basket to centrifuging speed without further effort at distributing the clothes.

3. The apparatus defined in claim 2 including vibration sensitive means positioned to sense unbalance vibrations of said basket and arranged in controlling relation to said multi-speed drive means, said vibration sensitive means preventing any further increase in basket speed when the vibrations reach a predetermined magnitude.

4. The apparatus defined in claim 2 including additional means for causing said speed increasing means to increase the speed of said basket one of said increments regardless of said sensing means, said additional means being arranged to be effective a small number of times during the predetermined period allotted to operation of said distribution improving means.

5. The apparatus defined in claim 1 wherein said increments of speed increase are between 3 and 7 r.p.m.

6. The apparatus defined in claim 1 wherein said multi-speed drive means includes a pulley member substantially coaxial with said basket, and resilient means connecting said pulley member to said basket in driving relation thereto, said resilient means providing for relative movement between said pulley and said basket during rotation to an extent dependent on the degree of unbalance in said basket, said sensing means being arranged to sense when relative motion is occurring between said pulley member and said basket.

7. The apparatus defined in claim 6 wherein one of said pulley member and said basket has an electrical resistance secured thereon and the other of said pulley member and said basket has a contact secured thereon and movable along said resistance, whereby movement of said basket relative to said pulley member changes the position of said contact on said resistance.

8. In a laundry machine, a clothes basket rotatable on a substantially non-vertical axis; multi-speed drive means rotatively engaging said basket, said drive means rotating said basket at a relatively low speed for tumbling clothes in said basket and at a relatively high speed for centrifugal extraction of liquid from the clothes; and means for improving the balanced distribution of the clothes for high speed rotation of said basket comprising means for sensing when the clothes are in substantially balanced distribution in said basket, and means for increasing the speed at which said drive means rotates said basket including a relay member having a coil and a pair of contacts arranged to be connected when said coil is energized and to be disconnected when said coil is de-energized, said contacts being in series with said speed increasing means whereby said speed increasing means is made operative by engagement of said contacts, said relay

being formed to maintain said contacts closed each time said coil is energized long enough for said speed increasing means to accelerate said basket one predetermined increment of speed before said contacts separate, said coil being controlled by said sensing means and being energized in response to a substantially balanced condition of the clothes and de-energized in response to unbalanced conditions of the clothes whereby said relay member causes said speed increasing means to raise the basket speed a predetermined increment at the time said sensing means determines there is a substantially balanced distribution of the clothes.

9. In a laundry machine, a clothes basket rotatable on a substantially non-vertical axis; a multi-speed variable-sheave belt drive system rotatively engaging said basket, said system rotating said basket at a relatively low speed for tumbling clothes in said basket and at a relatively high speed for centrifugal extraction of liquid from the clothes, said system including an electric motor operative when energized to move a sheave of said system so as to increase the speed of said basket; and means for improving the balanced distribution of the clothes for high speed rotation of said basket comprising means for sensing when the clothes are in substantially balanced distribution in said basket, and means for energizing said motor for a predetermined period in response to the sensing of a substantially balanced distribution by said sensing means whereby the speed of said basket is increased a predetermined increment during energization of said motor.

10. In a laundry machine, a clothes basket rotatable on a substantially non-vertical axis; multi-speed drive means rotatively engaging said basket, said drive means rotating said basket at a relatively low speed for tumbling clothes in said basket and at a relatively high speed for centrifugal extraction of liquid from the clothes; and means for improving the balanced distribution of the clothes for high speed rotation of said basket comprising means for sensing when the clothes are in substantially balanced distribution in said basket, first relay means including a first pair of contacts closed in response to sensing by said sensing means of a balanced condition, second relay means including a second pair of contacts closed for a predetermined brief period of time in response to closing of said first contacts, and speed increasing means operative when said second pair of contacts are closed, closing of said second pair of contacts for said predetermined period providing a predetermined increment of acceleration of said basket by said speed increasing means whereby said speed increasing means raises the basket speed a predetermined increment each time said sensing means determines there is substantially balanced distribution of the clothes.

No references cited.