

2,963,159

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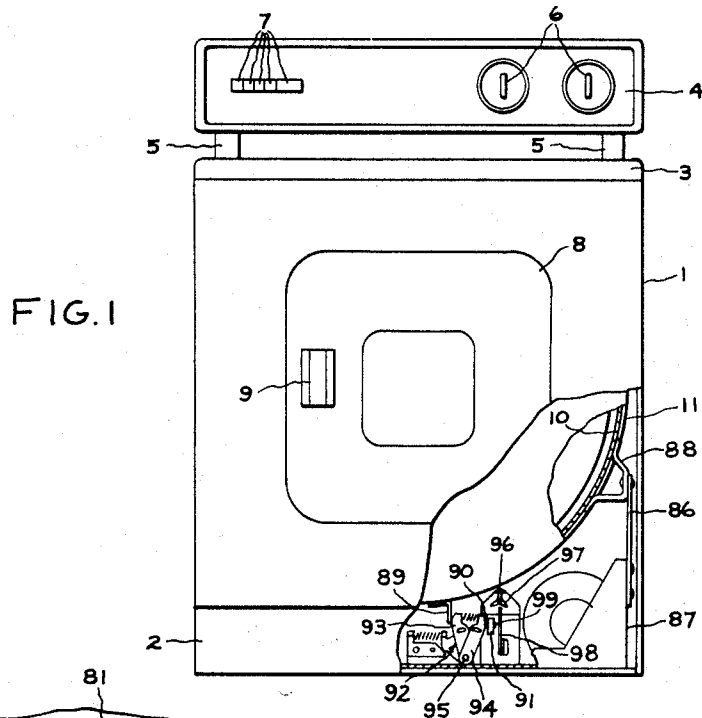


FIG. 1

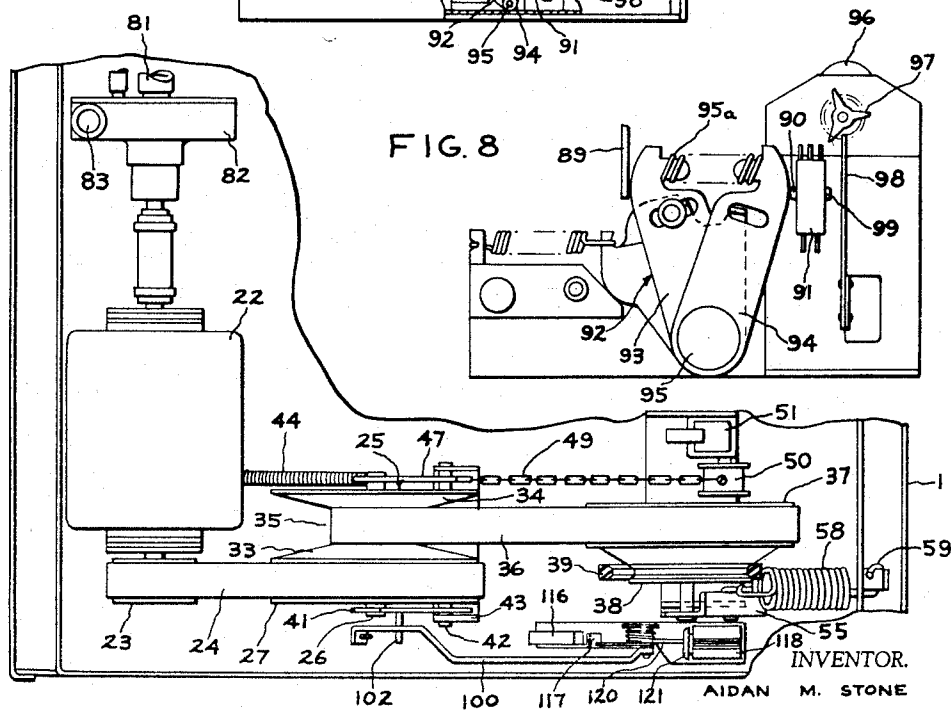


FIG. 8

FIG. 4

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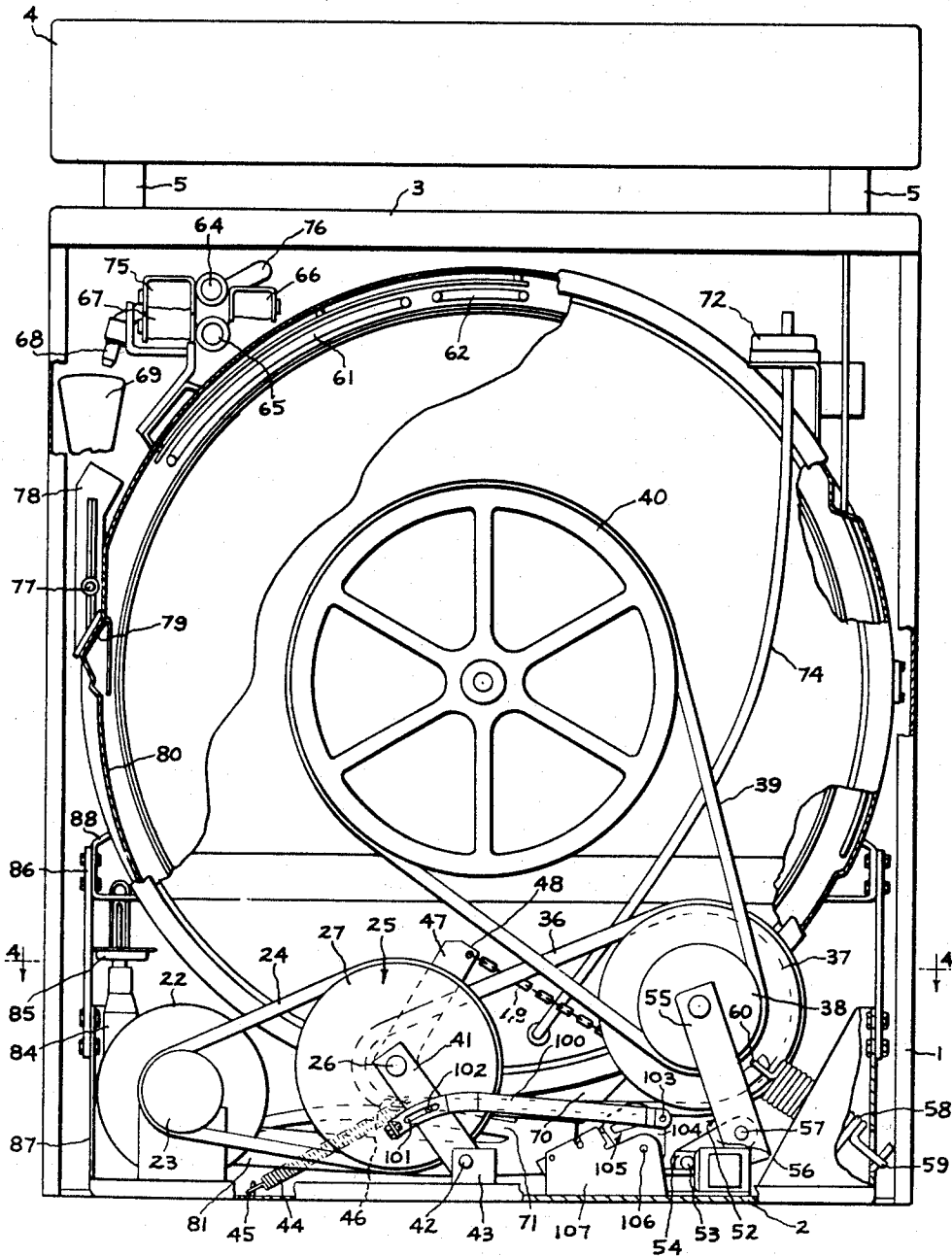
Dec. 6, 1960

A. M. STONE
LAUNDRY MACHINE

2,963,159

Filed Oct. 16, 1958

4 Sheets-Sheet 2



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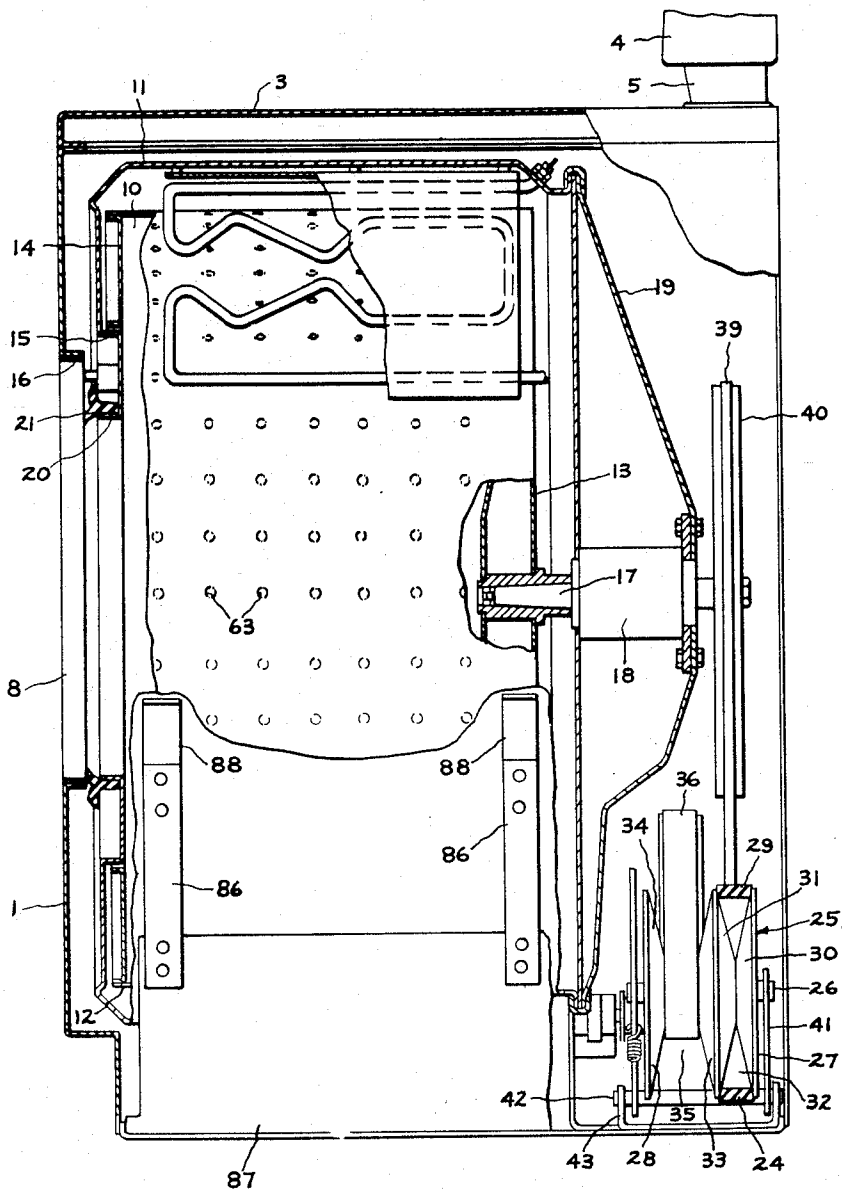
Dec. 6, 1960

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4 Sheets-Sheet 3



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FIG. 5

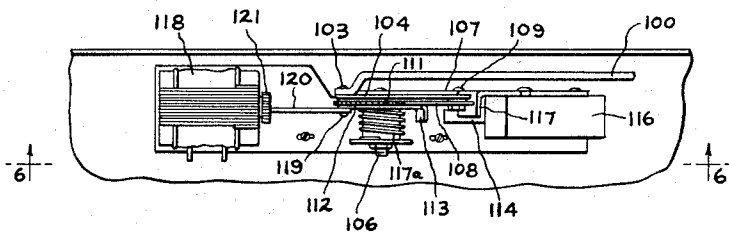


FIG. 6

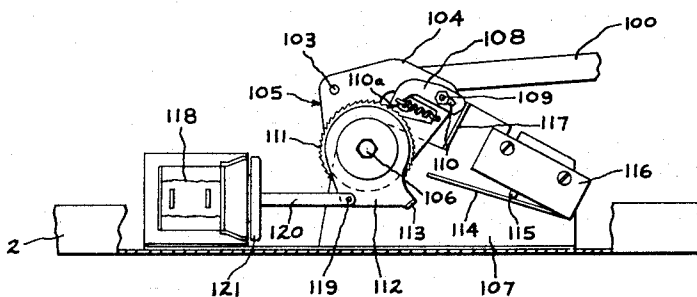
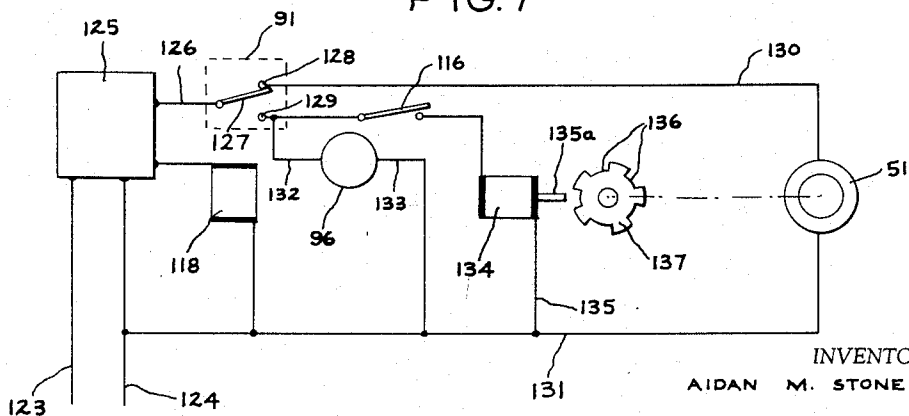


FIG. 7



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2,963,159

LAUNDRY MACHINE

Aidan M. Stone, Louisville, Ky., assignor to General Electric Company, a corporation of New York

Filed Oct. 16, 1958, Ser. No. 767,716

7 Claims. (Cl. 210—144)

This invention relates to laundry machines of the type which provide a centrifugal attraction of liquid from clothes, and more particularly to such machines which incorporate vibration sensitive arrangements for preventing operation at speeds capable of causing vibrations harmful to the machine.

Laundry machines of the type generally provided for domestic use frequently include a centrifugal extraction of liquid from washed clothes by rotating the clothes receptacle or basket at high speed. In most cases the washing of the clothes is provided in the same machine, using the same receptacle as that in which the clothes are contained during the centrifugal liquid extraction step. Such machines are generally of two main types: in washing machines of the type which provide a clothes basket rotatable on a vertical axis, there is generally provided some type of washing means movable independently of the basket positioned within the basket for the washing and rinsing operation, and the basket itself is rotated at high speed for the centrifugal liquid extraction; in the type of washing machine which provides the clothes basket rotatable on a non-vertical (usually horizontal) axis, the usual procedure is to effect the washing and rinsing operation by rotating the basket at an appropriate speed to make the clothes proceed in a tumbling pattern within the basket, and then rotating the basket at high speed to extract the liquid from the clothes. There are, of course, also those domestic laundry machines, generally of the non-vertical axis type, which combine the washing and centrifugal extraction steps with a heat drying step subsequent to the spin operation.

In machines which provide for washing and rinsing operations prior to the spin operation, and in those machines which provide a heat drying operation subsequent to the spin, the unbalances within the basket during such operations are so small as to be negligible. In vertical axis machines, there is normally no rotation of the basket at all during these operations, and in machines having a basket rotatable on a non-vertical axis the tumbling is generally conducted at speeds in the vicinity of 47 r.p.m. where the vibrations are small and harmless. However, in both types of machines, any unbalance present during the high speed centrifugal extraction operation tends to cause undesirable vibration of the machine and consequent strain on the various parts of the machine, as well as a possible "walking" of the machine, i.e., movement of the machine across the floor. This is particularly true where the basket is rotatable on a non-vertical axis, and, as is common, is supported in cantilever fashion at one end only.

To preclude the harm which may result from operation of the machine during the existence of the undesirable vibrations there is proposed, in application Serial Number 767,717 filed concurrently herewith by Aidan M. Stone and Joseph C. Worst and assigned to General Electric Company, owner of the present invention, an improved construction which insures some degree of cen-

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trifugal extraction regardless of continued poor distribution of the clothes. The joint invention of that application achieves this result by providing at least one intermediate speed below the normally provided centrifuging speed at which the transmission may operate, so that if the vibrations prove too severe to permit the regular centrifuging speed to be obtained then the centrifuging operation may be provided at an intermediate speed. The joint invention also contemplates that the centrifuging operation will be carried out at the intermediate speed only if a certain minimum speed has been reached; otherwise, a redistribution of the clothes and another attempt at maximum speed spin is made.

Since the joint invention, as set forth in the claims of the aforementioned application, I have discovered that it is desirable that the minimum speed at which an intermediate centrifuging speed becomes acceptable should be set relatively high, at least at the beginning of the operation. This is because, even where the clothes load is of the type which normally balances quite readily, it may occur that at the first attempt there will be an undesirable unbalance at a relatively low speed; in such a type of clothes load, it is very likely that a subsequent attempt would correct the situation and permit a much higher spin speed operation. However, if the intermediate speed spin has already been accepted, then the spin operation will be conducted at this speed, and although a substantial amount of liquid will be extracted from the clothes it will probably be below that which could have been expected if another redistribution attempt had been made.

I have also noted that the probability that a subsequent attempt will provide a substantial improvement decreases as the number of unsuccessful attempts increases. In other words, while a single unsuccessful attempt should not be taken to mean that a subsequent attempt will not give substantially improved balance, several unsuccessful attempts provide a much stronger suggestion that good balance will be difficult to attain.

In recognition of this situation, it is an object of my present invention to provide a minimum acceptable speed for the continued centrifuging operation which, at the beginning, will be as high or almost as high as the maximum speed which the machine is capable of providing, and which will be brought down gradually as the number of unsuccessful redistribution attempts increases; the decrease in the minimum acceptable speed is continued until it is so low that even a type of clothes load having very poor balance will be spun at a speed low enough to preclude harmful vibrations.

A more specific object of my present invention is to provide an improved laundry machine construction which provides for a spin operation at a maximum allowable speed after an acceptable minimum speed is reached, the clothes being redistributed if the unbalance is sensed below the acceptable minimum speed, wherein the minimum speed is decreased with each distribution attempt until finally it is below the level at which the unbalance switch closes. In this manner, I provide a machine which is highly discriminatory insofar as acceptable spin speed is concerned when the number of unsuccessful spin attempts is low, but which becomes decreasingly discriminatory as to the minimum spin speed as the continued lack of success of the redistribution attempts indicates that a high speed will probably not be readily attainable.

In accordance with the invention, I provide a laundry machine which includes a rotatable clothes basket, with drive means being provided for rotating the basket. Suitable control means are connected to the drive means so as to accelerate the basket toward a maximum centrifuging speed. I also provide means for sensing vibrations of the basket which result from unbalanced distribution of the

clothes therewithin. When the sensing means operates below a predetermined minimum speed, means are actuated for slowing the clothes basket down to redistribute the clothes therein and then attempt another spin operation. When the sensing means is operated above the predetermined speed, speed locking means are operated to stop acceleration of the basket and provide operation thereof at an intermediate centrifuging speed. To preclude premature acceptance of a relatively low speed, yet while also insuring acceptance of the low speed if the load should be a hard one to balance, I provide means for decreasing the predetermined minimum speed upon each decrease to tumble speed and redistribution. In other words, each unbalance which causes a speed decrease and redistribution also causes a decrease of the speed at which continued spin can take place upon a subsequent unbalance. In this manner, the standard for permitting continued spin is high to start with, but become increasingly less severe, with the certainty that eventually the minimum requirement will pass below the level at which the unbalance switch trips.

The subject matter which I regard as my invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. My invention itself, however, may best be understood by reference to the following description taken in conjunction with the accompanying drawings.

In the drawings,

Figure 1 is a front elevational view of a laundry machine, specifically a combination washer dryer, of the type which may incorporate my improved speed control arrangement;

Figure 2 is a rear elevational view of the combination washer dryer with the rear panel removed and with certain surfaces broken away to illustrate details;

Figure 3 is a side elevational view of the combination washer dryer, partly in section and with certain surfaces broken away to show details;

Figure 4 is a fragmentary view in cross section along line 4—4 in Figure 2, with the clothes basket and tub of the machine removed in order to illustrate details of the drive of the machine;

Figure 5 is an enlarged fragmentary plan view of a portion of the control mechanism shown in Figure 4;

Figure 6 is a view along line 6—6 in Figure 5;

Figure 7 is a schematic illustration depicting a circuit which incorporates our invention; and

Figure 8 is an enlarged front elevational view of the vibration sensing arrangement provided as a component of my inventive combination.

Referring now to Figures 1, 2 and 3 of the drawings, there is shown, by way of illustration, a combination clothes washing and drying machine. It will of course be understood that the invention is not restricted to this particular type of laundry machine; however, the invention finds particular application in this type of machine because it usually provided a clothes basket rotatable on a generally horizontal axis, and because the inclusion of components from both washing and drying machines puts space at a high premium, i.e., the clearances between operating parts are small and there is consequently only a small leeway for vibrations.

In the machine shown, the operating elements of the machine are included within an outer cabinet structure having a central wrap-around section 1. Section 1 is supported on a base and toe-board assembly 2 and carries a separate top 3 on which is supported a backsplash panel 4 which may, as shown, be mounted on posts 5. Control panel 4 is provided with appropriate control devices such as, for instance, dials 6 which may be provided for controlling various types of washing and drying sequences, and various drying temperatures, and such as buttons 7 which may control various other functions, such as water temperature, omission of dryer function, etc. Access to the interior of the machine is provided by a door 8 formed

in section 1, mounted on concealed hinges and opened by means of a latch control 9.

As best shown in Figure 3, the machine is of the horizontal type, that is, it has a substantially cylindrical clothes basket or receptacle 10 mounted for rotation on a generally horizontal axis within an outer enclosing tub structure 11. Basket 10 comprises a cylindrical shell or wall 12 which is closed at its rear end by means of a suitable wall or plate 13. The basket also includes a front wall 14 which is formed so as to define an access or loading opening 15 in registry with an opening 16 in wrap-around section 1 provided for door 8. The basket is rotatably supported by a shaft 17 which is mounted in an elongated bearing 18 supported from rear wall 19 of tub 11. The tub is also provided with an opening 20 aligned with opening 16 and opening 15 so that clothes may be placed into and removed from the basket when door 8 is opened. The door seals against a suitable gasket 21 during operation of the machine.

Referring now to Figures 2, 3 and 4, during the operation of the machine the basket 10 is driven from an electric motor 22. The drive from the motor to the basket includes a pulley 23 which is secured to the motor shaft so as to rotate therewith and over which passes a belt 24 driving an adjustable sheave assembly 25. The adjustable sheave assembly includes a shaft 26 to which are rigidly secured two sheave plates 27 and 28; an intermediate sheave plate 29 is keyed on shaft 26 so as to be movable along the shaft to varying distances from plates 27 and 28. It will be observed (Figure 3) that sheave plate 27 has a sloping surface 30 which, in cooperation with a sloping surface 31 on movable sheave plate 29, forms a groove 32 of adjustable width. Similarly, on its other side movable sheave plate 29 is provided with a sloping surface 33 which cooperates with a sloping surface 34 on rigidly secured sheave plate 28 to form a second groove 35 of adjustable width. Since belt 24 has a predetermined width, it can be seen that movement of sheave plate 29 relative to sheave plate 27 will cause the belt 24 to seat in groove 32 at a distance from the center of shaft 26 which is determined by the distance of sheave plate 29 from sheave plate 27. The linear speed of belt 24 is constant, assuming the speed of motor 22 to be substantially constant, and therefore the rotational speed of the adjustable sheave assembly 25 is dependent on the effective sheave diameter provided by the cooperation of sheave plates 27 and 29. When the sheave plates 29 and 27 are in the position shown in the figures, sheave assembly 25 is rotating at a relatively low speed. If sheave plate 29 is moved to the left as viewed in Figure 3, away from sheave plate 27, then belt 24 will move in radially toward shaft 26 as groove 32 widens, and will cause a greater rotational speed of the sheave assembly 25 for a given rotational speed of pulley 23 by motor 22.

A second belt 36 is driven in groove 35 by the sheave formed by the cooperation of sheave plates 29 and 28. When adjustable sheave plate 29 is in the position shown so that groove 35 is quite wide belt 36 has to move in radially toward shaft 26 a substantial amount before it seats on the surfaces 33 and 34 of sheave plates 29 and 28 respectively. This means that for a given rotational speed of the adjustable sheave assembly (as imparted to it by belt 24), belt 35 will be traveling at a relatively low rate of linear speed. If sheave plate 29 is moved to the left so that belt 36 is forced outwardly in groove 35, then for a given rotational speed of the sheave assembly a relatively high linear speed of belt 36 is provided. Thus, by controlling the position of sheave plate 29, an infinite variety of speed between the two limits of position of the sheave plates may be provided, with the arrangement shown in Figure 3 providing the lowest output speed to belt 36, since belt 24 is causing the lowest rate of rotation of sheave assembly 25, and since rotation of the sheave assembly 25 is causing the lowest linear speed of belt 36. The highest rate of speed will be provided as sheave

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plate 29 is moved as far as possible to provide the highest rotational speed of the assembly 25 for a given linear speed of belt 24, and the output linear speed of belt 36 is the highest possible for a given rotational speed of assembly 25.

Belt 36 passes over a sheave 37 which forms part of a unitary assembly with a sheave 38 which drives the belt 39. Referring now primarily to Figures 2 and 3, it will be seen that belt 39 drives a sheave or pulley 40 which is rigidly secured to the end of shaft 17 so as to rotate basket 10.

Returning now to the adjustable sheave assembly 25, and with particular reference to Figure 2, it will be observed that the assembly is mounted on an arm 41 which is pivotably secured on a pin 42 within a bracket 43 secured to the base 2 of the machine. A spring 44 has one end 45 secured to the machine base and has its other end 46 secured to an arm 47, also secured to assembly 25, so as to bias it to the left. At the outer end 48 of arm 47 there is secured a chain member 49. At its other end (Figure 4), chain member 49 is secured to a pulley 50 operated through a small electric motor and gear train assembly 51. It will be seen that when pulley 50 is caused to rotate by assembly 51 it will wind up chain 49, and through arm 47 pull the entire adjustable sheave assembly to the right. Since belt 24 cannot stretch it will be apparent that when this occurs belt 24 will move inwardly within groove 32 forcing sheave 29 to the left (as viewed in Figure 3) to effect an increase in the speed transmitted to pulley 40 and basket 10. When motor and gear train assembly 51 shut off, the spring 44 overcomes the motor and pulls the adjustable sheave 25 back to the position shown in the figures to reduce the speed.

The assembly of sheaves 37 and 38 is also movably mounted on a linkage arrangement 52 pivotably secured on a pin 53 mounted within a bracket 54 secured to the base. The linkage arrangement includes two arms 55 and 56 which are pivotably secured together through a pin 57. A spring 58 secured at one end 59 to the base 2 of the machine is secured at its other end 60 to the assembly of sheaves 37 and 38 so as to bias them downwardly and to the right as viewed in Figure 2 in order to effect a belt tensioning function for the belts 36 and 39.

The proportioning of the various parts of the drive assembly above described is such as to provide an appropriate range of speeds. For instance, when the parts are in their position shown, a tumbling speed of approximately 47 r.p.m. is provided to the basket 10 while in the other extreme position a centrifuging speed of approximately 350 r.p.m. is provided to the basket.

Machines of the type illustrated generally include appropriate means to heat the clothes during the drying portion of the cycle, and also to warm the wash water during the washing portion of the cycle when so desired. To effect this function, there is provided in the machine a heater assembly including two heaters 61 and 62. These heaters are mounted within the upper portion of tub 11 so that when energized they heat basket 10. The heating elements are preferably of the sheathed type in which a resistance wire is maintained in spaced relation with a sheath by a highly compressed granulated heat-conducting electrically-insulating compound such as magnesium oxide. When the heaters are energized during the washing cycle, they heat the water by first heating the basket; then, as the basket dips into the wash water at the bottom of the tub, it in turn heats the water. In other words, the rotating basket serves as an active heat transfer means between the heating element and the water or other washing liquid. When the heaters are energized during the drying cycle, the heat transferred to the clothes basket 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 63 (Figure 3) some of the heat from the heating elements passes directly to the clothes by radiation.

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The means whereby water is admitted to and discharged from the tub 11 during operation of the machine is particularly shown in Figure 2. The water supply means includes connections 64 and 65 through which hot and cold water is supplied to the machine for the washing operation. A valve controlled by a solenoid 66 admits hot water to the machine and a valve controlled by an opposed solenoid 67 admits cold water to the machine. The hot and cold water valves under the control of the solenoids 66 and 67 discharge through a common outlet conduit 68, through a suitable air gap, and then into a funnel 69 to a sump 70 formed at the bottom of tub 11. The connection may be made through a suitable conduit 71, a portion of which is shown adjacent the sump in Figure 2. The air gap provided by the funnel 69 makes it impossible for the water to be siphoned from the machine and to contaminate the incoming water supply line. A pressure actuated sensing device or water level control 72 controls both solenoids 66 and 67 to maintain the proper water level in the machine during the washing operation. Sensing device 72 is connected to the interior of tub 11 by a suitable line 74.

The illustrated machine is of the type which uses cold water during the drying cycle for condensing the moisture extracted from the clothes. The condenser water is admitted to the machine through an additional solenoid actuated valve controlled by a solenoid 75 which 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 a conduit 76. From this conduit the water flows through an appropriate air gap (not shown) and then through another conduit (not shown) to the inlet 77 of a vent trap 78 which is of the type commonly provided in connection with machines of this type in order to seal up the tub and basket from atmosphere during the heat drying of the clothes while leaving the tub vented to atmosphere at other times. An appropriate construction for trap 78 is, for instance, fully described and claimed in Patent 2,800,008—Raczynski, issued on July 23, 1957, and assigned to the General Electric Company, owner of the present invention. From the vent trap 78, the condenser water flows into the tub 11 through an opening 79 and flows in a thin sheet down the lower left wall 80 of the tub (Figure 2) so as to cool a substantial portion of the area of the side wall and provide 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 the sump 70 mounted at the bottom of the tub. A suitable discharge hose 81 leads from the sump to a motor driven drain pump 82 which may, as shown in Figure 4, be driven directly from motor 22 and which discharges through an outlet 83 to a conduit 84 (Figure 2) leading to a drain valve 85 controlled by an appropriate solenoid (not shown). Since pump 82 is continuously operated by motor 22, the draining of water from the sump 70 is controlled by the drain valve, draining occurring upon energization of the solenoid associated with the drain valve.

Referring now primarily to Figures 1 and 2, it will be observed that tub 11 is supported from base 2 by means of a plurality of brackets or arms 86 which are mounted on upstanding plates 87 fixedly attached to the base. Four of these arms are provided, two being secured to each side of the tub. The arms on the opposite sides of the tub are spaced apart so that the tub in effect is supported near its front and near its rear on each side thereof. Although the arms 86 can be secured directly to the wall of tub 11, preferably, and as shown, the arms 86 are attached thereto by means of suitable brackets 88. With the tub 11 supported in the manner shown, it is

able to vibrate sideways in a plane parallel to the front of the machine if the basket 10 should be unbalanced during a high speed rotation thereof. The arms 86 are relatively long compared to their width, and they flex so as to allow slight sideways vibration of the tub relative to the base 2. However, the arms are effective substantially to prevent vibration of the tub both from front to rear and in the vertical direction since they are not at all flexible in these directions.

Means are provided for sensing the amount of sideways vibration thereby to prevent that vibration from ever becoming great enough to damage the machine, or to cause it to move on the floor. The sensing means may be conventionally formed to include a depending bracket 89 secured to the tub 11 as shown in Figures 1 and 8. The bracket, being secured to the tub 11, and therefore to the moving system mounted on arms 86, is movable in response to vibrations caused by unbalances within the rotating basket 10. When the magnitude of vibration of bracket 89 reaches a predetermined level, the bracket causes actuation of a button 90 of a switch 91 to cause an appropriate control sequence as explained herebelow.

A suitable transmitting means, generally indicated at 92, is interposed between the bracket 89 and button 90 of switch 91. Motion transmitting means 92 includes an adjustable scissors arrangement in which a pair of movable members 93 and 94 are formed as arms pivotably mounted on a pin 95 which is mounted on the base 2. The one arm 93 of the scissors engages bracket 89 on tub 11 so as to be moved thereby, and the other arm 94 is actuated by arm 93 through a spring 95a so as to operate switch button 90 upon a sufficient movement of the tub. This motion transmitting construction is fully described and illustrated in Patent 2,832,208—Stone, issued on April 29, 1958, and assigned to the General Electric Company, owner of the present invention.

Actuation of button 90 causes energization of an auxiliary timer motor 96 (as will be further described, as to circuitry, in connection with Figure 7) which drives a star wheel 97 through suitable reduction gear means (not shown). The star wheel 97 rotates counterclockwise, as viewed in Figures 1 and 8, and is adapted to engage the upper end of a leaf spring 98 which is fixedly mounted at its lower end on the switch mounting bracket. As the start wheel 97 rotates, it bends the upper end of the leaf spring 98 to the right; this bending of the spring continues until such time as the spring is bent far enough for the engaging arm of the star wheel to slip over its top. At that time the spring snaps in the opposite direction, striking button 99 of switch 91 to cause de-energization of motor 96.

With the unbalance sensing arrangement described, when the predetermined magnitude of vibration is reached bracket 89 transmits its motion through scissors members 93 and 94 to actuate button 90 of switch 91. As will be more fully described herebelow in connection with the circuit of Figure 7, this de-energizes motor 51 so that spring 44 pulls adjustable sheave assembly 25 back to the position shown in the figures so that a redistribution of the clothes occurs at tumble speed. At the same time, as stated, auxiliary motor 96 is rotating star wheel 97 so that after an appropriate period, generally in the vicinity of 20 seconds, the star wheel will cause the spring member 98 to actuate button 99 of switch 91. In addition to de-energization of motor 96, this re-energizes motor 51 and thus the drive accelerates the basket once again towards maximum spin speed.

Referring now to Figures 2, 5 and 6, a linkage member 100 has at its outer end an elongated slot 101 into which extends a pin 102 formed as part of arm 41. With this connection, when adjustable sheave assembly 25 is moved to the right by energization of motor 51 pin 102 will, after a small amount of such movement, engage the end of slot 101 and start to push the member 100 to the right, as viewed in Figure 2 (to the left in Figure 6).

Linkage member 100 is pivotably secured by a pin 103 to a plate 104 of an assembly generally indicated at 105 which is pivotably mounted by a pin 106 to a bracket 107 secured to base 2. It will readily be seen that motion of link member 100 as described causes clockwise motion of assembly 105 about pin 106 as viewed in Figure 2 (counterclockwise as viewed in Figure 6).

A ratchet member 108 is slidably and pivotably mounted on member 104 by means of a pin 109 extending from member 104 through a slot 110 formed in the ratchet member 108. A spring 110a secured between the ratchet member 108 and member 104 biases the ratchet member down into engagement with a ratchet wheel 111. Ratchet wheel 111 has enough friction in sliding on member 104 to prevent relative motion except as actuated by the ratchet member 108. A member 112 having a switch actuating portion 113 is secured to move counterclockwise with ratchet wheel 111 as the assembly 105 is pivoted around. Actuating part 113 engages an arm member 114 which presses in the button 115 of a switch indicated generally at 116. In order for member 113 to cause depression of button 115 with the parts in the position shown, the sheave assembly 25 has to be moved substantially its full extent to the right (as viewed in Figure 2).

When the assembly 25 is in tumble speed position, the assembly 105 is so arranged that the end of the ratchet 108 comes into engagement with a flange 117 formed on bracket 107. Each time the assembly 105 returns completely to its tumble position, flange 117 causes the ratchet 108 to be pushed against the action of spring 110a, with pin 109 sliding in slot 110. Because of the engagement of the ratchet 108 with the teeth of the ratchet wheel, and because the length of slot 110 is such as to allow ratchet 108 to move slightly more than the width of one tooth, this causes the ratchet wheel to be pushed around the width of one ratchet tooth relative to member 104. A clutch arrangement 117a secures member 112 to ratchet wheel 111 for counterclockwise movement of the ratchet wheel so that the movement of the wheel by 108 carries member 112 with it.

This then has the result of moving actuating member 113 around toward member 114 a little, so that the assembly 105 does not have to rotate as much in a counterclockwise direction (as viewed in Figure 6) the next time before the switch button 115 is depressed. In other words, every time there is an attempt at spin speed so that sheave assembly 25 causes link member 100 to rotate assembly 105 about pin 106, and the attempt fails because of unbalances so that the assembly is returned to its tumble position, ratchet 108 moves wheel 111 around one tooth and consequently member 113 has to travel that much less before there is actuation of button 115.

A solenoid member, generally indicated at 118, is mounted on the base 2 and is pivotably connected by a pin 119 and extending arm 120, which are secured to movable core 121, to the member 112 carrying switch actuator 113. When the solenoid is not energized, it, of course, has no effect on the operation of link member 100 and assembly 105, i.e., assembly 105 is completely under the control of link member 100. When the solenoid 118 is energized, it snaps the solenoid plunger 121 back into the solenoid, pulling with it arm 120. This exerts a clockwise pull on member 112; due to the action of friction clutch 117a, member 112 is then rotated relative to ratchet wheel 111 back to its starting position as shown in Figure 6. Ratchet wheel 111 is prevented from moving at this time as a result of the engagement of the teeth thereof with ratchet 108.

Having now explained the operation of the drive means of the machine, the operation of the vibration sensing mechanism, and the operation of the mechanism of Figures 5 and 6, I will now describe the operation of the entire vibration controlling system, referring to Figure

7. Power is supplied to the components of the machine through a pair of conductors 123 and 124 which are connected in the usual manner across an appropriate source of alternating current power. Conductors 123 and 124 energize the components through a control 125 which may be of the conventional type, as well known in the art. It will be understood that control 125, in addition to performing the functions specifically described in Figure 7, is also normally arranged to control the other electrical components of the machine including, for instance, motor 22, solenoids 66, 67 and 75, heating elements 61 and 62, etc. However, the connection and control of these components by control 125 has been omitted to retain as much clarity as possible in the specific features contributing to the applicant's invention. From control 125, a conductor 126 extends to switch 91 described in connection with the unbalance sensing arrangement of Figures 1 and 8. After the button 99 of switch 91 has been depressed, switch arm 127 of the switch is in the position shown, that is, in engagement with conductor 128. When the button 90 of switch 91 is actuated, switch arm 127 moves down to a position where it engages contact 129. When the switch arm 127 engages contact 128, an energizing circuit is completed through conductor 120 to motor 51 to cause acceleration of the basket by movement of sheave assembly 25 to the right as viewed in Figure 2. The circuit for motor 51 is completed back to conductor 124 through a conductor 131. When switch arm 127 moves down into engagement with contact 129 (see Figure 6) a circuit is completed through a conductor 132, auxiliary timer motor 96 (Figure 1) and conductor 133, back to conductors 131 and 124. Switch 116 is in series with a solenoid 134 and a conductor 135, so that when the switch is open the solenoid coil is de-energized.

The operation of motor 96 causes the de-energization of motor 51 to continue for a predetermined amount of time, generally on the order of 20 seconds, and then causes switch arm 127 to be moved back into engagement with contact 128. Thus, in effect, what occurs is that after the appropriate washing, rinsing and draining operation, when the machine control 125 designates that the time is appropriate for spin, a circuit is completed through control 125 to cause energization of auxiliary motor 51 to accelerate the basket. If the unbalance sensing means indicates that the vibrations are excessive at any time, switch arm 127 is moved from the position shown into engagement with contact 129. With switch 116 open, this provides, under control of motor 96, a period of redistribution and then again energizes motor 51 for another attempt at spin speed. The open position of switch 116 to start with is insured by causing the solenoid 118 to be energized prior to each spin operation; as explained in connection with Figure 6, this energization of solenoid 118 returns the member 112 to a position where actuator 113 has a maximum distance to travel before switch 116 is closed. That is, switch 116 does not become closed until approximately the maximum spin speed provided by the machine. At all other times the solenoid 118 is de-energized, its sole function being to return the actuating member 113 to its initial position for the commencement of each spin cycle.

Each time there is an unbalance sufficient to cause a de-energization of motor 51, redistribution of the clothes, and another attempt at high speed spin, the assembly 105 (Figure 6) has been moved counterclockwise and then returned to its previous position to cause rotation of ratchet wheel 111 by ratchet 108. Thus, each attempt at redistribution causes actuator 113 to move closer to member 114 so that less travel of sheave assembly 125 is necessary before the switch 116 is closed. In other words, the larger the number of unsuccessful redistribution attempts, the lower the speed at which the switch 116 closes. In fact, after a predetermined number of attempts, the switch will be closed as soon as

assembly 25 moves sufficiently to effect, through linkage member 100, any movement of actuator 113. Thus, the mechanism of Figures 5 and 6 is in effect a counting device, providing certain closing of switch 116 after a predetermined number of balancing attempts.

When switch 116 finally closes, movement of switch arm 127 to engage contact 129 energizes the solenoid 134. Energization of solenoid 134 causes a plunger member 135a to move down into one of the recessed portions 136 of a cam member 137 which is directly connected to the shaft of motor 51; engagement of plunger 135a in a recess 136 of cam 137 locks the motor 51 in a predetermined position so that neither energization of the motor 51 nor operation of spring 44 can change the speed. In other words, the speed is precluded from further variation until motor 96 causes arm 127 to return to contact 128, de-energizing solenoid 134. If the unbalance condition has improved because of extraction of water, motor 51 will again increase the spin speed, otherwise the unbalance switch will immediately again be tripped to re-energize motor 96 and solenoid 134. Thus, the spin operation is carried out, under such circumstances, at the reduced speed determined by solenoid 134, throughout the period allotted by timer 125 for the spin operation, unless the unbalance decreases; in this event, the speed increases until energization of solenoid 134 causes cam 137 to be locked at a new position corresponding to a higher spin speed.

Thus, to summarize, if the balance of the clothes load is such that maximum spin speed is permissible, motor 51 will move sheave assembly 25 over to its farthest extent to accelerate the basket to the maximum speed which is provided by the machine. However, if before maximum spin speed is reached, there is an unbalance sufficient to cause a slowing back to tumble and redistribution, the member 113 (Figure 6) is moved to an extent where a little less than maximum speed on the next attempt will cause closing of switch 116 and, therefore, a complete centrifuging operation at a speed between that at which the switch closes and maximum speed, depending upon the instant when the unbalance switch trips after switch 116 closes. If, however, the unbalance switch should again trip before switch 116 closes, there will be a redistribution and another adjustment of member 113 to decrease the minimum permissible centrifuging speed still further.

Thus, an indication that the clothes load is not of the easiest kind to balance, by the requirement for a first slowing and redistribution, is used to provide a decrease in the minimum speed at which the spin operation may be conducted. A second operation of the unbalance mechanism will decrease the minimum permissible spin speed a like amount further, and so on until the speed is finally decreased to the extent where, even though the type of clothes load may be one where the unbalance is continually severe, a spin operation will be provided at the maximum speed which is possible without causing damage to the machine, or "walking" of the machine. In the extreme case, this will occur only when the number of unbalance trips has been such as to actually close switch 116 as soon as assembly 25 accelerates into the spin range, i.e., the mechanism of Figures 5 and 6, in addition to its function of gradually decreasing the minimum acceptable speed, will in such a case also have performed a counting function as well, ensuring spin after a predetermined maximum number of unsuccessful attempts.

The concept and structure providing for an intermediate speed spin when the vibrations would be harmful at full speed, and the concept and basic structure for providing a predetermined minimum speed before ensuring spin action at the maximum safe speed constitute the joint invention of Aidan M. Stone and Joseph C. Worst and are claimed in copending application Serial Number 767,717 filed concurrently herewith.

My invention, as claimed in this application, lies in the

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concept and structure provided as described herein for progressively lowering the minimum permissible spin speed in response to each unsuccessful spin attempt.

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

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

1. A laundry machine including a rotatable clothes basket, drive means for rotating said basket, drive accelerating means arranged to accelerate said basket toward a maximum centrifuging speed, means responsive to vibrations of said basket resulting from unbalanced distribution of the clothes therewithin, means operated by said responsive means when a predetermined magnitude of vibration is sensed below a predetermined minimum speed for slowing said drive means to effect redistribution of the clothes in said basket and for providing a subsequent acceleration by said drive accelerating means, speed locking means operated by said responsive means when said predetermined magnitude of vibration is sensed at a speed above said predetermined minimum for stopping acceleration of said basket and providing operation thereof at an intermediate centrifuging speed, speed responsive means for making said speed locking means operable when said predetermined minimum speed is reached, and means for decreasing said predetermined minimum speed upon each decrease to redistribution speed, whereby each unbalance causing a speed decrease and redistribution also causes a decrease of the minimum speed at which a continued centrifuging operation can take place upon a subsequent unbalance.

2. A laundry machine including a rotatable clothes basket, drive means for rotating said basket, drive accelerating means arranged to accelerate said basket toward a maximum centrifuging speed, means responsive to vibrations of said basket resulting from unbalanced distribution of the clothes therewithin, means operated by said responsive means when a predetermined magnitude of vibration is sensed below a predetermined minimum speed for slowing said drive means to effect redistribution of the clothes in said basket and for providing a subsequent acceleration, speed locking means operated by said responsive means when said predetermined magnitude of vibration is sensed at a speed above said predetermined minimum for stopping acceleration of said basket and providing operation thereof at the speed at which vibrations of said predetermined magnitude were sensed, and means for decreasing the minimum speed each time the slowing of said basket and a redistribution of the clothes are provided comprising a switch having a first position in which said speed locking means are not operable and a second position in which said speed locking means are operable, a switch actuating member operative upon engagement with said switch to move said switch from said first position thereof to said second position thereof, said switch actuating member moving toward said switch as said accelerating means increases the basket speed, and means for moving said switch actuating member slightly toward said switch upon each slowing of said basket and redistribution of clothes thereby to decrease the distance said switch actuating member has to travel before closing said switch upon a subsequent unbalance.

3. The apparatus defined in claim 2 wherein said means for moving said switch actuating member toward said switch upon each slowing and redistribution operation comprise a rotatably secured ratchet wheel, said switch actuating member being secured to move with said ratchet wheel, a ratchet secured to maintain said

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ratchet wheel in a predetermined position, and means for moving said ratchet when said drive means returns said basket to tumble speed so as to rotate said ratchet wheel a predetermined amount, said ratchet wheel as it rotates carrying with it said switch actuating member and moving said switch actuating member toward said switch.

4. The apparatus defined in claim 3 wherein means are provided for returning said switch actuating member to its original position relative to said ratchet after the completion of a spin operation and prior to the commencement of a subsequent spin operation.

5. The apparatus defined in claim 2 wherein said drive means includes a variable speed belt drive comprising a belt and a pair of rotatable sheave plates forming a belt-receiving groove between them, said sheave plates being axially movable relative to each other thereby to vary the distance from the center of rotation thereof at which said belt seats in said groove thereby to vary the output speed of said belt, said drive accelerating means comprising means for moving said sheave plates relative to each other to increase the output speed of said belt.

6. A laundry machine including a rotatable clothes basket, drive means for rotating said basket including a variable speed belt drive comprising a belt and a pair of rotatable sheave plates forming a belt receiving groove between them, said sheave plates being axially movable relative to each other thereby to vary the distance from the center of rotation thereof at which said belt seats in said groove so as to vary the output speed of said belt, and means for accelerating said basket through said variable speed belt drive comprising an electric motor secured to effect relative axial movement of said sheave plates, means responsive to vibrations of said basket resulting from unbalanced distribution of the clothes therewithin, means operated by said responsive means when a predetermined magnitude of vibration is sensed below a predetermined minimum speed for slowing rotation of said basket to effect redistribution of the clothes and for providing a subsequent acceleration, speed locking means operated by said responsive means when said predetermined magnitude of vibration is sensed at a speed above said predetermined minimum for stopping acceleration of said basket and providing operation thereof at the speed at which vibrations of a predetermined magnitude were sensed, said speed locking means comprising cam means secured to said motor and having a plurality of recesses, and an electrically operated cam follower operative when seated in one of said recesses to lock said motor to provide a constant basket speed by locking said sheave plates in a predetermined axial relation, and means for decreasing the minimum speed each time the slowing of said basket and a redistribution of the clothes are provided comprising a switch having a first position in which said speed locking means are not operable and second position in which said speed locking means are operable, a switch actuating member operative upon engagement with said switch to move said switch from said first position thereof to said second position thereof, said switch actuating member being movable toward said switch as said sheave plates move relative to each other to accelerate said basket, and means for moving said actuating means slightly towards said switch upon each slowing of said basket and redistribution of clothes thereby to decrease the distance said switch actuating member has to travel before closing said switch upon a subsequent unbalance.

7. A laundry machine including a rotatable clothes basket, drive means for rotating said basket, drive accelerating means arranged to accelerate said basket toward a maximum centrifuging speed, means responsive to vibrations of said basket resulting from unbalanced distribution of the clothes therewithin, means operated by said responsive means when a predetermined magni-

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tude of vibration is sensed for slowing said drive means to effect redistribution of the clothes in said basket and for providing a subsequent acceleration, speed locking means operated by said responsive means when said predetermined magnitude of vibration is sensed at a speed above a predetermined minimum speed for stopping acceleration of said basket and providing operation thereof at the speed at which vibration at said predetermined magnitude was sensed, said speed locking means being effected to eliminate the slowing function of said redistribution and acceleration means above said predetermined speed without affecting the subsequent acceleration function thereof, and means for decreasing the minimum speed each time the slowing of said basket and the redistribution of the clothes are provided comprising a switch having a first position in which said speed locking means are not operable and a second position in which said speed locking means are operable,

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a switch actuating member operative upon engagement with said switch to move said switch from said first position thereof to said second position thereof, said switch actuating member moving toward said switch as said accelerating means increases the basket speed, and means for moving said switch actuating member slightly toward said switch upon each slowing of said basket and redistribution of clothes thereby to decrease the distance said switch actuating member has to travel before closing said switch upon a subsequent unbalance.

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