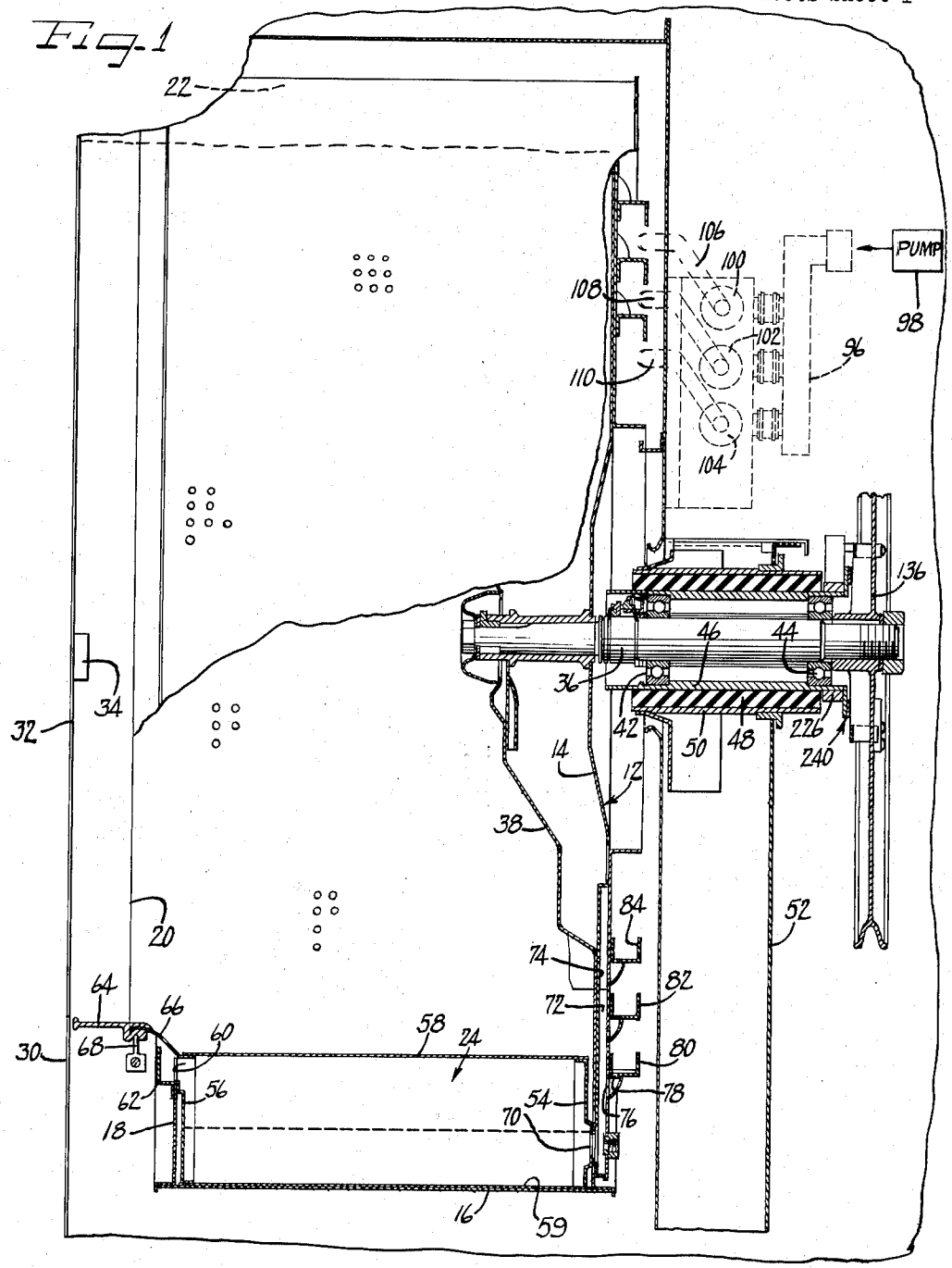
Feb. 15, 1966 W. K. COMPANS 3,235,082

LAUNDRY MACHINE AND METHOD

Original Filed Aug. 14, 1957 7 Sheets-Sheet 1

Fig. 1



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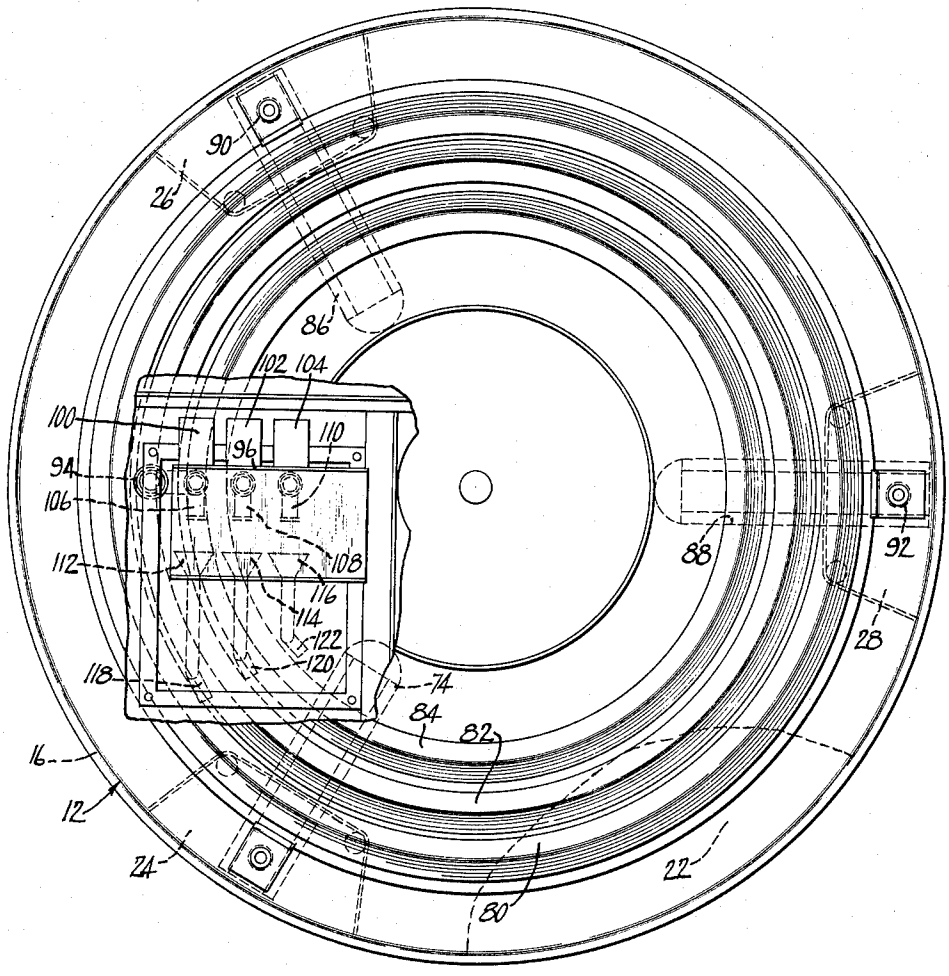
by Hill, Sherman, Meroni, Gross & Simpson Attys

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LAUNDRY MACHINE AND METHOD

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Fig. 2



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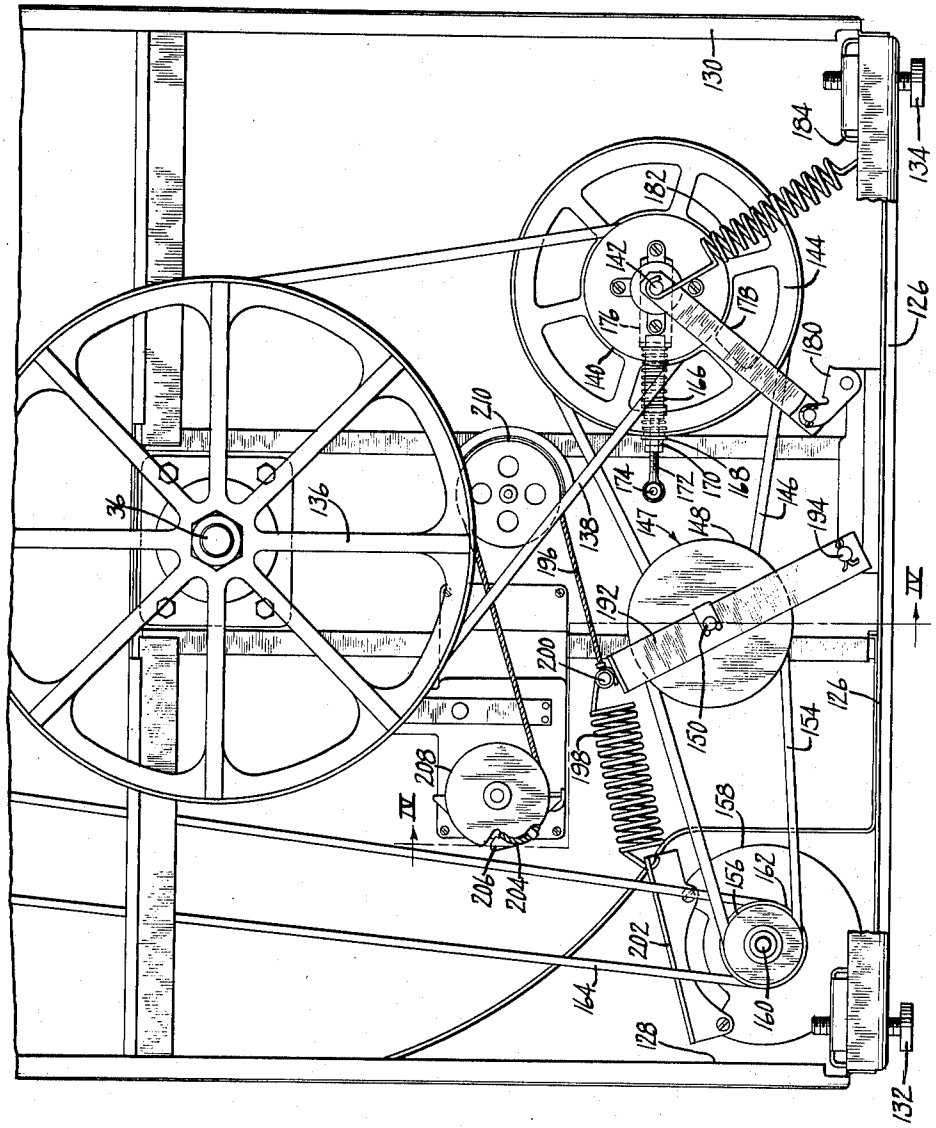
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LAUNDRY MACHINE AND METHOD

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Fig. 3



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LAUNDRY MACHINE AND METHOD

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Fig. 4

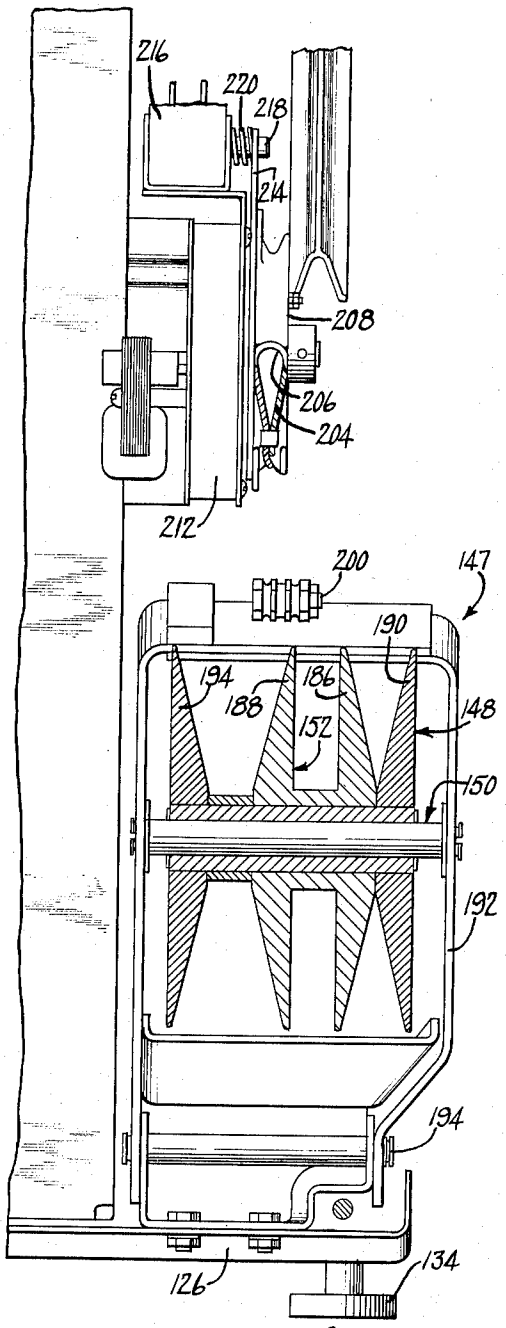
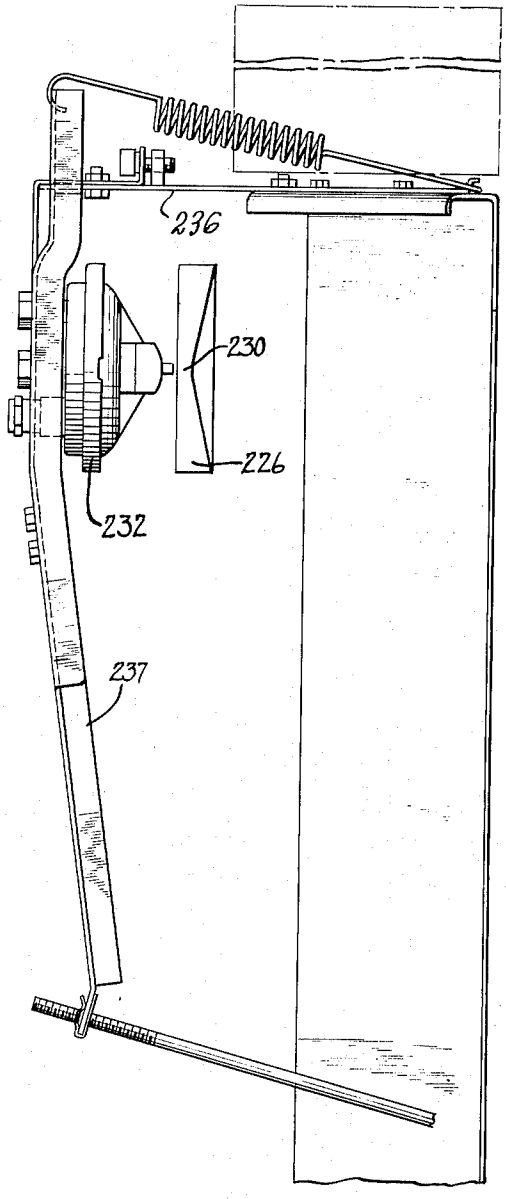


Fig. 6



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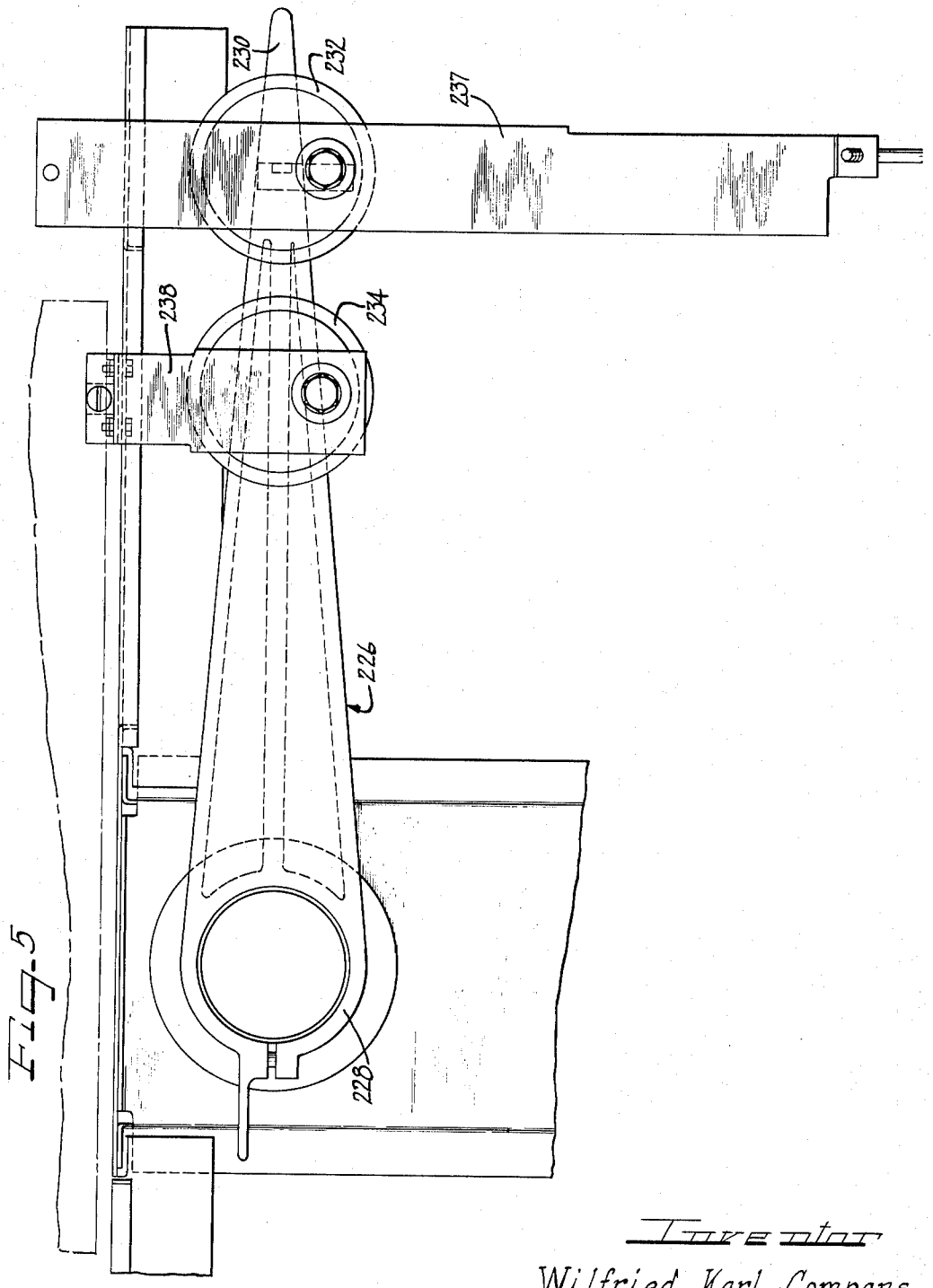


Fig. 5

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LAUNDRY MACHINE AND METHOD

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Fig. 7

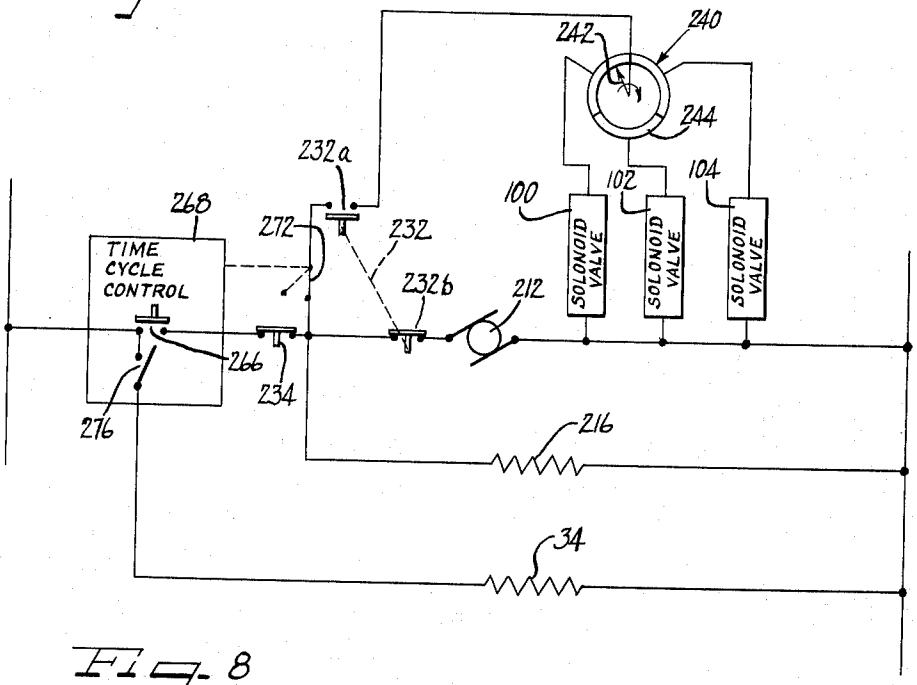
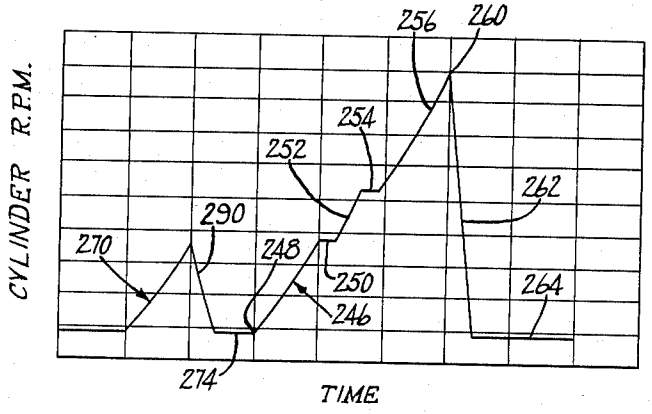


Fig. 8



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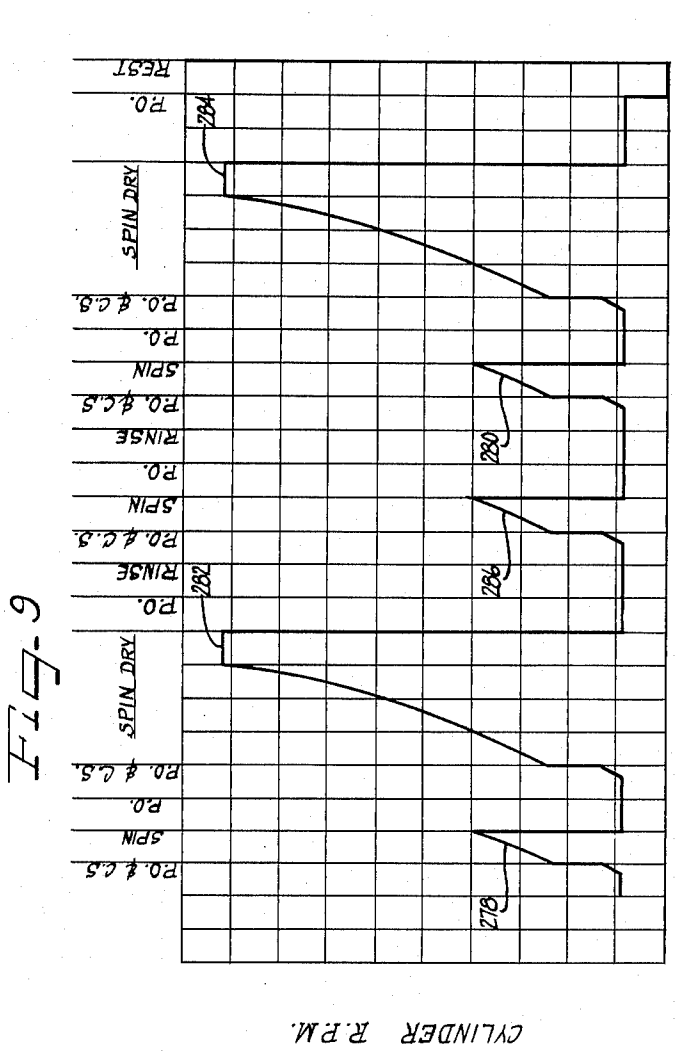
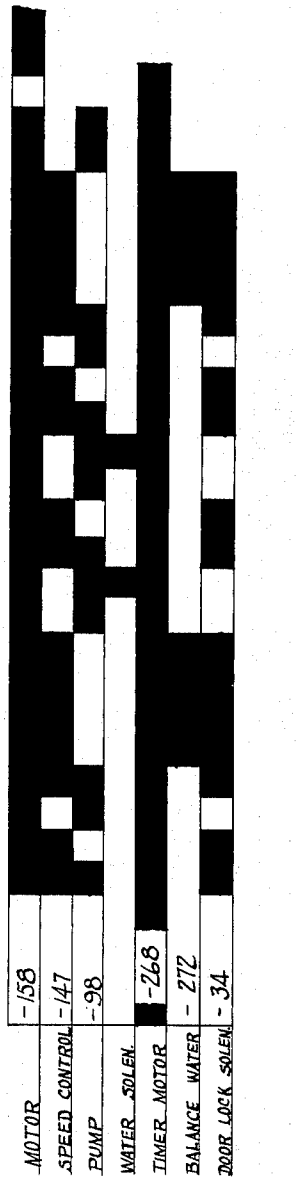


Fig. 9



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United States Patent Office 3,235,082 Patented Feb. 15, 1966

3,235,082

LAUNDRY MACHINE AND METHOD

Wilfried Karl Compans, St. Joseph, Mich., assignor to Whirlpool Corporation, St. Joseph, Mich., a corporation of Delaware

Continuation of application Ser. No. 678,224, Aug. 14, 1957. This application Apr. 23, 1962, Ser. No. 192,021
16 Claims. (Cl. 210—78)

This application is a continuation of my copending application Serial No. 678,224 filed August 14, 1957, now abandoned.

The present invention relates to improvements in laundering machines and more particularly to an improved balancing device and method for automatically correcting unbalance in rotors such as laundering machine containers which are spun at high speeds to centrifugally extract fluid from laundered articles.

Centrifugal extraction is a commonly used expedient in laundering machines, and especially in automatic home laundering machines for the extraction of washing fluid from the laundered articles after the washing and rinsing periods. At the termination of a laundering operation, the laundering container is spun at a high speed, preferably without manually arranging the clothes and articles being washed to obtain balancing. Even if an attempt is made to distribute the laundered articles within the container, a dynamic balance of the container is difficult to achieve.

A relatively high spinning speed is used for centrifugal extraction of laundering fluid from the articles for a drying operation and the wet articles have a considerable weight. It is, therefore, imperative that the container with the articles therein be balanced to prevent an excessive vibration and movement of the appliance across the floor. If any substantial unbalance is present, correction of this unbalance is necessary before the machine reaches operating speed. This is frequently difficult, inasmuch as the location of unbalance and amount of unbalance varies for each load and for each spin cycle in a complete cycle of operation. The amount of unbalance changes as fluid is being extracted from the articles.

It is, therefore, an objective of the present invention to provide an improved method and apparatus for reducing dynamic unbalance in rotors such as laundy container to permit rotation at high speed without excessive vibration and shaking of the machine.

It is a further object of the invention to provide an improved method and apparatus for balancing laundry machine containers wherein the unbalance caused by the volume of washing liquid which will be extracted in the early stages of rotation is taken into consideration so as to avoid applying improper corrective masses, and correction is made only for the unbalance of the articles less the bulk of extracted liquid.

Another object of the invention is to provide a method and apparatus for applying balancing masses to a rotating laundry container as unbalanced forces are detected, and wherein excessive vibration is not generated due to rotational speed before the corrective masses are applied.

A further object of the invention is to provide an apparatus and method for the balancing of the containers for drying laundered articles wherein the excessive fluid in the articles is first removed before applying corrective counter balancing masses.

A still further object of the invention is to provide an apparatus and method wherein balancing masses are applied to a rotating laundering container while the container is accelerating to the operational speed, the acceleration interrupted, and additional balancing masses applied to the container.

A still further object of the invention is to provide an apparatus and method for the balancing of a laundry drying container wherein the speed of rotation of the container is rapidly returned to tumbling speed when an excessive condition of unbalance occurs.

A further object of the invention is to provide improved mechanism which will act to automatically correct unbalance in a rotating laundry container and which is well adapted to use with an automatically controlled laundry machine which performs its washing, rinsing and drying operations in a predetermined controlled time sequence.

Other objects and advantages will become more apparent in connection with the teaching of the principles of the invention in the disclosure of the preferred embodiments thereof in the specification, claims and drawings, in which:

FIGURE 1 is a vertical sectional view taken through a laundry machine drum embodying apparatus for balancing the drum with parts removed for clarity;

FIGURE 2 is a rear elevational view of the laundry drum of FIGURE 1 with parts of the drive mechanism removed;

FIGURE 3 is a rear elevational view of the laundry drum illustrating the drive mechanism to be used for rotating the drum;

FIGURE 4 is a vertical sectional view taken along line IV—IV of FIGURE 3 with parts removed for better illustrating certain features of construction;

FIGURE 5 is a detailed fragmentary elevational view taken from the back of the machine illustrating part of the unbalance detection mechanism;

FIGURE 6 is a detailed fragmentary side elevational view illustrating the unbalance detection mechanism of FIGURE 5;

FIGURE 7 is a diagrammatic presentation of the electrical circuitry used for detecting and correcting the unbalance of the laundry container;

FIGURE 8 is a graph illustrating operation of the machine during an unbalance correction period with the speed of rotation of the cylinder plotted against time; and,

FIGURE 9 is a graph illustrating the rotation of the cylinder against the full time of operation with a chart located beneath the graph and corresponded to it in time to illustrate the function of various operational machine elements over the period of operation of the machine.

FIGURES 1 through 6 illustrate apparatus which is utilized in the method of correction of unbalance in a laundry container employing the principles and method of the present invention. It will be recognized by those skilled in the art that apparatus of various types may be used in the detection of the location and amount of the unbalance forces and the actual correction of unbalance. The present invention utilizes this apparatus in a unique manner and in combination with apparatus for an improved mechanism and method for correcting unbalance. In FIGURES 7 through 9 the electrical circuitry used in the control mechanism is illustrated as well as the operation of the machine to teach the arrangement of the preferred embodiments and the principles of the invention.

As shown in FIGURES 1 through 4, apparatus for detecting the amount and location of unbalance and applying a corrective force are illustrated employed in combination with a laundry machine which is preferably of the automatic type. In the machine, the functions of the machine, as well as the unbalance detection and correction apparatus are controlled by a presettable sequential time cycle control which automatically causes the machine to proceed through its program of operations with each of the operational elements performing its function at a predetermined time and for a predetermined period of time in accordance with the method of the present invention.

The laundering machine is illustrated in FIGURES 1 through 4 as having a drum 12 which is rotatable about a horizontal axis. The drum is provided with a rear wall 14 which is joined at its outer peripheral edge to a wrap-around cylindrical outer wall 16. The front end of the drum 12 is formed by an annular wall 18 which is secured at its outer peripheral edge to the front end of the cylindrical outer wrap-around wall 16 and which has an outwardly extending flange 66 provided with a circular opening 20 at the front end for the insertion and removal of articles such as clothes 22, which are laundered within the drum. It will be understood that the drum is preferably adapted for laundering clothes and the space within the drum defines a laundering zone wherein the functions of washing, rinsing and drying are performed, although the drum may be used for drying alone. It will be apparent that these washing and rinsing functions are performed with the aid of auxiliary elements for supplying the washing fluid, for agitating the fluid and the like. These elements are not shown in detail for purposes of simplicity of the drawings. While the drum is illustrated as rotating about a horizontal axis, it will be understood that laundering containers of different sizes and shapes and operating in different positions may be utilized adapting the principles of the invention to maintain the container in balance for high speed rotation.

Rotation of the container or drum 12 is employed for the drying function wherein the drum 12 is rotated at a relatively high speed for centrifugally extracting the washing liquid from the clothes 22. In order to provide for the escape of washing fluid which is removed from the clothes 22, the outer wall 16 of the drum is preferably perforated with openings (not shown), in locations intermediate of the balancing fluid-containing compartments 24, 26 and 28, FIGURES 1 and 2. To catch the laundering fluid as it is thrown outwardly from the drum 12 through the perforations, a surrounding tub or water container is provided with a suitable outlet leading to a drain.

The overall machine is preferably of the automatic type and is housed within a cabinet, not shown, upon which is mounted a control for a sequential time control of the cycle of operations, which may be manually presettable to start the machine through its sequence of events.

In a machine of the type illustrated, a drum 12 is utilized for containing the clothes 22 for the washing, rinsing and drying functions and may be of the type that is known as a combination machine. The cabinet will enclose the entire working mechanism and a portion of a front wall 30 of the cabinet is shown in FIGURE 1. The front wall is provided with a door 32 which opens to provide access through the front opening 20 of the drum. The door is illustrated as preferably provided with an automatic electrically operated latch 34 which prevents accidental opening of the door at high speeds and the control for the latch 34 will be described in connection with the circuit diagrams of FIGURES 7 and 8. The drum 12 is rotatable on its horizontal axis through a range of speeds which are controllable by the sequential time cycle control mechanism. One basic speed is a tumbling speed during which time the articles of clothing 22 will tumble from the maximum height within the drum 12 to the base of the drum. Another speed will be full spin-drying speed, also referred to herein as operating speed, wherein the articles remain in one place against the outer wall 16 of the drum, held there by centrifugal force. At this speed, the moisture or laundering fluid is spun from the clothes and forced therefrom by centrifugal force.

The drum is rotatably supported on a cantilever shaft 36 rigidly secured to the center of the rear wall 14. An inner wall 38 is spaced from the rear wall 14 to lend rigidity to the connection between the drum and the shaft and for aiding in supporting the weight of the drum which must support the clothes.

The shaft is supported by spaced bearings 42 and 44 which are carried in a non-rotatable sleeve 46. The bearing sleeve 46 is completely suspended in a resilient material such as rubber 48, which extends annularly around the sleeve and is carried within a hollow hub 50. This permits unbalance vibration or oscillation of the sleeve 46 and of the shaft 36 and its supported drum 12. This vibration is detected for purposes of correcting the unbalance and applying corrective balancing masses.

The hub 50 which supports resilient rubber carrier 48 for the bearing sleeve 46, is mounted on the frame at the machine as shown in part as represented by rear supporting frame work 52.

Still referring to FIGURES 1 and 2, the balancing mechanism for applying corrective balancing masses will be described. The balancing liquid compartments 24, 26 and 28 are shown as extending across the outer circumferential wall 16 of the drum with each compartment having individual end walls 54 and 56 with an inner wall 58 and an outer wall 59. Liquid such as water, is filled into a selected compartment or compartments in an amount to counterbalance unbalanced masses. For example, in FIGURE 2, the articles of clothing 22 lie in a group between the compartments 24 and 28. To counterbalance this weight, liquid is filled into the balancing compartment 26 to counterbalance the weight of the clothing 22 and bring the drum into balance. If the clothes 22 are weighted so that complete filling of compartment 26 will supply an insufficient corrective force, the speed then attained is the maximum allowed and further acceleration is stopped.

During the rotation of the drum 12, at speeds above tumbling speed, the fluid in the compartments will be centrifugally held against the outer wall 59 of the compartments. When the drum is slowed down to a tumbling speed, the fluid will flow against the inner wall 58 of the compartment while it rotates through the upper portion. The fluid escapes through the compartment outlet port 60, as shown for the compartment 24. A shield 62 forming a drain cup is positioned over the outlet port 60. A cylinder flange collar 64 is secured to the flange 66 around the opening 20 in the front wall 18 of the cylinder and held in place by a clamp ring 68. This collar 64 and clamp ring 68 form a channel with front wall 18 to guide the water into the sump and prevent contact with the interior of the cylinder 12 and wetting the spun dry clothing load.

Balancing fluid or water is admitted to the compartments during rotation of the drum 12. The water enters through a compartment inlet port 70 in the end wall 54 of the compartment. The water flows to the inlet port 70 through a passageway 72 formed between the rear wall 14 of the drum and an elongated channel-shaped baffle wall 74 secured to the inner surface of the rear wall to provide the passageway. Water enters the passageway 72 through a port 76 in the rear wall 14 of the drum which communicates with an outlet opening 78 in the annular concentric water distributing ring 80.

Additional water distributing rings 82 and 84 are provided for each of the other balancing compartments 26 and 28. Openings lead from each of the rings 82 and 84, which are concentric with the drum, into channel-shaped baffle plates 86 and 88 which lead outwardly through ports 90 and 92 into the balancing compartments 26 and 28. Thus, when water is deposited in either of the rings 80, 82 or 84, it will flow outwardly into the balancing compartment to which the ring connects.

Balancing liquid is directed to the distributor rings from a balancing liquid conduit 94 leading to a balancing liquid manifold 96. Liquid, which may be in the form of water, is supplied from a pump 98 which is shown diagrammatically in FIGURE 1, and may be controlled by the sequential time control mechanism, as will be described in connection with FIGURE 8. The liquid manifold 96 and associated parts is shown in a true position in FIGURE 2, and rotated for the purposes of illustration in FIGURE 1.

The flow of balancing water from the manifold **96** is regulated by solenoid valves **100**, **102** and **104**. The valves, when opened, permit the flow of water through balancing fluid nozzles **106**, **108** and **110**, as shown in FIGURES 1 and 2. The water flows through vacuum breakers **112**, **114** and **116** which have ends **118**, **120** and **122** discharging into the respective annular rings **80**, **82** and **84**.

Thus, by selective operation of the solenoid valves **100**, **102** and **104**, balancing water is fed to one or more of the balancing compartments **24**, **26** or **28**.

In FIGURES 3 and 4, portions of the enclosing cabinet are shown with the cabinet having a supporting base **126** and side walls **128** and **130**. Feet **132** and **134** project from the base **126** of the cabinet to support it. To drive the drum **12** within the cabinet in rotation, a drive pulley **136** is secured to the drum supporting shaft **36** in the manner shown in FIGURES 1 and 3. The pulley **136** is of the V-type and is driven by a V-belt **138**. The V-belt is driven by passing over a driving pulley **140** secured to an idler shaft **142**. The shaft **142** is driven by a larger pulley **144**, driven by a belt **146** which in turn is driven by a driving pulley **148** of a variable speed drive **147**. The driving pulley **148** of the variable speed drive is shown in FIGURES 3 and 4, mounted on a shaft **150**. Also mounted on the shaft is a driven pulley **152** which is driven by a drive belt **154** passing over the drive pulley **156** of an electric motor **158**. The electric motor is mounted on the base **126** of the cabinet and is supplied electricity to be operated by the presettable sequential control system. The drive pulley **156**, which is mounted on a drive shaft **160** of the electric motor, is located next to a fan drive pulley **162** which drives a belt **164** leading up to the air circulating fan, which is not shown. This fan is used to circulate air through the drum **12** in the event the machine is adapted to perform a complete laundering operation wherein the last step will complete the drying of the clothes by circulating the heated air therethrough.

The motor and pulleys are suitably suported on frame work within the cabinet and the pulleys **140** and **144**, mounted on the idler shaft, are urged in a direction to tension the belts **138** and **146** by a compression spring **166**. The compression spring bottoms against a washer **168** adjustably positioned by a nut **170** on a spring supporting rod **172**. The rod **172** is mounted on a pin **174** which is located on the frame, and the spring **166** urges a shaft bracket **176** to the right, as shown in FIGURE 3, to maintain a tension on the belts. The shaft **142** is supported on the pivoted arm **178** which is also pivotally supported at its base on a pivotal link **180**. Spring **182**, connected between the idler shaft **142** and a bracket **184** on the frame, aids in maintaining tension in the belts **138** and **146**.

The variable speed drive pulleys **148** and **152** function to change the drive ratio between the drive motor **158** and the drum **14**. This variable speed drive may take varying forms and is shown in the form of a pulley drive which is utilized because of its simplicity and suitability to use with the amount of power which must be transmitted and the space available. The pulleys **148** and **152** constitute sheave plates which are mounted on a common shaft **150** and the inner wall **186** of the pulley **148** and the inner wall **188** of the pulley **152** are movable with respect to their opposing pulley walls **190** and **194**. For example, as the inner wall **186** moves away from the wall **190** to reduce the effective driving diameter of the pulley **148**, the wall **188**, which is attached to wall **186** simultaneously moves toward its opposing wall **194** to increase the effective diameter of pulley **152**. Movement of the pulley walls is effected by pivotal movement of a supporting yoke **192** which supports the shaft **150** carrying the pulleys. The yoke is pivotally supported on a pin **194** and pivotal position is influenced by a cable **196** and a spring **198**, both of which are attached to a pin **200** on the free end of the yoke **192**.

The tension spring **198** is connected at one end to the pin **200** on the yoke **192** and at the other end to a fixed bracket **202** which is shown secured to the motor frame. The cable **196** pulls the yoke **192** in a direction opposing the action of the spring **198** to pivot the yoke **192** in a clockwise direction, as shown in FIGURE 3. The end **204** of the cable is looped over a finger **206** on a speed control winch pulley **208**. The cable **196** passes over an idler pulley **210** and the end **204** is wound on the winch pulley **208** which is rotated by a speed control drive motor **212**, as shown in FIGURE 4 (similar to the copending application Serial No. 676,815 filed August 7, 1957, now U.S. Patent 2,942,447 owned by my assignee).

The speed control pulley **208** acts as a winch winding the cable **196** as it is driven by the motor to pivot the yoke **192** and gradually increase the speed of rotation of the laundry drum. The speed control motor **212** operates for a predetermined length of time as determined by the sequential time control switch and when it is automatically stopped, the drier drum will have reached operating speed for centrifugally drying the articles therein.

For decreasing the speed of the drier drum by increasing the transmission ratio of the variable speed control assembly **147**, this speed control winch pulley **208** is released to release the cable **196** whereupon the tension spring **198** will rapidly swing the yoke **192** back to the left, as shown in FIGURE 3. Release of the speed control pulley **208** is obtained by release of a clutch arm **214** which controls a clutch engaging the speed control motor **212** to the winch pulley **208**. The clutch arm **214** is actuated by a solenoid **216** which has its plunger **218** connected to the clutch arm **214**. When the solenoid **216** is electrically energized, the plunger core **218** moves the clutch arm **214** to an engaged position and the speed control winch **208** is rotated. When the solenoid **216** is deenergized, a coil compression spring **220** rapidly moves the clutch arm **214** to disengaged position thereby releasing the winch pulley **208**. This rapidly moves the variable speed control pulleys **147** to their low speed position returning the speed of rotation of the drum to tumbling speed.

Tumbling speed will be used for drying and a fast return to tumbling speed is done at the end of a preliminary run during which excessive laundering fluid is removed from the clothes and is done at any time when the vibration of the drum becomes excessive so as to cause "walking" of the cabinet or cause damage to the operating mechanism.

For sensing unbalance of the drum, a deflector arm **226** is secured at a base end **228** to the bearing sleeve **46**, FIGURES 1 and 5. Vibration of the drum will cause vibration of the sleeve within its rubber support **48** to cause vibration of a free end **230** of the deflector arm **226**.

The end **230** of the deflector arm **226** is positioned to actuate an unbalance detection switch **232**. When the drum vibrates with unbalance, the end **230** of the deflector arm **226** will actuate the switch **232** operating an unbalance correction circuit in a manner which will be described.

The deflector arm **226** is also adapted to operate an unbalance safety switch **234** with excessive unbalance and excessive deflection. The safety switch, when actuated, actuates a safety circuit to quickly return the speed of rotation of the drum to tumbling speed in a manner which will be described.

The unbalance detection switch **232** is firmly mounted on a bracket **236** and the unbalance safety switch **234** is also fixedly mounted on a bracket **238**. An adjustable vertical bar **237** limits the movement of the deflector arm **226** away from the switch and dampens vibrations.

The deflector arm **226** in combination with the unbalance detection switch **232**, operates to detect unbalance and the arm will actuate the switch when the unbalance moves the arm against the switch. This will occur when the drum is in a rotational position so that the location of unbalance on the drum is substantially diametrically oppo-

site the direction in which deflector arm 226 extends. Thus, the location of the unbalance will be determined and the balance correction compartment or compartments which are opposite this location of unbalance must be filled with water. To insure filling the correct compartment, the unbalance switch 232 completes a circuit only to the valve which supplies water to the correct balancing compartment.

The selective closing of the correct circuit is obtained by the use of a commutator ring 240, FIGURES 1 and 7.

The commutator ring 240 is secured at the end of the bearing sleeve 46 in order to be fixed with respect to a rotating commutator brush 242 which rotates with the drum shaft 36, and which is connected in series with the unbalance detection switch 232. Thus, with reference to FIGURE 7, whenever the unbalance detection switch 232 is actuated and closed, a circuit will be completed through the commutator ring segment which is in electrical circuit with the correct valve solenoid controlling the flow of water to the balancing compartment which will correct the unbalanced condition.

For example, if the unbalance load is created by the articles 22 within the drum 12, as shown in FIGURE 2, the balancing compartment 26 must be filled. Assuming that the distributing ring 82 leads to the compartment 26, the solenoid valve 102 must be opened. This will automatically occur because the deflector arm 226 will actuate the switch 232 when the brush 242 is in electrical engagement with the commutator segment 244 which is connected to the solenoid 102.

If the unbalance occurs at a different location in the drum, the deflector arm 226 will actuate the unbalance detection switch 232 when the commutator brush 242 is in contact with the proper segment of the commutator ring which actuates a solenoid valve to distribute water to the correct balancing compartment. Thus, a balancing force will be applied which will automatically correct the unbalanced condition. Furthermore, the unbalance detection switch 232 will be actuated for each rotation of the drum as long as the unbalanced condition exists and water will be fed to the compartment until the corrective force caused by water in the balancing compartment corrects the unbalanced condition.

As indicated in FIGURE 7, the unbalance detection switch 232 is preferably a time delay switch so that water will flow to the balance correcting compartment in a steady flow. The unbalance detection switch 232 is also provided with dual contacts so that normally open contact 232*a* controls the circuit through the commutator segments to the water valves and normally closed switch contacts 232*b* control the circuit to the speed control 212. Contacts 232*b* are normally closed so that each time the switch 232 is actuated, due to unbalance of the drum, the circuit to the speed control motor 212 is broken.

As shown in FIGURE 8, a stopping of the speed control motor 212 during the correction of the unbalance condition temporarily terminates acceleration of the speed of the drum. The inclined graph line 246 illustrates the operation of the drum during its balancing run. The drum starts to accelerate at point 248 and the horizontal break 250 in the line 246 indicates a period of speed unbalance correction. During this period, the drum stops accelerating and continues to operate at a constant speed while balancing mass, in the form of water supplied to the balancing compartments are being applied. In accordance with the method of the present invention, this prevents increase in the vibration caused by the unbalanced condition, and acceleration does not resume until the unbalanced condition is corrected.

Operation at an intermediate speed may continue throughout a predetermined centrifuging cycle, as determined by the cycle controller 268, if conditions of unbalance continue throughout this period. The unbalance detection switch 232 has dual contacts wherein contact 232*a* controls the circuit through the commutator segments to the water valves and normally closed switch contacts 232*b* control the circuit to the speed control motor 212. Contacts 232*b* are normally closed so that each time the switch 232 is actuated, due to unbalance of the drum, the circuit to the speed control motor 212 is broken. The period of time delay begins with the first actuation of the switch by movement of the arm 226.

As is illustrated in FIGURE 8 of the drawings, a stopping of the speed control motor 212 temporarily terminates acceleration of the speed of the drum. The horizontal portion 250 on the graph of FIGURE 8 illustrates operation at constant speed wherein the drum continues to operate at constant speed during a balancing operation. Further, because the speed control pulley 208 acts as a winch, it will not unwind unless it is released by a clutch arm 214 under the control of a solenoid 216. Thus, the pulley 152 or movable sheave plate is held axially relative to the other pulley 148 upon actuation of the sensing means, thereby to provide operation thereof substantially at the speed at which said predetermined vibrations were sensed. The speed control drive motor is similar to the motor illustrated in greater detail in U.S. Patent No. 2,942,447.

Upon unbalance being sensed by the operator of switch 232, drum acceleration will be stopped one or more times as designated at points 250 and 254 of the FIGURE 8 graph. This will not go on indefinitely. If the rebalancing mechanism has reached the limit of its capacity by the complete filling of the appropriate rebalancing liquid compartment as described hereinabove, then the drum speed will remain at this "maximum allowed" speed until the end of the centrifuging cycle, as determined by the program switch 268. The drum will not drop back to tumbling speed on failure of sufficient corrective force to rebalance the drum. This latter takes place only on the occurrence of another event; namely, the opening of a limit switch 234 as a result of vibration of such severity as to cause "walking" of the machine.

After the unbalance correction period, as represented by the horizontal line 250, switch 232*a*, FIGURE 7, is again open while switch 232*b* is again closed. The period is determined by the time delay of the switch. However, a new time delay period will begin if the unbalance has not been fully corrected by the end of the first period.

The drum is then accelerated, as indicated by section 252 of the graph line 246. At a location 254 of the graph line an unbalance condition is again encountered which causes actuation of the unbalance sensing switch 232. During this time, switch contact 232*a* closes to distribute additional water to the balancing compartments and switch contact 232*b* opens to stop speed control motor 212 and cause the drum to rotate at an even speed.

At the end of the line 254, after unbalance corrections have been made, the speed control motor 212 is again started, and the drum is accelerated along the line section 256 until it reaches operating speed at 260. The drum may be rotated for a period of time at 260 until the fluid is extracted from the articles within the drum. The speed of the drum is then rapidly dropped, as indicated by a line segment 262, to tumbling speed as indicated by a line 264. The rapid reduction in speed indicated by graph line 262, is caused by the release of the clutch by the clutch arm 214, FIGURE 4, to free the winch pulley 208. This releases the cable 196 whereupon the spring 198 rapidly pulls the arm 192 to its return position to cause the speed control pulleys 147 to drop to their low speed ratio.

The release of the speed control clutch by the clutch arm 124 is caused by deenergization of the solenoid 216. This is a result of the opening of switch 266 which is operated by the presettable sequential time cycle control mechanism, shown diagrammatically at 268.

The presettable sequential control 268 may be of the type employed in an automatic home appliance wherein a cam shaft carrying a plurality of switch operating cams

is rotated by a constant speed timer motor. The cam-operated switches control individual circuits to operating elements to cause their performance at a predetermined time to complete the program of operation. Switch **266** controls the circuit to the speed control clutch solenoid **216** as wel as to the speed control motor **212** and the valve operating solenoids **100**, **102** and **104** for controlling the flow of water to the balance correcting compartments.

When a washing or rinsing operation is first completed, the articles within the drum are saturated with water thereby greatly magnifying any unbalance condition. The bulk of this saturating water is thrown off during the first stages when the drum is being accelerated to attain operational spin-dry speed. During the time this first bulk of the water is being extracted, the position, as well as the amount of off-balance, may change rapidly. In accordance with the method of the present invention, no attempt is made to compensate for the first unbalance forces to thereby prevent over-compensation or inaccurate compensation.

The drum is first spun through a preliminary spin period at a speed less than spin-dry operating speed to remove the bulk of the water. This period of preliminary acceleration is shown in FIGURE 8 by the Section 270 of the line which represents cylinder speed plotted against time. During this preliminary acceleration period, switch **272**, as shown in FIGURE 7, is opened, as shown by the dotted line position of the switch arm. This switch may be controlled by the sequential time control mechanism **268**, and will be moved to the solid line position during the high speed run indicated by the line **246**. However, in the open position, switch **272** permits vibration of the drum and prevents application of correction forces. The first acceleration run is made to a speed which is safely obtainable without attempting to compensate for off-balance and which will not cause "walking" of the machine or damage to the parts by vibration.

When the first run is completed without balancing compensation, in accordance with the method of the present invention, the speed of the machine is slowed down as indicated by the graph line **290** to tumbling speed **274**. At this tumbling speed the articles of clothing within the drum are permitted to distribute themselves which will have a balancing effect. After the slowed tumbling redistribution speed, as indicated by the line **274**, the machine is accelerated along the line indicated by the graph **246** during which time balance corrections are made. At the start of this acceleration operational run, switch **272**, FIGURE 7, is closed so that unbalance corrections will be made.

At the beginning of the speeds above tumbling speed the door control switch **276** is also closed. This switch completes the circuit to the electrical door lock **34** which prevents the door from being accidentally opened during high speed operation.

As may be observed in FIGURE 9, preliminary low speed rotation of the drum is indicated by the accelerationlines **278** and **280** made before operational runs **282** and **284**. The first operational run **282** is completed at the end of the washing period for removing the wash water from the clothing. The second operational run **284** is made at the end of the rinse period for completely removing the rinse water from the clothing. A preliminary rotational period, indicated by an acceleration line **286**, is sufficient in itself to remove the rinse water after an intermediate rinse and is followed by no operational period.

The lower portion of FIGURE 9, indicates the operation of the different elements of the machine over the entire program of operation. It will be noted that the motor functions during the entire operation and the speed of rotation of the drum is controlled by the speed control mechanism **147**.

The chart is self-explanatory with the word "Pump" indicating the pump for pumping the water from the tub after it has been extracted from the articles of clothing within the drum. The term "Water Solen" indicates the control valve for supplying rinse water to the articles within the drum.

Although the operation of the mechanism will be apparent from the description of structure and method of operation of the individual elements, a brief summary of operation will be helpful in understanding the advantages and objectives of the invention.

The articles of clothing **22** are laundered within the drum **12** which rotates on a supporting shaft **36**. The shaft is supported on bearings **42** and **44** which are mounted in a bearing sleeve **46** resiliently supported by rubber mounting **48**.

At the end of a laundering operation, the bulk of the fluid absorbed by the articles is thrown off during a preliminary acceleration period shown at **270** in FIGURE 8. During this time, switch **272**, FIGURE 7, is open and no balance correction is applied to the drum. The drum is then decelerated, as indicated by line **290** of the graph of FIGURE 8, to tumbling speed **274** during which period of time the clothes realign themselves within the drum.

The drum is then accelerated along the line **246** of FIGURE 8 to an operational speed **260**. During the preliminary run **270**, and the operational balance-correcting run **246**, the door lock switch **276** is closed to prevent accidental opening of the door. The program of events is controlled by a presettable sequential time cycle control mechanism **268** which operates the control switches.

During the operational run, switch **272** is closed in order that the circuit may be completed to the water control solenoid valves **100**, **102** and **104** whenever unbalance exists. Balancing switch **232** is closed by lateral movement of the end **230** of the deflection arm **226** when the drum vibrates. Balancing water will be supplied automatically to the balancing compartment **24**, **26** or **28** to correct the unbalance. The flow of balancing water will be controlled by the completion of the electrical circuit through the solenoid valve **100**, **102** or **104** by the brush **242** engaged with the correct segment of the commutator ring **244** dependent on the position of the drum when the unbalance vibration occurs to move the deflector arm **226** against the switch **232**. During the time the unbalance correction is being applied, the switch contact **232***b* is opened to stop the speed control motor **212**, thus stopping the winch pulley **208**. When the balance has been corrected and the time delay switch contact **232***b* again closes, the speed control motor **212** will again start to pull on the cable **196** and gradually increase the speed transmission ratio of the pulleys **147**.

If the unbalance vibration becomes excessive during any period of the run, the safety switch **234** will open, thus breaking the circuit to the solenoid **216** releasing the clutch driving the winch pulley **208**. This will permit the spring **198** to take over and rapidly move the variable speed drive pulleys **147** to the low speed position thus causing the speed of the drum to drop rapidly to tumbling speed.

At the end of the operational run, the speed control clutch operated by the speed control arm **214**, is also released thus slowing the drum to tumbling speed.

As illustrated in FIGURE 9, throughout the sequence of operations during the operational program of the laundry machine, the elements are controlled by the presettable sequential time control switch. At the end of the laundering period, the drum is rotated through the preliminary acceleration **278**, and then slowed to permit the articles of clothing to be rearranged. The drum is then accelerated to the operational speed **282** for the spin-dry operation. The preliminary period is repeated at **286** and **280** and the operational acceleration is repeated to bring the drum up to operational speed at **284**

at the end of a rinse period for the final spin-dry operation.

Thus, it will be seen that I have provided an improved method and apparatus for correcting unbalance in a rotor such as a container used in an automatic laundry machine, which meets the objectives and advantages hereinbefore set forth. The method is well adapted to use with a domestic home laundry machine wherein the fluid is centrifugally spun from the clothes at the end of the washing period and at the end of the rinsing periods.

The balancing can be accomplished in a minimum amount of time and without overbalancing, inasmuch as the original bulk of the washing water is removed from the clothes before balancing correction forces are applied. Further, the problem of "walking" of the machine cabinet or dangerous vibrations being reached is greatly reduced since the acceleration of the drum is stopped during the correction period. Also, corrections are applied as they occur during acceleration, thus achieving dynamic balance of the drum for safely rotating the machine at the high speed spin-dry operational speed.

I have, in the drawings and specification, presented a detailed disclosure of the preferred embodiment of my invention, but it is to be understood that I do not intend to limit the invention to the specific form disclosed but intend to cover all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by my invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An automatic unbalance correction apparatus for a laundry container unbalanced by laundered articles therein comprising a rotatable hollow laundry container adapted to contain articles for a laundering operation, a power drive for driving the container in rotation for applying centrifugal force to remove moisture from the articles therein, balancing means operative to make balancing corrections by changing the weight of the container at a selected radial location determined by the location of unbalance, unbalance detecting means for regulating said balancing means including means for determining the location of the unbalance and means for transmitting a control signal to the balancing means whereby the location for operation of the balancing means will be selected and the unbalance corrected, and speed control means gradually increasing the speed of the container to an operational speed and operatively connected to the unbalance detecting means and temporarily stopping the increase of speed and maintaining an intermediate rotating speed during the operation of the balancing means to correct an unbalanced condition, said intermediate rotating speed being a speed at which the unbalance is detected and timer regulated means rendering the balancing means inoperative during a first rotative speed of the container of a preliminary period when the bulk of water is being removed and also during a second rotative speed less than the first of subsequent periods when the clothes are rearranging themselves to a balanced condition, said first rotative speed being less than the normal rated operational speed of the container.

2. An automatic unbalance correction apparatus for a laundry container unbalanced by laundered articles therein comprising a rotatable hollow laundry container adapted to contain articles for a laundering operation, a power drive for driving the container in rotation for applying centrifugal force to remove moisture from the articles therein, balancing means operative to make balancing corrections by changing the weight of the container at a selected radial location, a speed control for the power drive operative to cause the drive to operate with a gradual speed increase, and time delay means for the speed control connected to the balancing means and operative to render ineffective the balancing means during a first relatively low speed rotation of the container when the bulk of water is being removed, to reduce the rotative speed below said first speed when the clothes rearrange themselves to a balanced condition, to interrupt operation of the speed control at the start of operation of the balancing means, and to again start operation of the speed control after a predetermined time sufficient for an unbalance to be corrected.

3. The method of correcting unbalance in a rotating member such as a laundry container comprising the steps of first accelerating the container to a preliminary centrifuging speed to extract a portion of the fluid in the articles, then secondly accelerating the container in rotation toward an essentially full operating speed for extraction of other fluid portions, detecting unbalance in the container during the second acceleration, applying corrective balancing masses to the container when an unbalance condition is detected only after completion of said first acceleration step, temporarily terminating the second acceleration of the container when the unbalance is detected and operating and maintaining the container rotatably at a constant intermediate centrifuging speed while corrective balancing masses are being applied, said intermediate centrifuging speed being the speed at which the unbalance is detected, and immediately slowing the rotation of the container to a tumbling speed below said preliminary centrifuging speed when an excessive unbalance of a predetermined magnitude is reached.

4. The method of centrifugally extracting fluids from wet fabrics carried within a revoluble receptacle comprising, extracting the bulk of absorbed fluid from said fabrics by accelerating said receptacle to a first preliminary centrifuging speed unmolested of an unbalance correction, lowering the rotational speed of said receptacle below said first perliminary centrifuging speed as required to redistribute said fabrics within said receptacle, thereafter accelerating said receptacle with the redistributed partially extracted fabrics to a second speed above said preliminary speed, said second speed constituting a speed wherein the rotation of said fabrics vibrates said receptacle to a predetermined amplitude of vibration, interrupting acceleration of said receptacle above said second speed and providing and maintaining operation at a constant intermediate centrifuging speed while applying counterbalancing mass to said receptacle to thereby reduce the amplitude of vibration of said receptacle, said intermediate centrifuging speed being the speed at which the rotation of said fabrics vibrates said receptacle to a predetermined amplitude of vibration, and then accelerating said receptacle to still higher centrifuging speeds above said second speed to extract additional fluid from said fabrics.

5. The method of centrifugally extracting fluids from wet fabrics carried within a revoluble receptacle comprising, extracting the bulk of absorbed fluid from said fabrics during a first period by accelerating said receptacle to a preliminary centrifuging speed unmolested of an unbalance correction, thereafter decreasing the rotational speed of said receptacle during a second period to a tumbling speed below said preliminary centrifuging speed to redistribute said fabrics within said receptacle, thereafter accelerating said receptacle with the redistributed fabrics during a third period towards a high speed above said preliminary centrifuging speed, interrupting the acceleration during said third period in response to vibration of predetermined magnitude and maintaining the rotational speed at a constant intermediate speed while applying a counterbalancing mass to said receptacle to thereby reduce the amplitude of vibration of said receptacle, said intermediate centrifuging speed being the speed at which the vibration of predetermined magnitude occurs, and then alternately repeating the accelerating and counterbalancing of said receptacle to increase the speed towards maximum speed above said speed during the third period and extract residual absorbed fluid from said fabrics.

6. The method of centrifugally extracting fluids from wet fabrics carried within a revoluble receptacle comprising, extracting a portion of absorbed fluid from said

fabrics by accelerating said receptacle to a preliminary centrifuging speed unmolested of an unbalance correction, decreasing the rotational speed of said receptacle below said preliminary centrifuging speed to redistribute said fabrics within said receptacle, accelerating said receptacle with the redistributed fabrics to a speed above said preliminary speed, interrupting said acceleration when the rotation of said receptacle vibrates said receptacle to a first predetermined amplitude of vibration and maintaining a constant first intermediate centrifuging speed while applying counterbalancing mass to said receptacle to thereby reduce the amplitude of vibration of said receptacle, thereafter accelerating said receptacle to a higher centrifuging speed above the previous speed, again interrupting the acceleration of said receptacle when the rotation of said fabrics again vibrates said receptacle to a second predetermined amplitude of vibration and maintaining a constant second intermediate centrifuging speed while applying additional counterbalancing mass to said receptacle, and then accelerating said receptacle to still higher centrifuging speeds above previous speed to extract additional residual absorbed fluid from said fabrics, said first intermediate centrifuging speed being the speed at which said first predetermined amplitude of vibration occurs, and said second intermediate speed being the speed at which said second amplitude of vibration occurs.

7. In combination with a rotating laundry container provided with power drive means balancing means operative to make balancing corrections by changing the weight of the container at selected radial locations, and unbalance detecting means connecting with the balancing means determining the location of the unbalance, the improvement which comprises speed control means connecting with the power drive means, time control means connecting with said unbalance detecting means and with said speed control means and including first switch means connecting said time control means with said unbalance detecting means, and second switch means connecting said time control means with said speed control means, said speed control means operating in connection with said time control means to impart a first relatively low speed rotation to the container during a first period to remove the bulk of water therein and thereafter to reduce the speed of rotation during a second period to a speed such that the clothes within the container rearrange themselves to a generally balanced condition, said first switch means during said first speed rotation being open to prevent application of balancing corrections, said time control means after clothes rearrangement regulating the increase of the speed of rotation of the container during subsequent periods towards a maximum centrifuging speed, closing the first switch means and rendering effective the unbalance detecting means, said latter means being operative during subsequent high speed rotation to actuate the balancing means, and simultaneously through opening of the second switch means to temporarily maintain the rotative speed of the container at intermediate centrifuging speeds corresponding to speeds at which unbalance is detected while the balancing corrections are being made.

8. A laundry machine including a rotatable clothes basket, drive means for rotating said basket, said drive means being formed to accelerate said basket toward a maximum centrifuging speed and being also formed to operate said basket at an intermediate centrifuging speed, sequence control means causing said drive means to provide a centrifuging speed to said basket for a predetermined centrifuging cycle, means for sensing vibrations of said basket resulting from unbalanced distribution of the clothes therewithin during centrifuging thereof, and means responsive to sensing of vibrations of a predetermined magnitude to stop acceleration of said basket towards said maximum centrifuging speed and provide and maintain operation at a constant intermediate centrifuging speed, said constant intermediate centrifuging speed being the speed at which the vibrations of predetermined magnitude are sensed.

9. A laundry machine including a rotatable clothes basket, drive means for rotating said basket, said drive means including a variable speed belt drive comprising a belt and a pair of rotatable sheave plates forming a groove between them, at least one of said sheave plates being axially movable relative to the 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, means for moving at least one of said sheave plates relative to the other so as to accelerate said basket toward a maximum centrifuging speed, means for sensing vibrations of said basket resulting from unbalanced distribution of the clothes therewithin, and means responsive to sensing of vibrations of a predetermined magnitude to hold said sheave plates axially relative to each other upon actuation of said sensing means thereby to provide operation thereof substantially at the speed at which said predetermined vibrations were sensed.

10. The apparatus defined in claim 9 wherein said means for moving at least one of said sheave plates relative to the other comprise a gear motor assembly.

11. A laundry machine including a rotatable clothes basket, drive means for rotating said basket including a variable speed belt drive comprising a pair of rotatable sheave plates forming a belt-receiving groove between them, at least one of said sheave plates being axially movable relative to the other thereby to vary the width of said groove, belt means seated within said groove at varying distances from the center of rotation of said sheave plates depending upon their axial position relative to each other, electric motor means for moving at least one of said sheave plates relative to the other to accelerate said basket toward a maximum centrifuging speed, means for sensing a predetermined magnitude of vibration of said basket resulting from unbalanced distribution of the clothes therewithin, switch means having first and second operative positions, said switch means having said first position prior to the sensing of vibrations of said predetermined magnitude, said sensing means moving said switch means to said second position thereof upon sensing vibrations of said predetermined magnitude to stop said electric motor means and hold said sheave plates stationarily positionable positioned axially relative to each other upon actuation of said sensing means and stopping of said electric motor means, said switch means operative to energize said motor in said first position thereof, and means rendering said switch means being operative in said second position only after a predetermined period of acceleration to a minimum centrifuging speed to thereafter provide for a centrifuging operation at an intermediate spin speed corresponding to the speed at which said vibrations of predetermined magnitude are sensed.

12. A laundry machine including a rotatable clothes basket, drive means for rotating said basket, drive control means formed to accelerate said basket toward a maximum centrifuging speed, means for sensing a predetermined magnitude of vibrations of said basket resulting from unbalanced distribution of the clothes therewithin, means for stopping acceleration of said basket towards said maximum centrifuging speed and providing and maintaining operation thereof at a constant intermediate centrifuging speed when said predetermined magnitude of vibrations occurs, said intermediate centrifuging speed being the speed at which said predetermined magnitude of vibration is sensed, and means for slowing said clothes basket down for a redistribution of the clothes therewithin when a second predetermined magnitude of vibration occurs.

13. A laundry machine including a rotatable clothes basket, drive means for rotating said basket, said drive means being formed to accelerate said basket toward a maximum centrifuging speed and being also formed to operate said basket at at least one intermediate cen-

trifuging speed, sequence control means causing said drive means to provide a centrifuging speed to said basket for a predetermined centrifuging cycle, means for sensing vibrations of said basket resulting from unbalanced distribution of the clothes therewithin during centrifuging thereof, and means responsive to sensing of vibrations of a predetermined magnitude to stop acceleration of said basket and provide operation continuously at an intermediate centrifuging speed for the remainder of said centrifuging cycle.

14. A laundry machine including a rotatable clothes basket, drive means for rotating said basket including a variable speed belt drive comprising a pair of rotatable sheave plates forming a belt-receiving groove between them, at least one of said sheave plates being axially movable relative to the other thereby to vary the width of said groove, belt means seated within said groove at varying distances from the center of rotation of said sheave plates depending upon their axial position relative to each other, electric motor means for moving at least one of said sheave plates relative to the other to accelerate said basket toward a maximum centrifuging speed, means for sensing a predetermined magnitude of vibration of said basket resulting from unbalanced distribution of the clothes therewithin, switch means having first and second operative positions, said switch means having said first position prior to the sensing of vibrations of said predetermined magnitude, said sensing means moving said switch means to said second position thereof upon sensing vibrations of said predetermined magnitude, and means for retaining said sheave plates axially relative to each other, said switch means being operative to energize said motor in said first position thereof, means rendering said switch means operative in said second position only after a predetermined period of acceleration to an appropriate minimum centrifuging speed to render said retaining means effective thereafter thereby to provide for a centrifuging operation at an intermediate spin speed, said appropriate minimum centrifuging speed being less than normal rated operational speed and said intermediate spin speed corresponding to the speed at which said vibrations of predetermined magnitude are sensed.

15. A laundry machine including a rotatable clothes basket, drive means for rotating said basket, said drive means including a variable speed belt drive comprising a belt and a pair of rotatable sheave plates forming a groove between them, at least one of said sheave plates being axially movable relative to the 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, means for moving at least one of said sheave plates relative to the other so as to accelerate said basket toward a maximum centrifuging speed, means for sensing vibrations of said basket resulting from unbalanced distribution of the clothes therewithin, and means responsive to sensing of vibrations of a predetermined magnitude to retain said sheave plates axially relative to each other thereby to provide operation thereof substantially at the speed at which said predetermined vibrations were sensed

16. The apparatus defined in claim 15 wherein said means for moving at least one of said sheave plates relative to the other comprise a gear motor assembly, and said means for retaining said sheave plates in a predetermined axial relation comprise means for retaining said gear motor assembly against rotation.

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