

Nov. 29, 1960

J. C. WORST
COMBINATION WASHER-DRYER

2,961,861

Filed Oct. 26, 1959

4 Sheets-Sheet 1

FIG. 1

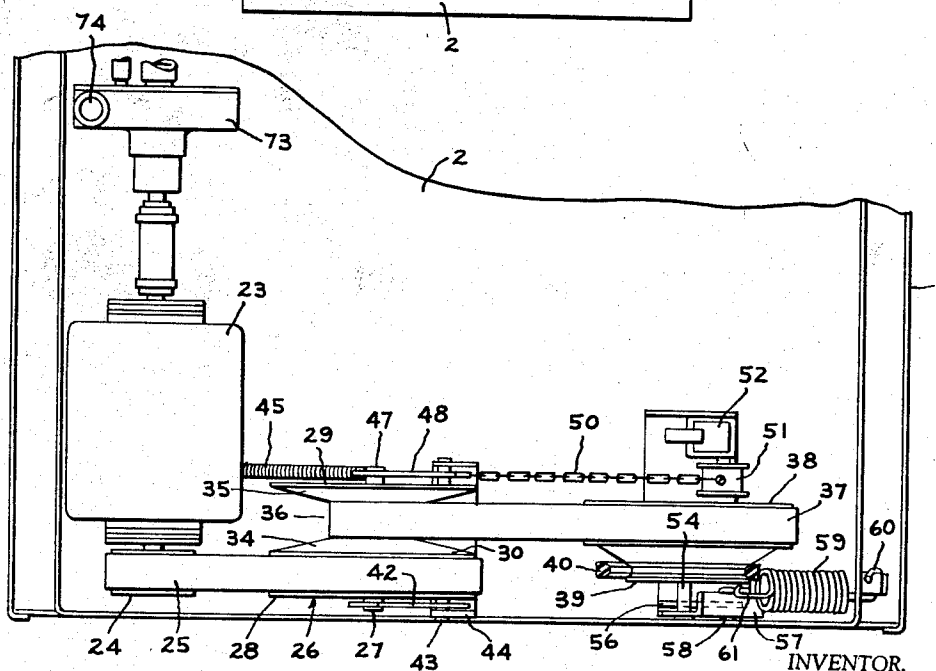
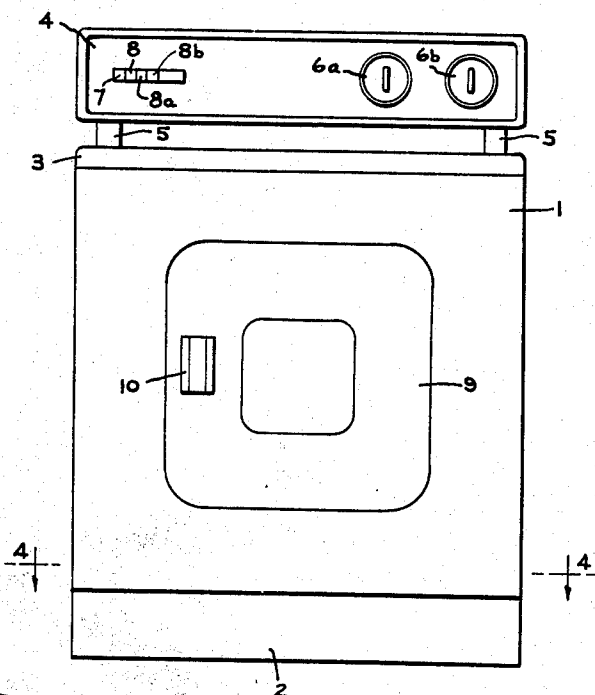


FIG. 4

INVENTOR.
JOSEPH C. WORST
BY *De P Lawrence*
HIS ATTORNEY

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J. C. WORST

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4 Sheets-Sheet 2

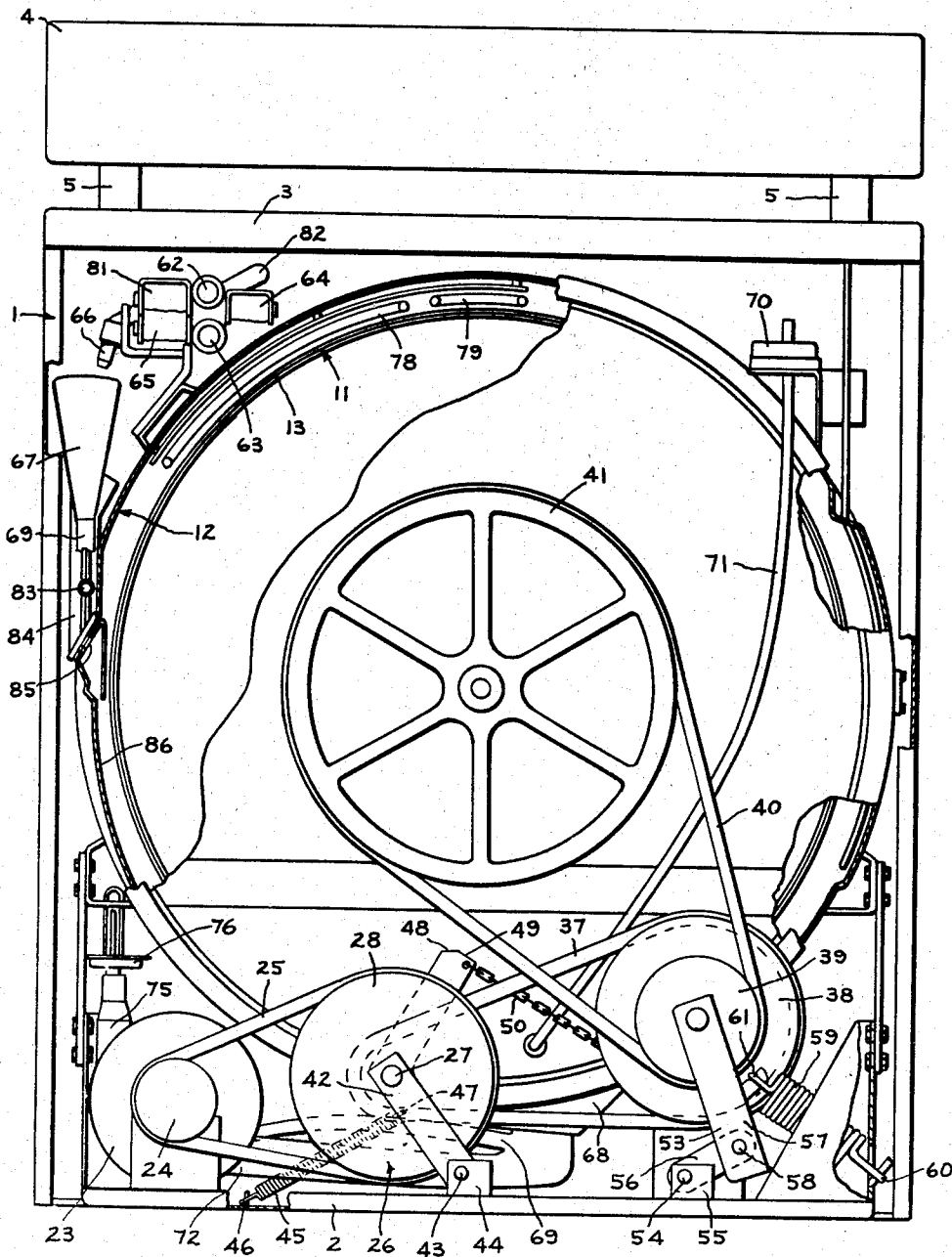


FIG. 2

INVENTOR.

JOSEPH C. WORST

BY

David P. Lawrence

HIS ATTORNEY

Nov. 29, 1960

J. C. WORST

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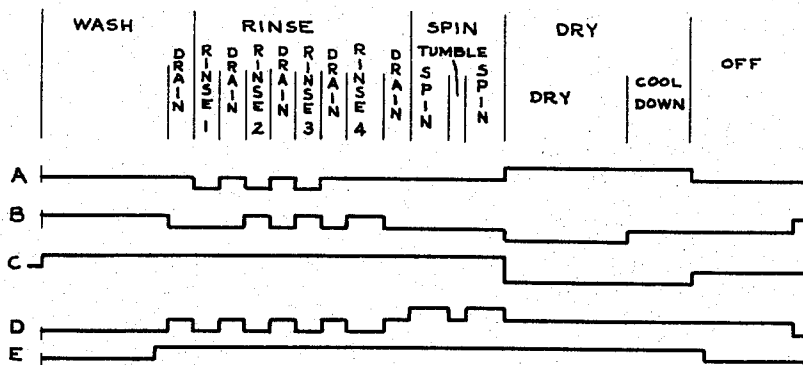
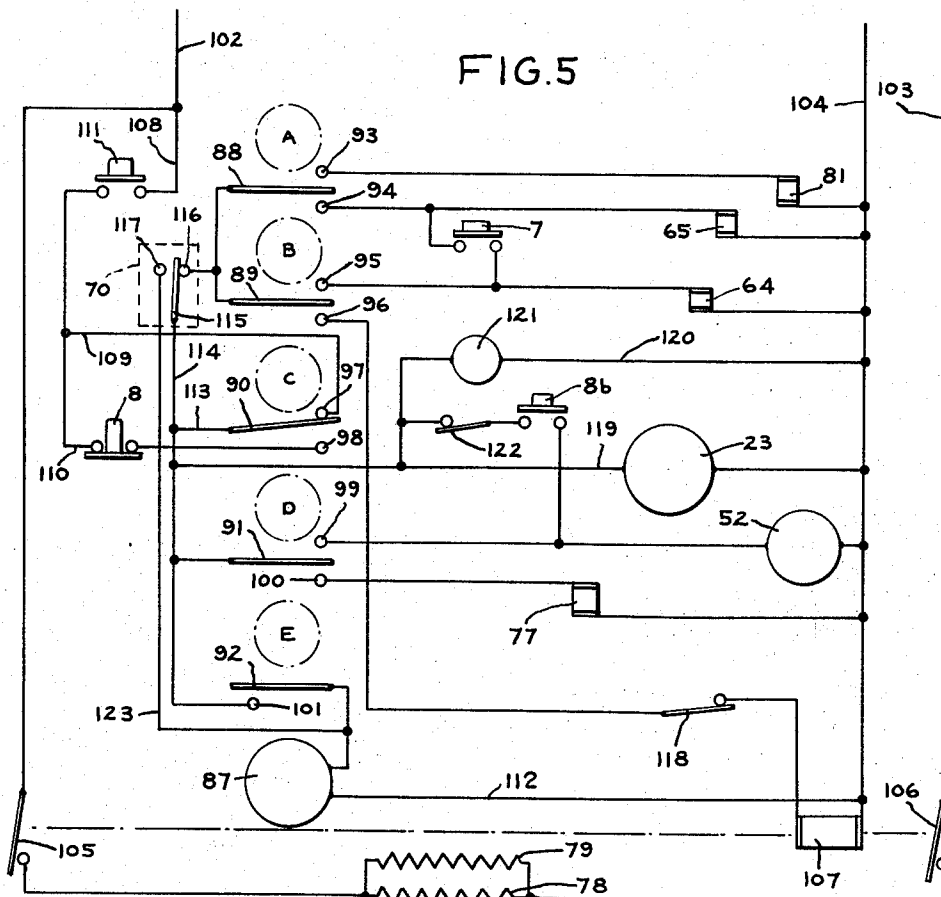


FIG. 6

INVENTOR.
JOSEPH C. WORST
BY *De P Lawrence*
HIS ATTORNEY

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2,961,861

COMBINATION WASHER-DRYER

Joseph C. Worst, Louisville, Ky., assignor to General Electric Company, a corporation of New York

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10 Claims. (Cl. 68—12)

This invention relates to combination washer-dryers of the type wherein, during washing and drying, the clothes are tumbled in a container rotated on a non-vertical axis; more particularly, the invention relates to such machines wherein the rotational speed during washing and drying may be continually varied between tumbling and a higher speed such as, for instance a low centrifuging speed.

Combination washer-dryers perform the combined functions of washing machines and drying machines. In other words, the same machine washes the clothes, then spins most of the liquid out of the clothes, and then dries the clothes, generally by heat. The washing portion of the sequence which is provided is in general approximately the same as that of standard washing machines in that it includes, basically, a washing cycle and at least one rinse cycle to get rid of the washing liquid, both cycles being conducted at a speed which insures tumbling of the clothes in the washing and rinsing liquids. This washing portion of the sequence is followed by a high speed spin operation to effect centrifugal extraction of liquid from the clothes, and the spin operation in turn may be followed by the drying operation. In this latter, heat is generally provided to vaporize moisture from the clothes as they are tumbled in the clothes receptacle.

The tumbling of the clothes is of very substantial importance in effecting proper washing and rinsing in the first operation preceding the spin and in effecting proper drying in the last operation subsequent to the spin. Because of the presence of a substantial amount of liquid during the washing operation, as opposed to the absence of free-standing liquid during the drying operation, the optimum speed for effecting tumbling of the clothes is slightly different for the two operations; for instance, with a 26-inch diameter cylindrical clothes container rotating on a horizontal axis, it has been found that the optimum rotational speed for washing is on the order of 51 r.p.m. whereas the optimum rotational speed for drying is on the order of 44 r.p.m. Because of the expense of providing for two different tumbling speeds, a compromise speed of 47 r.p.m. has generally been provided for containers, or baskets, of the type described above. While the compromise speed provides thoroughly satisfactory results both for washing and drying, the fact that the speed represents a compromise means that it cannot be allowed to vary to any substantial extent during the life of the machine otherwise the speed will have departed too far from either the optimum washing speed or the optimum drying speed. For this reason, it has been necessary to manufacture machines with very close tolerances, and this has increased substantially the cost of production of such machines.

I have, however, discovered that a varying speed, wherein the speed touches the optimum of both the washing operation and the drying operation, provides highly satisfactory results in both operations, because the speed is varying, and therefore, the necessity for the close tolerances and the difficulties involved in maintain-

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ing one specific tumbling speed throughout the life of the machine can be obviated. I have also found that a continuously varying speed such as that described may be used to provide a "delicate" washing cycle in a tumbler type machine in addition to the "regular" washing cycle. The delicate cycle is achieved by varying the speed between a low tumbling speed and a relatively low centrifuging speed, sufficient to plaster the clothes about the inner surface of the clothes receptacle. During the time that the clothes are so plastered, some washing is effected during the washing operation since the clothes are passing in and out of the wash liquid, but there is no wear on the clothes whatsoever due to the fact that they are not being tumbled but are being maintained in one predetermined position relative to each other and to the clothes container. By varying the amount of time that the clothes are so maintained centrifugally against the inner surface of the container, longer and shorter periods of tumbling may be achieved for one single total operation of a predetermined length.

In view of the foregoing, it is an object of this invention to provide a combination washer-dryer having improved means for permitting a single compromise speed to be replaced by a variable speed suitable both for washing and for drying.

It is a further object of this invention to provide a combination washer-dryer wherein during the washing operation which precedes spin, and during the drying operation which follows spin, the speed of the rotating container will continually be varied from a tumbling speed to a speed sufficient to plaster the clothes centrifugally against the inner surface of the container, and then back to the clothes tumbling speed.

Yet a further object of my invention is to utilize this variable speed feature to provide a "delicate" cycle wherein the clothes are tumbled for only that portion of time during which they are at the clothes tumbling speed.

According to one aspect of my invention, I provide a laundry machine with a clothes receptacle rotatable on a substantially non-vertical axis. Suitable drive means are provided for rotating the container, and means are provided for varying the speed at which the drive means rotates the container. Two separate means for controlling the container rotational speed are provided: the first such control means causes the drive means to increase the rotation of the container from a low clothes tumbling speed to a high liquid extracting speed; the second control means causes the drive means to continually vary the rotation of the container between clothes tumbling speed and a higher speed, generally one high enough to centrifugally plaster clothes against the inner surface of the container. The structure also includes means for providing, first, a washing operation in the container during control of the drive means by the second control means; second, a centrifuging operation in the container during control of the drive means by the first control means; and third, a drying operation in the container during control of the drive means by the second control means.

The use of control means which effects continually a varying speed of the container between a low clothes tumbling speed and a higher speed has been found to cause both washing and drying to be effected as desired without the necessity for a single compromise speed having to be maintained. In addition, where so desired, the feature of the variable speeds may be used to provide a "delicate" cycle inasmuch as during the varying speed operation the clothes are plastered against the container part of the time and therefore are not undergoing the same wear as during the ordinary tumbling operation. Thus, a continuous tumble may be used for instance for a standard washing operation for regular fabrics, and a

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varying speed operation may be used if delicate fabrics are to be laundered. Or, in similar vein, different varying speed operations, each providing different ratios of tumble time to plaster time, may be used to effect the "regular" and "delicate" wash cycles.

The subject matter which constitutes my invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. The invention, both as to organization and method of operation together with further objects and advantages thereof, 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 combination washer-dryer of the type in which my invention may be embodied;

Figure 2 is a rear elevational view of the combination washer-dryer with the rear panel removed to illustrate details;

Figure 3 is a side elevational view of the machine, 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 1, with the clothes basket and tub of the machine removed in order to illustrate details of the drive of the machine;

Figure 5 is a schematic electrical wiring diagram illustrating in simplified form a control system for the machine embodying my invention in one form thereof; and

Figure 6 is a sequence control cam chart illustrating a suitable sequence of operation for the timer switches shown in Figure 5 in order to provide an operative cycle for the machine.

Referring now to Figures 1, 2 and 3 of the drawings, there is shown a combination washer and dryer machine where 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 back splash panel 4 which may, as shown, be mounted on posts 5. Control panel 4 is provided with appropriate control devices, such as, for instance, dial 6a (which provides for various types of washing and drying sequences), dial 6b (for controlling drying temperature), and levers 7, 8, 8a and 8b which control various other functions such as, respectively, water temperature, the selection or omission of the heat drying function after the washing is completed, and whether the washing action is to be "regular" or "delicate." Access to the interior of the machine is provided by a door 9 formed in section 1 which is mounted on concealed hinges and is opened by means of a latch control 10.

As best shown in Figure 3, the machine is of the horizontal axis type, that is, it has a substantially cylindrical clothes container, or basket, 11 mounted for rotation on a generally nonvertical (specifically, in this case, horizontal) axis within an outer enclosing tub structure 12. Basket 11 comprises a cylindrical shell or wall 13 which is closed at its rear end by means of a suitable wall or plate 14. The basket also includes a front wall 15 which is formed so as to define an access or loading opening 16 in registry with an opening 17 provided in wrap-around section 1 for door 9. The basket is rotatably supported by a shaft 18 which is mounted in an elongated bearing 19 supported from rear wall 20 of tub 12. The tub is also provided with an opening 21 aligned with opening 17 and opening 16 so that clothes may be placed into and removed from the basket when door 9 is opened. The door seals against a suitable gasket 22 during operation of the machine.

Referring now particularly to Figure 4, and also to Figures 2 and 3, during the operation of the machine the basket 11 is driven from an electric motor 23. The drive from the motor to the basket includes a pulley 24 which

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is secured to the motor shaft so as to rotate therewith and over which passes a belt 25 driving an adjustable sheave assembly 26. The adjustable sheave assembly includes a shaft 27 to which are rigidly secured to sheave plates 28 and 29. An intermediate sheave plate 30 is keyed on shaft 27 so as to be movable along the shaft to varying distances from sheave plates 28 and 29. It will be observed (Figure 3) that sheave plate 28 has a sloping surface 31 which in cooperation with a sloping surface 32 on movable sheave plate 30 forms a groove 33 of adjustable width. Similarly, on its other side movable sheave plate 30 is provided with a sloping surface 34 which cooperates with a sloping surface 35 of rigidly secured sheave plate 29 to form a second groove 36 of adjustable width.

Since belt 25 has a predetermined width, it can be seen that movement of sheave plate 30 relative to sheave plate 28 will cause the belt 25 to seat in groove 33 at a distance from the center of shaft 27 which is determined by the distance of sheave plate 30 from sheave plate 28. The linear speed of belt 25 is constant, assuming the speed of motor 23 to be substantially constant, and therefore the rotational speed of the adjustable sheave assembly 26 is dependent on the effective sheave diameter provided by the cooperation of sheave plates 28 and 30. When the sheave plates 28 and 30 are in the position shown in the figures, sheave assembly 26 is rotating at a relatively low speed. When sheave plate 30 is moved to the left, as viewed in Figure 3, away from sheave plate 28, then belt 25 will move in radially toward shaft 27 as groove 33 widens and will cause a greater rotational speed of the sheave assembly 26 for a given rotational speed of pulley 24 by motor 23.

A second belt 37 is driven in groove 36 by the sheave formed by the cooperation of sheave plates 30 and 29. When adjustable sheave plate 30 is in the position shown so that groove 36 is quite wide, belt 37 has to move in radially toward the shaft 27 a substantial amount before it seats on the surface 34 and 35 of sheave plates 30 and 29 respectively. This means that for a given rotational speed of the adjustable sheave assembly 26 (as imparted to it by belt 25), belt 37 will be travelling at a relatively low rate of linear speed. If sheave plate 30 is moved to the left so that belt 37 is forced outwardly in groove 36, then for a given rotational speed of the sheave assembly a relatively high linear speed of belt 37 is provided. Thus, by controlling the position of sheave plate 30, an infinite variety of speeds between the two limits of position on the sheave plates may be provided, with the arrangement shown in Figure 3 providing the lowest output speed to belt 37 since belt 25 is causing the lowest speed of rotation of sheave assembly 25 and rotation of the sheave assembly 26 is causing the lowest linear speed of belt 37. The highest rate of speed will be provided if sheave plate 30 is moved as far as possible to the left: this will provide the highest rotational speed of the assembly 26 for a given linear speed of belt 25, and the highest output linear speed of belt 37 for a given rotational speed of assembly 26.

Belt 37 passes over a sheave 38 which forms part of a unitary assembly with a sheave 39 driving a belt 40. Referring primarily to Figures 2 and 3, it will be seen that belt 40 drives a sheave 41 which is rigidly secured to the end of shaft 18 so as to rotate basket 11.

Returning now to the adjustable sheave assembly 26, and with particular reference to Figures 2 and 4, it will be observed that the assembly is mounted on an arm 42 which is pivotably secured on a pin 43 within a bracket 44 secured to the base 2 of the machine. A spring 45 has one end 46 secured to the machine base and has the other end 47 secured to an arm 48 which is rigidly secured to the sheave assembly 25, whereby the assembly is biased to the left as shown in Figure 2. At the outer end 49 of arm 48 there is secured a chain member 50. At its other end (Figure 4) chain member 50 is secured

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to a pulley 51 operated through a small electric motor and gear assembly 52. It will be seen that when pulley 51 is caused to rotate by assembly 52 it will wind up chain 50 and through arm 48 will move the entire adjustable sheave assembly to the right as viewed in Figure 2 causing arm 42 to pivot to the right. Since belt 25 cannot stretch, it will be apparent that when this occurs belt 25 will move inwardly within groove 33 forcing sheave 30 to the left (as viewed in Figure 3) to effect an increase in the speed transmitted to sheave 41 and basket 11. When motor and gear assembly 52 is shut off, the spring 45 overcomes the motor and gear assembly and pulls the adjustable sheave 26 back to the position shown in the figures to reduce the speed. The motor and gear assembly 52 is of the type which can, without adverse effect, remain energized although stalled; this has the result that high speed operation is maintained only as long as energization of the motor continues.

The assembly of sheaves 38 and 39 is also movably mounted, on a linkage arrangement 53 pivotably secured on a pin 54 mounted within a bracket 55 secured to the base 2. The linkage arrangement includes two arms 56 and 57 which are pivotably secured together through a pin 58. A spring 59 secured at one end 60 to the base 2 of the machine is secured at its other end 61 to the assembly of sheaves 38 and 39 so as to bias them downwardly and to the right as viewed in Figure 2 in order to effect a belt tensioning function for belts 37 and 40.

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 positions as shown, and when the diameter of basket 11 is on the order of 26 inches, a tumbling speed of approximately 47 r.p.m. may be provided to the basket, while in the other extreme position a suitable liquid extraction centrifuging speed, such as, for instance, 250 r.p.m. may be provided.

The components for effecting the washing operation, that is, the means for supplying water to the tub and for removing water from the tub are particularly shown in Figure 2. The water supply means includes connections 62 and 63 through which hot and cold water is supplied to the machine for the washing operation. A valve controlled by a solenoid 64 admits hot water to the machine and a valve controlled by an opposed solenoid 65 admits cold water to the machine. The hot and cold water valves under the control of the solenoids 64 and 65 discharge through a common outlet conduit 66, through a suitable air gap, and then through a funnel 67 to a sump 68 formed at the bottom of tub 12. The connection may be made through a suitable conduit 69, a portion of which is shown joining funnel 67 and another portion of which is shown adjacent the sump. The air gap provided by the funnel 67 makes it impossible for the water to be syphoned from the machine and to contaminate the incoming supply line. A pressure-actuated sensing device or water level control 70 controls both solenoids 64 and 65 to maintain the proper water level in the machine during the washing operation. Sensing device 70 is connected to the interior of tub 12 by a suitable line 71.

In order to discharge water from the machine through sump 68 at the bottom of tub 12 at appropriate times during the operating sequence of the machine, suitable means are provided. In the present case these include a discharge hose 72 which leads from the sump to a motor driven drain pump 73 which may (as shown in Figure 4) be driven directly from motor 23 and which discharges through an outlet opening 74 to a conduit 75 (Figure 2) leading to a drain valve 76 controlled by a suitable solenoid 77 (Figure 5). Since pump 73 is continually operated by motor 23, the draining of water from sump 68 is controlled by the drain valve 76, draining occurring except when solenoid 77 is energized.

Suitable means are provided to heat the clothes during the drying portion of the cycle which follows a centrifugal

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extraction operation. In the present machine, these include a pair of heaters 78 and 79 which are mounted within the upper portion of tub 12 so that when energized they heat the basket 11. When the heaters are energized, the heat transferred to the clothes basket is then passed onto 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 80 (Figure 3), there is also some heat from the elements which passes directly to the clothes by radiation.

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 81 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 82. From this conduit, the water flows through an appropriate air gap (not shown) and then through another conduit (not shown) to the inlet 83 of a vent trap 84 which is of the type commonly provided in connection with machines of this type in order to seal off the tub and basket from atmosphere during heat drying of the clothes while leaving the tub vented to atmosphere at other times. An appropriate construction for vent trap 84 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 vent trap 84 the condenser water flows into tub 12 through an opening 85 and then flows in a thin sheet down the lower left wall 86 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 condenser water and the moisture extracted from the clothes during the drying operation may, of course, be discharged from the machine through the sump 68 by the same drain means including pump 73 and valve 76 as described for removing the washing and rinsing water.

Referring now to Figure 5, there is shown in schematic form a control arrangement for controlling the sequence of operation of the various components of the machine hereinabove described. It will, of course, be understood that in actual practice various additional interlocking arrangements of the different functions may be provided together with various electrically controlled safety features; however, these frequently assume some complexity and have been omitted since they do not form a part of the invention and such circuit modifications are well known to those skilled in the art.

The basic operation of the means for controlling the sequence is provided through a suitable timer motor 87 (Figure 5); the timer further includes a series of switches 88, 89, 90, 91 and 92 which are actuated in a desired sequence by appropriate switch operating means such as cams, A, B, C, D, and E, respectively, driven by the timer as indicated schematically in Figure 5. Typically, the cams are also manually controlled by dial 6a, so that they may be rotated to cycle starting position by the operator, with motor 87 then carrying them through the cycle. Switch 88 is engageable in its upper position with a contact 93 and in its lower position with a contact 94. Similarly, switch 89 is engageable with either of contacts 95 and 96, switch 90 with either of contacts 97 and 98, and switch 91 with either of contacts 99 or 100. Switch 92 is movable into engagement with contact 101.

In the particular representation of Figures 5 and 6, it is to be understood that each of switches 88-91 is closed with the upper contact associated therewith during the periods indicated by the upper level lines in Figure 6, with the lower contact associated therewith during the periods indicated by the lower lines, and is open (between

the contacts) during the periods indicated by the intermediate level lines. Switch 92 is closed during the periods indicated by the raised level line and is open during the periods indicated by the lower level line. In other words, the chart of Figure 6 may be regarded for the purpose of this explanation as a development of the peripheries of the respective switch operating cams.

It will further be understood that in the usually provided construction the switch operating cams are preferably driven by an impulse, or intermittent, motion. At switch-over points, where the chart shows one switch opening and another closing, the impulse type action readily provides a quick break action so that one switch is closed simultaneously as the other is opened.

The power for energizing the different components shown in Figure 5 may be supplied from a three-wire power source comprising power supply lines 102 and 103 and a neutral line 104. This three-wire source may, for example, comprise the conventional 230 volt domestic supply having a voltage of 230 volts between lines 102 and 103 and a voltage of 115 volts between each of the supply lines and neutral line 104. The heating elements 78 and 79 are connected across the 230 volt supply lines 102 and 103. Energization of the heating elements is controlled by movable contacts 105 and 106 which in turn are controlled by a relay coil 107.

All of the other components of the machine (including relay coil 107) are connected between supply line 102 and neutral line 104. More specifically, from supply line 102 a conductor 108 is connected through conductors 109 and 110 in parallel with each other to contacts 97 and 98. Thus, when switch 90 engages contact 97 the energizing circuit for the components of the machine passes through the switch 90 from conductor 109 whereas when switch 90 engages contact 98 the completion is through conductor 110. It will be observed that the "omit dry" switch 8 is connected in conductor 110 so that completion of the circuit through conductor 110 is provided when desired by the operator and may be omitted. Conductor 108 includes a main switch 111 which may, for instance, be actuated by operation of either the "regular" cycle lever 8a or the "delicate" cycle lever 8b. Thus, whichever cycle is selected the main switch 111 is closed in order to provide operation of the machine as will be described.

From switch 90 the energizing circuit for the components continues through conductor 113 to a conductor 114. In the case of the electrical components which provide for the entry of water to the machine, that is, the condenser solenoid 81, the cold water solenoid 65, and the hot water solenoid 64, the circuit to them is completed through a switch blade member 115, incorporated in water level responsive device 70. When the water is below a predetermined level in the machine the switch arm 115 is in the position shown in engagement with contact 116, and when the water reaches a predetermined level switch arm 115 moves over into engagement with contact 117. Thus, if there is no water in the machine the circuit is completed to the two switch arms 88 and 89. If switch arm 88 engages contact 93, the condenser water solenoid is energized. When switch 88 engages contact 94, the hot water solenoid is energized. When switch arm 89 engages contact 95, the cold water solenoid is energized. It will be observed that manually operable switch 7 is arranged to connect solenoids 64 and 65 in parallel with each other when closed, the energization of these solenoids otherwise being entirely dependent on switches 89 and 88 respectively.

When switch arm 89 engages contact 96, the heater relay 107 is energized provided a thermostatic switch 118 is in the position shown. When switch 118 moves to its open position, as occurs when a predetermined temperature is reached in the machine during operation of heating elements 78 and 79, the circuit to the heater relay 107 is opened regardless of the timer action so that the

machine is prevented from any temperature greater than that desired being experienced by the clothes in the machine. Of course, switch 118 may be made adjustable in the conventional manner to provide for various temperatures to be selected by the operator.

Returning to the connection of conductors 113 and 114 from switch 90, it will be seen that they also extend to switch 91: when switch 91 engages contact 99 it provides for energization of the small motor and gear assembly 52 to cause acceleration of the basket until the adjustable sheave assembly 26 has been moved all the way over the right as viewed in Figure 2; when switch 91 is in its other closed position in engagement with contact 100, the drain valve solenoid 77 is energized to close the drain valve and prevent water from being pumped out of the machine. In addition, conductor 114 is connected through timer switch 92 to timer motor 87 and then through conductor 112 to the other side of the line so that the operation of the timer motor is thus, as shown, generally dependent on the closing of switch 92.

It will be observed that the main motor 23 is connected by a conductor 119 between conductor 114 and supply line 104 and that in parallel with the main motor there is a conductor 120 connected to a small motor 121 which, when energized, continually opens and closes a switch 122. In series with switch 122 is a manual switch 8b, which when closed completes an energizing circuit through the switches 122 and 8b for the accelerating motor and gear assembly 52 which is independent of the timer switch 91. In other words, timer switch 91 and cam D which controls it represent a first control means for causing acceleration of the basket, and may be used to cause the basket to accelerate to its spin speed in order to effect centrifugal extraction of liquid from the clothes. Switch 122 is used on the other hand as a second control means to provide a brief acceleration of the assembly 52 to cause the speed of the basket to be raised to a level which, while substantially higher than the ordinary tumbling speed, should preferably not reach a value substantially greater than that required to plaster the clothes about the inner surface of the basket. This may be achieved in the construction shown in the drawing by having switch 122 opened for five seconds and then closed for ten seconds repeatedly by the operation of the motor 121.

One further point to be covered before describing the operation of the machine of this invention is that when water level responsive switch 115 is moved into engagement with contact 117, it permits completion of a circuit through conductor 123 to timer motor 87 independently of the timer switch 92.

The operation of the machine will now be described with particular reference to Figures 5 and 6 and with the assumption that the operator wishes to select a hot water wash for regular fabrics. The switch 7 is left open and, in view of the fact that regular fabrics are to be washed rather than delicate, switch 8b is left open so that the opening and closing of switch 122 is without effect on the operation of the machine. It will further be assumed that it is desired that the drying operation follow automatically after the extraction of liquid from the clothes, and therefore switch 8 is left in its ordinary closed position. With the selection of "regular" wash by depression of lever 8a, switch 111 is closed.

At the beginning of the cycle it will be observed that cam B has caused engagement of switch 89 with contact 95, cam C has caused engagement of switch 90 with contact 97 and cam D has caused engagement of switch 91 with contact 100. The closure of switch 90 with contact 97 and of switch 89 with contact 95 causes a circuit to be completed, starting from supply line 102, through conductor 108, switch 111, conductor 109, switch 90, conductors 113 and 114, switch arm 115, switch 89, solenoid 64 and neutral line 104. Because of this, solenoid 64 is energized and opens its associated hot water valve to permit hot water to be introduced to the machine. Be-

cause switch 88 is open, no cold water is introduced at this time. It will, however, be observed that if switch 7 had been closed solenoid 65 would have been energized in parallel with solenoid 64 to cause warm water to be introduced.

When a suitable level for clothes washing purposes is reached within basket 11 switch arm 115 moves out of engagement with switch 116 and into engagement with contact 117. This deenergizes the valve solenoids and, through conductor 123, causes energization of timer motor 87 to start rotation of cams A, B, C, D and E. It will be observed that during all the time that water is being introduced to the machine the closure of switch 90 causes the drive motor 23 to be energized through line 119 so that the clothes are tumbled. This action, of course, continues as long as switch 90 is closed so that after the proper water level has been reached the clothes continue to be tumbled in the water to effect washing thereof. The energization of motor 87 permits the washing operation to continue for a suitable period of, for instance, 7 minutes, and then, shortly before the end of the washing operation the timer motor causes cam E to close switch 92. This locks in the timer motor so that it is independent of the water level sensing device 70.

Shortly thereafter, cam B opens its associated switch 89 and cam D opens its associated switch 91. The opening of switch 89 prevents energization of solenoid 64 independently of the water level control device 70. The opening of switch 91 causes de-energization of the drain valve solenoid 77, with the result that the operation of pump 73 through its direct connection to drive motor 23 drains the water out of the basket 11.

After the water has been drained out over an appropriate period of, for instance, two impulses of the timer (1½ minutes in the conventional case where each impulse takes 45 seconds) the valve solenoid 77 is re-energized to close the valve and prevent water from being removed while at the same time cam A causes switch 88 to engage contact 94 to energize the cold water valve solenoid. Since the machine is now empty of water, switch 115 is back in position to permit energization of the valve solenoid 65 and cold water enters the machine for a rinse operation. At the end of the rinse operation, which may be allowed to last on the order of two impulses, both solenoids 65 and solenoid 77 are de-energized again to prevent further entry of water and to provide for draining of water from the machine. An appropriate number of additional rinse and drain operations may be provided as shown. Also, while cold water is preferably used in the first rinse operation, one appropriate cycle provides for instance for warm water in the second and third rinse operations by energization of both solenoids 64 and 65, and for the use of hot water in the last and fourth rinse operation.

After the water has been drained from the last rinse operation, cam D moves switch 91 into engagement with contact 99 to cause energization of the gear motor assembly 52. This accelerates the basket to a relatively high spin speed which may, as stated, be on the order of 250 r.p.m., the high centrifuging speed causing the rinse water to be extracted from the clothes by centrifugal force. The water so removed from the clothes flows down into the sump and is removed by pump 73 in the same manner as the wash and rinse water. At the end of three impulses, the spin operation is interrupted by opening switch 91 to cause a return to tumble speed. After this, switch 91 is again caused to engage contact 99 to provide the remainder of the spin operation.

After the spin, cam C causes switch 90 to engage contact 98, cam A causes switch 88 to engage contact 93 to provide condenser water for the drying operation, cam B comprises switch 89 to engage contact 96 to energize relay 107 to cause, in turn, energization of heaters 78 and 79.

Provided the "omit-dry" switch 8 has not been opened,

the effect of the engagement of switch 90 with contact 98 is the same as if it engaged contact 97, that is, the operation continues. If, however, switch 8 has been opened it will be observed at this point that all components of the machine are de-energized and that the operation is ended so that the operator may remove the damp dry clothes from the machine. However, in our assumed operation the switch 8 has not been opened so that the drying operation proceeds, with heaters 78 and 79 causing drying of the clothes and operation of condenser valve 81 causing de-humidification of the air in the dryer. This continues for a suitable period of time, as selected by timer 87, at the end of which the timer opens the switch 89 to permit the clothes to continue to tumble for a period of several impulses so that they may cool down before being handled by the operator. After this cool down period, the timer then opens all the remaining switches 88, 90 and 92 to end the operation. It will be seen that this is a relatively typical type of operation of a combination washer-dryer machine, with the machine providing a sequence first a washing operation, second a liquid extracting centrifugal operation, and third a heat drying operation.

Let it now be assumed that for the next operation of the machine the operator intends to wash relatively delicate fabrics. In this case she depresses lever 8b, and quite probably closes switch 7 to select warm water instead of hot water. By proper setting of the thermostat 118 at a relatively low temperature the operator may well be able to provide the desired heat drying operation and thus again leave the "omit dry" switch 8 closed. The closing of switch 7 provides, instead of hot and cold water at various times, warm water at all times to prevent any harm from occurring to the delicate fabrics. The closing of switch 8b has the important effect of making the switch 122 effective, whenever switch 91 is open, to energize the assembly 52 when closed and de-energize it when open. The effect of the closing and opening of switch 122 is to make the speed of the basket rotation vary from a low of, for instance, 44 r.p.m., up to a high of on the order of 60 r.p.m. It has been found that by having the switch closed 10 seconds and open 5 seconds, and by varying the speed between the two limits named, the clothes are tumbling for approximately 50% of the time during the washing operation, and are plastered to the basket the other 50% of the time. It is obvious that the major part of clothes wear due to washing results from the mechanical washing action, that is, the tumbling. While this is necessary to some extent for all washings, it is preferable to reduce the mechanical washing action without reducing the chemical washing action (by the soap, detergent, etc.) for relatively delicate fabrics. The provision of switch 122 and its alternate opening and closing achieves this goal: by causing tumbling half the time, there is a desired limited amount of mechanical washing action, with the clothes the remainder of the time being plastered to the basket wall but still passing through the washing solution. In this manner, by the simple addition of the interrupter switch 122 and its controlling motor 121, a special cycle is provided which is of a highly desirable nature for the washing of delicate garments.

It will, of course, further be observed that with the circuit shown the spin operation will take place in its usual manner upon the closing of switch 91 with contact 99 since the opening of switch 122 will then be without effect to de-energize assembly 52. After the spin operation, the switch 122 again takes over control of the assembly 52 to provide the alternate tumbling and plastered condition of the clothes during the drying operation. It has further been found that this alternative condition of the clothes during drying also has desirable results, the heat transfer to the clothes being improved while the clothes are centrifuged and the evaporated moisture having the best opportunity to migrate to the condenser during

tumbling.

It will of course readily be observed that the circuitry shown in Figure 5 may be provided with switch 8b continually closed if only a single type of cycle is desired in a particular machine, and that the time the switch is opened and closed may be varied for various purposes. Thus, it has been found that the manufacturing tolerances may be far more liberal when a variable speed tumbling action is provided by the opening and closing of switch 122. This results from the fact, as described above, that if the tumbling speed is held constant it must be prevented from varying more than 3 or 4 r.p.m. over the life of the machine.

The structure thus represents the further major advantage that when so used it greatly facilitates manufacturing of the machine while at the same time obtaining the improved drying characteristics mentioned above.

It will be obvious that various modifications may be made in the construction set forth above: one such modification which readily occurs is the provision of a circuit wherein the "delicate" and "regular" cycles are obtained as described above, but only for the washing operation, with continuous tumbling being provided for the drying operation. Also, another construction which becomes obvious when the subject invention has been disclosed is the provision of a structure whereby, to obtain different types of cycles, the ratio of "open" to "closed" time of switch 122 during a given cycle is varied; such a construction, providing different total tumbling times, could readily be used instead of the "on" or "off" arrangement described.

Thus, while in accordance with the patent statutes I have described what at present is considered to be the preferred embodiment of my invention, it will be apparent to those skilled in the art that various changes and modifications, including but not limited to those mentioned above, 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 comprising a clothes container rotatable on a substantially non-vertical axis; drive means for rotating said container; means for varying the speed at which said drive means rotates said container; first control means for causing said speed varying means to increase the rotation of said container from a low clothes tumbling speed to a high liquid extracting speed; second control means for causing said speed varying means to continually vary the rotation of said container between said clothes tumbling speed and a speed higher than said clothes tumbling speed; and means for providing first a washing operation in said container during control of said speed varying means by said second control means, then a centrifuging operation in said container during control of said speed varying means by said first control means, then a drying operation in said container during control of said speed varying means by said second control means.

2. The apparatus defined in claim 1 wherein said second control means causes said speed varying means to vary the rotation of said container between said clothes tumbling speed and a speed high enough to centrifugally plaster clothes against the inner surface of said container.

3. A laundry machine comprising a clothes container rotatable on a substantially non-vertical axis; a belt drive including an adjustable sheave for transmitting rotation to said container, said drive transmitting a predetermined low speed when said adjustable sheave is in one extreme position, a predetermined maximum speed when said adjustable sheave is in its other extreme position, and being infinitely variable between said positions; means for moving said adjustable sheave between said positions; first control means for causing said sheath moving means to move said adjustable sheave to a position causing said container to rotate at a high liquid extracting speed; second control means for causing said sheath moving means

to move said adjustable sheave back and forth to continually vary the rotation of said container between clothes tumbling speed and a speed higher than said clothes tumbling speed; and means for providing first a washing operation in said container during control of said sheath moving means by said second control means, then a centrifuging operation in said container during control of said sheath moving means by said first control means, then a drying operation in said container during control of said sheath moving means by said second control means.

4. The apparatus defined in claim 3 wherein said second control means varies the rotation of said container between said clothes tumbling speed and a speed high enough to centrifugally plaster clothes against the inner surface of said container.

5. The apparatus defined in claim 3 wherein spring means are secured to said adjustable sheave to bias it to its clothes-tumbling extreme low speed position, and said sheath moving means includes an electric gear motor assembly effective when energized to move said adjustable sheave toward its other extreme position.

6. A laundry machine comprising a clothes container rotatable on a substantially non-vertical axis; drive means for rotating said container, means biasing said drive means to rotate said container at a clothes tumbling speed; means for varying the speed at which said drive means rotates said container; first control means for causing said speed varying means to overcome said biasing means thereby to increase the rotation of said container from said clothes tumbling speed to a high liquid extracting speed; second control means for causing said speed varying means to intermittently overcome said biasing means so as to continually vary the rotation of said container between said clothes tumbling speed and a speed high enough to centrifugally plaster clothes against the inner surface of said container; means for providing first a washing operation in said container during control of said speed varying means by said second control means, then a centrifuging operation in said container during control of said speed varying means by said first control means, then a drying operation in said container during control of said speed varying means by said second control means; and manually operable means for disabling said second control means to prevent it from having any effect on said speed varying means during said washing operation and said drying operation.

7. A laundry machine comprising a clothes container rotatable on a substantially non-vertical axis; drive means for rotating said container, means biasing said drive means to rotate said container at clothes tumbling speed; means for varying the speed at which said drive means rotates said container; first control means for causing said speed varying means to increase the rotation of said container from said clothes tumbling speed to a high liquid extracting speed; second control means for causing said speed varying means to continuously vary the rotation of said container between clothes tumbling speed and a speed high enough to centrifugally plaster clothes against the inner surface of said container; means for providing first a washing operation in said container during control of said speed varying means by said second control means, and then a centrifuging operation in said container during control of said drive means by said first control means; and manually operable means for disabling said second control means from affecting said speed varying means during said washing operation.

8. A laundry machine comprising a clothes container rotatable on a substantially non-vertical axis; belt drive means for rotating said container, said belt drive means including an adjustable sheave assembly having first and second extreme positions, means biasing said sheave assembly to one of said extreme positions, said sheave assembly in said one extreme position causing rotation of said container at a clothes tumbling speed and in the other of said extreme positions causing rotation of said con-

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tainer at a high liquid extracting speed; means for varying the speed at which said drive means rotates said container comprising an electric gear motor assembly operable when energized to move said adjustable sheave assembly from said first extreme position towards said second extreme position; first control means for energizing said gear motor assembly to increase the rotation of said container from a low clothes tumbling speed to a high liquid extracting speed; second control means for alternately energizing and de-energizing said gear motor assembly to continually vary the rotation of said container between said clothes tumbling speed and a speed high enough to centrifugally plaster clothes against the inner surface of said container; means for providing first a washing operation in said container during control of said gear motor assembly by said second control means, and then a centrifuging operation in said container during said control of said gear motor assembly by said first control means; and manually operable means for disabling said second control means from energizing said gear motor assembly.

9. A laundry machine comprising a clothes container rotatable on a substantially non-vertical axis; drive means for rotating said container, said drive means being biased to a position wherein it rotates said container at clothes tumbling speed; means for increasing the speed at which said drive means rotates said container comprising an

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electric gear motor assembly; first and second circuits for energizing said gear motor assembly; a timer mechanism; switch means in said first circuit operable by said timer mechanism to complete said circuit thereby to increase the rotation of said container from a low clothes tumbling speed to a high liquid extracting speed for a predetermined period; switch means in said second circuit; means alternately opening and closing said second circuit switch means during operation of said machine, for causing said drive means to continually vary the rotation of said container between clothes tumbling speed and a speed high enough to centrifugally plaster clothes against the inner surface of said container; said timer mechanism including means for providing first a washing operation in said container, then providing a centrifuging operation in said container, and then providing a drying operation in said container, said timer mechanism opening said first circuit switch means during said washing and drying operations and closing said first circuit switch means during said centrifuging operation.

10. The apparatus defined in claim 9 including a manually operable switch in said second circuit in series with said second circuit switch means, said manually operable switch having an open position and a closed position.

No references cited.

UNITED STATES PATENT OFFICE
CERTIFICATION OF CORRECTION

Patent No. 2,961,861

November 29, 1960

Joseph C. Worst

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 11, lines 72 and 75, for "sheath", each occurrence, read -- sheave --; column 12, lines 5, 8, 10 and 19, for "sheath", each occurrence, read -- sheave --; same column 12, line 63, for "drive" read -- speed varying --.

Signed and sealed this 2nd day of May 1961.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents