Dec. 8, 1959 W. R. RICKEL 2,915,888

LAUNDRY MACHINE

Filed May 2, 1955 4 Sheets-Sheet 1

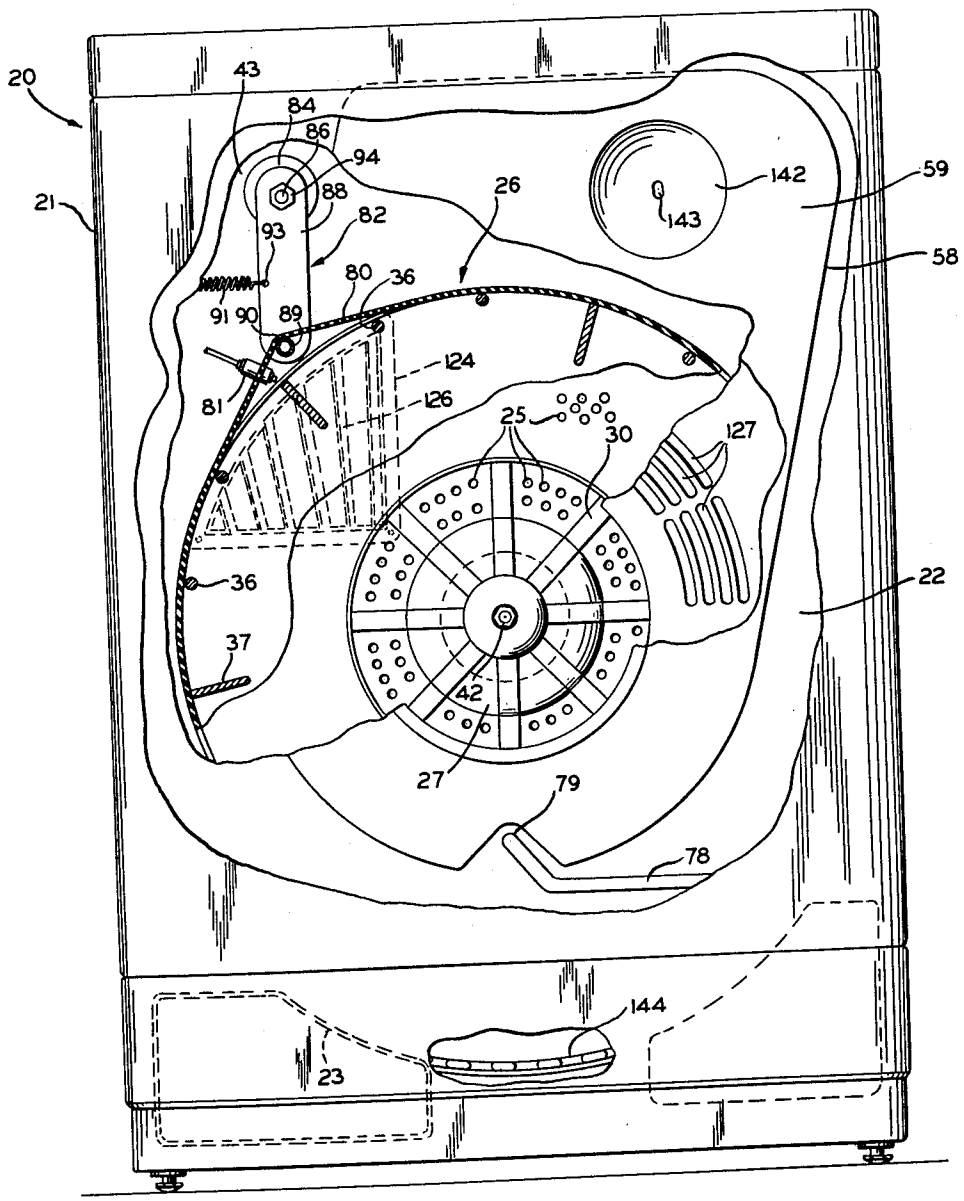


Fig. 1

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LAUNDRY MACHINE

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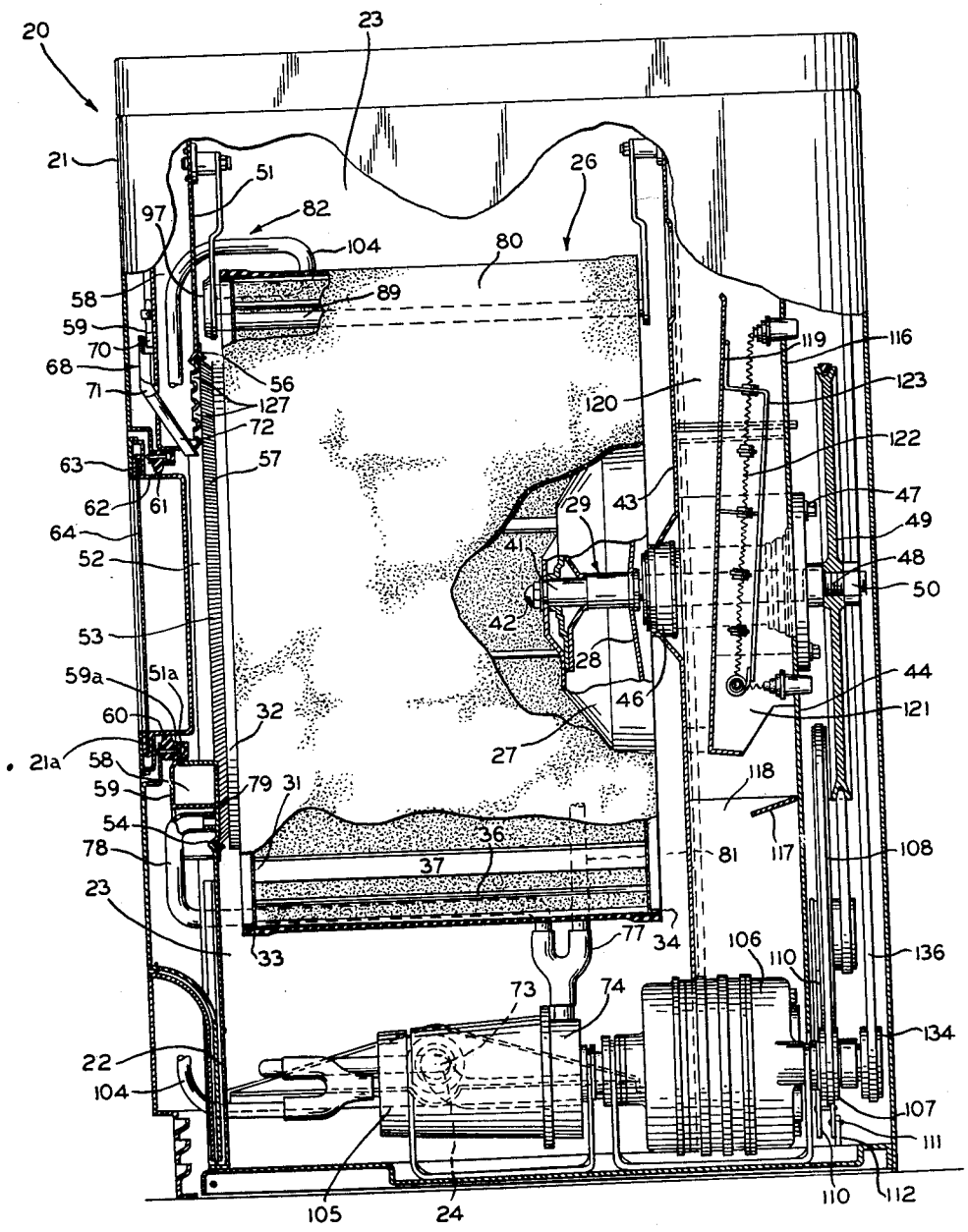


Fig. 2

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LAUNDRY MACHINE

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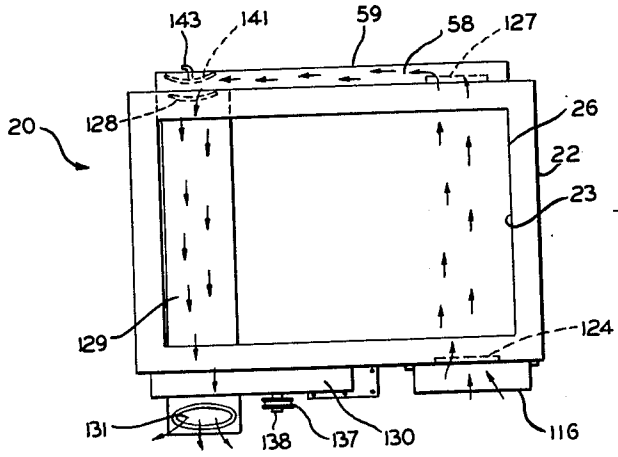


Fig. 3

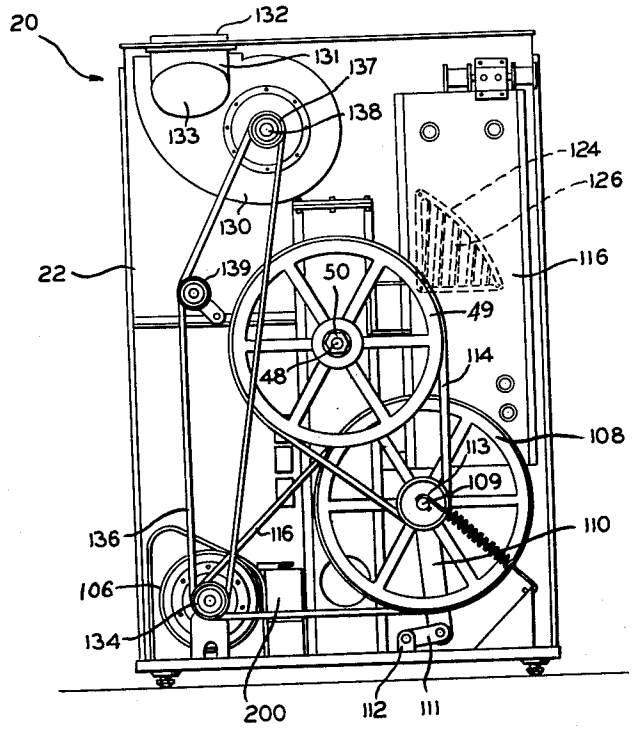


Fig. 4

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Dec. 8, 1959 W. R. RICKEL 2,915,888

LAUNDRY MACHINE

Filed May 2, 1955 4 Sheets-Sheet 4

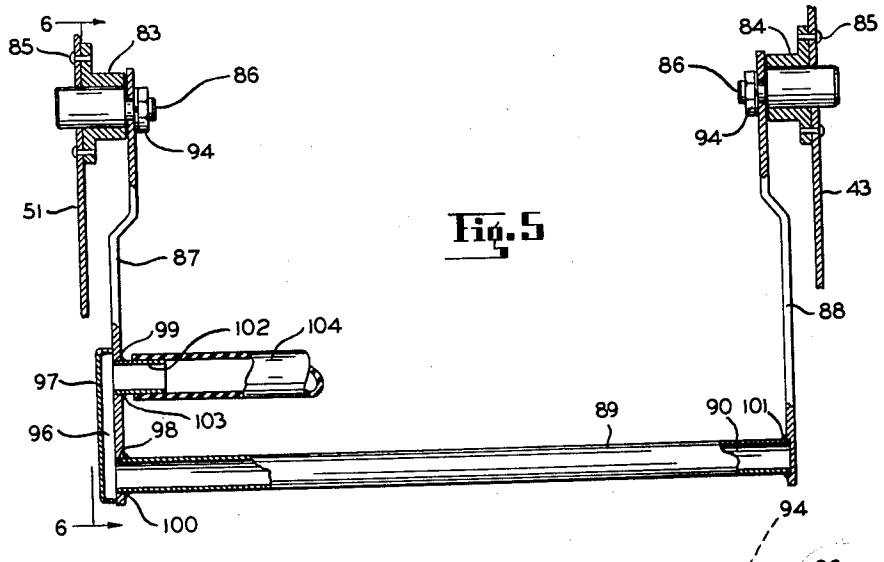


Fig. 5

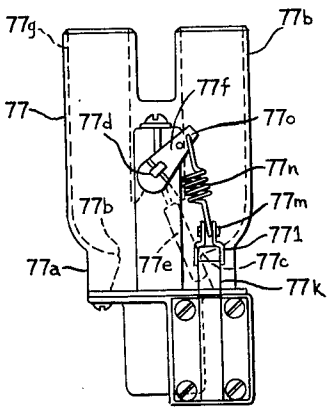


Fig. 7

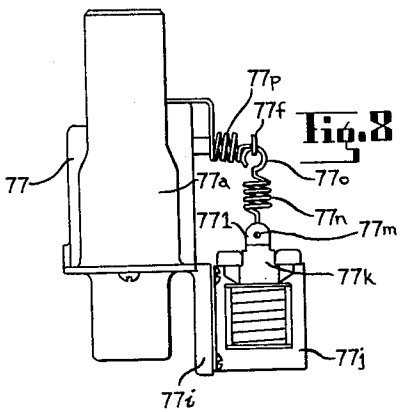


Fig. 8

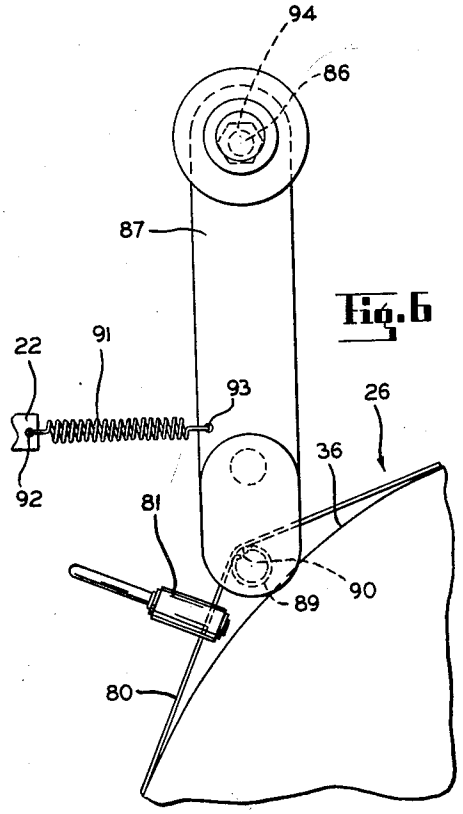


Fig. 6

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United States Patent Office 2,915,888 Patented Dec. 8, 1959

2,915,888

LAUNDRY MACHINE

William R. Rickel, Benton Harbor, Mich., assignor, by mesne assignments, to Whirlpool Corporation, a corporation of Delaware

Application May 2, 1955, Serial No. 505,310

3 Claims. (Cl. 68—19)

This invention relates generally to the art of cleaning textiles and similar materials and more specifically relates to an improved laundry machine and method whereby clothes may be subjected to the laundering steps of washing, rising, extracting and drying in one continuous operation and without the necessity of manual intervention during any intermediate portion of the laundering procedure.

Generally, the method of the present invention contemplates the laundering of a mass of textile materials such as clothes by impacting clothes wetted with a laundry liquid against a non-liquid surface to flex the clothes and force a substantial amount of the laundry liquid therefrom. The clothes are thereby enabled to take on a new supply of laundry liquid to replace that displaced by impact and the action of the impact in forcing the water from the clothes flushes away the particles of dirt carried by the clothes. The clothes are thereafter impacted against an impact-resistant liquid-absorptive surface whereupon the blotting action which occurs between the clothes and the liquid-absorptive surface will extract liquid from the clothes by a conductive transfer of moisture.

During the washing portion of the laundry procedure of the present invention, the laundry liquid used to wet the clothes is collected, after it leaves the treatment zone in which the clothes are confined, in a pool below the level of the treatment zone. Liquid is continuously returned from the pool to supply the laundry liquid entering the treatment zone.

During rinsing, a stream of rinsing liquid is substituted for the laundry liquid. The rising liquid may either be collected for recirculation, or the pool below the level of the treatment zone may be drained and a fresh supply of rinsing liquid introduced into the treatment zone.

By ceasing the supply of either laundry liquid, or rinsing liquid to the treatment zone, continued impaction of the clothes against the liquid absorptive surface will result in an extraction of liquid from the clothes. The absorptivity of the liquid-absorptive surface may be considerably improved by physically removing liquid therefrom. For example, if the liquid-absorptive surface is provided by a belt or a similar web-like device, a suction head in close association with the liquid-absorptive surface can be advantageously employed to physically remove liquid therefrom, for purposes of improving the absorptivity thereof.

To effectively complete the laundering process, the clothes are completely dried in one continuous operation by flowing a stream of air into the treatment zone for conditioning contact with the clothes. If desired, the moisture-entraining capacity of the air is enhanced by some form of temperature-conditioning.

In one preferred structural apparatus for practicing the method referred to above, a generally horizontal rotatable drum is employed. The drum is particularly characterized by the provision of front and rear walls, held in spaced parallel relationship by rods and lifters,

or by a peripheral wall in the form of a grill or grid, or by a peripheral wall of perforate sheet metal. Surrounding the periphery of the drum is a belt made of a web-like liquid-absorbent material such as a woven fabric. Substantial areas of the belt are exposed between the rods and lifters or in the open areas of the grill or grid for impingement thereagainst by the clothes contained within the drum.

A drive motor is provided for the drum to effect rotation thereof at such a speed or speeds as to manipulate the clothes for the purposes set forth.

The drive motor can also be advantageously used to drive pumping means used for either circulating laundry liquid or rinsing liquid between the interior of the drum and a pool formed below the level of the drum or to draw suction upon a manifold juxtaposed immediately adjacent the liquid-absorptive surface for the purpose of transferring liquid from the absorptive surface and to thereby improve the absorptivity thereof.

Since liquid-absorptive means are utilized to effect an extraction of liquid from the clothes, the present invention provides a machine capable of effecting a complete laundering process without the necessity of a high speed centrifugal extraction period. A rotatable drum having a liquid-absorptive belt around one wall thereof is rotated continuously in one direction at relatively low speeds for all of the steps of washing, rinsing, extracting and drying.

Furthermore, because the containing means of the laundry machine forming the subject matter of the present invention is located above the level of the pool of laundry liquid or rinsing liquid, the successive steps of the laundering process can be initiated immediately upon cessation of each preceding step, thereby reducing the length of the laundering cycle and substantially eliminating the need for waiting periods while washing or rinsing solution is being drained from the machine.

It is an object of the present invention, therefore, to provide an improved laundry method and apparatus.

Another object of the present invention is to provide a combination washer-extractor-drier in which washing, rinsing, extracting and drying operations can be carried out at relatively low rotational speeds.

Yet another object of the present invention is to provide a method and apparatus for laundering textile materials which will minimize the amounts of washing fluid and detergent or soap used as well as the amount of rinsing fluid required to be used.

A further object of the present invention is to provide a laundry machine wherein washing, rinsing, extracting and drying steps may be commenced immediately upon completion of a preceding cycle without requiring draining or other time-consuming procedures.

Another object of the present invention is to provide a horizontal-type washer wherein power requirements are reduced and wherein the necessity of providing expensive and complicated balancing apparatus is eliminated.

Yet a further object of the present invention is to provide a laundry machine wherein the time to wash, rinse and dry a load of textile materials is shortened by the amount of the time normally required to drain the machine at the end of a washing and/or rinsing period.

Still another object of the present invention is to provide a laundry machine for washing clothes which eliminates the problem of excessive build-up of suds.

A still further object of the present invention is to provide a method and apparatus for washing clothes wherein the washing operation begins almost immediately after introduction of water into the machine is commenced and as soon as recirculation of laundry liquid

begins, thereby substantially eliminating waiting periods for filling.

Many other features, advantages and additional objects of the present invention will become manifest to those versed in the art upon making reference to the detailed description which follows and the accompanying sheets of drawings in which is illustrated at least one structural embodiment of an apparatus incorporating the principles of the present invention and capable of practicing the method herein disclosed.

On the drawings:

Figure 1 is a front elevational view of a laundry machine illustrating one structural embodiment of an apparatus incorporating the principles of the present invention;

Figure 2 is a side elevational view with parts broken away and with parts shown in cross-section illustrating additional details of construction of the laundry machine shown in Figure 1;

Figure 3 is a somewhat diagrammatic plan elevational view of the laundry machine shown in Figures 1 and 2, the view of Figure 3 being reduced in size and illustrating the flow of air through the machine;

Figure 4 is a rear elevational view with parts removed illustrating additional elements of construction of the machine of Figures 1 and 2;

Figure 5 is a fragmentary view with parts broken away and with parts shown in cross-section illustrating details of a subassembly more particularly comprising the suction head apparatus utilized in connection with the present invention;

Figure 6 is a fragmentary view illustrating additional details of construction of the suction head subassembly;

Figure 7 is an elevational view of the two-way valve provided in accordance with the principles of the present invention; and

Figure 8 is a side view of the valve shown in Figure 7.

As shown on the drawings:

Although the principles of the present invention are of general utility in the laundering art, a particularly advantageous application thereof is made to a combination washer-extractor-drier apparatus wherein a batch of soiled flexible textile material such as clothes may be cleansed in one continuous operation by a series of cycles which include washing, rinsing, extracting and drying. The inventive principles herein disclosed may be embodied equally well either in a washing machine, per se, in dry cleaning apparatus, or in other subcombinations of the preferred embodiment herein shown by way of illustrative example only.

Referring first of all to Figures 1, 2, 3 and 4, a structural embodiment is illustrated which incorporates the principles of the present invention to practice the methods hereinabove described. The apparatus comprises a combination washer-extractor-drier indicated generally at **20** comprising an outer shell **21** suitably finished to enhance the decorative appearance of the machine. Inside the shell **21** is a casing indicated generally at **22** which is generally rectangular in overall configuration but which is provided with a curved generally arcuately-shaped bottom wall indicated at **23** and a sump **24** is provided at the bottom portion thereof subjacent a large hollow space enclosed by the casing **23** and which shall be characterized as a treatment zone in which the washing, rinsing, extracting and drying operations are carried out.

In order to manipulate a mass of flexible textile materials such as clothes or the like within the treatment zone, there is provided a rotatable generally cylindrical drum indicated at **26**. The drum **26** has a rear wall **27** which has offset portions spaced from an auxiliary support plate **28**, the wall **27** and the plate **28** together serving to attach and connect the drum **26** to a shaft support unit indicated generally at **29**. As shown in Figure 1, the rear wall **27** of the drum **26** is preferably provided with a plurality of openings **25**. Moreover, the rear wall **27** of the drum **26** is also characterized by the provision of a plurality of spoke-like supports **30** which are circumferentially spaced and extend radially outwardly from the central hub provided by the shaft support unit **29**, thereby serving to rigidify and support the drum structure.

As shown in Figure 2, the drum **26** includes a front wall **31** comprising a generally annular disk having its inner peripheral edge reversely turned to provide a rounded edge **32** for a centrally disposed front opening.

At the outermost extremities of the front wall **31** and the wall **27**, there is provided a flange indicated at **33** and **34**, respectively. Secured to the flanges **33** and **34** are rings **35** and **45**. Walls **31** and **27** are maintained in a parallel and spaced relationship by rods **36—36** secured as by welding to rings **35** and **45**.

It will be appreciated that a peripheral wall in the form of a grill, grid or other foraminous material, preferably metal, may be secured to the flanges **33** and **34** in lieu of the rings and rods.

The periphery of the drum is further characterized by the provision of a plurality of circumferentially spaced upstanding radially inwardly extending ribs **37**. The ribs **37** are approximately equally spaced circumferentially throughout the drum **26** and materially assist in elevating the mass of clothes contained within the drum **26** towards the upper portion of the treatment zone in which the drum **26** is located.

The shaft support unit **29** includes a rotatable shaft **41** to which the drum **26** is firmly connected for co-rotation by means of a fastening nut **42**. The shaft unit **29** is supported in a rear wall **43** of the casing **22**. A supplementary wall **44** is spaced from the rear wall **43** and together therewith serves to support the shaft unit **29** by means of a bearing housing unit **46**. Suitable fastening means for effecting this connection are shown at **47**.

The shaft **41** projects out of the rear end of the casing **22** and has a threaded end **48** on which is received a pulley wheel **49** held in firm assembly with the shaft **41** by means of a fastener indicated at **50**.

The casing **22** has spaced away from the rear wall **43** a front wall **51** particularly characterized by a centrally disposed opening **52** lying in register with the drum opening prescribed by the turned over edge **32**.

The front wall **51** is rather closely spaced to the drum **26** and in order to prevent clothes contained within the drum from becoming caught between the stationary front wall **51** and the rotatable front wall **31** of the drum **26**, there is provided an annular brush **53** having a support ring **54** locked by a retainer **56** carried on the front wall **51** and including bristles **57** which project into the drum opening closely adjacent the turned over edge **32**. If the turned over edge **32** moves in a direction to bring the edge into contact with the adjacent portion of brush **53**, the individual bristles **57** of the brush will be distorted only as necessary to accommodate the pressure exerted by the edge **32** as contrasted to a one piece retainer ring such as an annular rubber ring which would be deformed not only at the point of contact with the edge **32**, but elsewhere.

As is clearly shown in Figures 1, 2 and 3, the front wall **51** of the casing **22** forms the inner side of an irregularly-shaped air duct indicated at **58**, more specifically comprising a duct wall **59** spaced outwardly of the front wall **51**.

The duct wall **59** is also provided with a center opening lying in register with front wall opening **52** and the drum opening. A flange **59***a* surrounds the center opening. At this locale, a flange **51***a* is formed in the front wall **51** and a flange **21***a* is formed in the front wall of casing **21**. An annular rubber sealing gasket **60** embraces the flanges **21***a*, **59***a* and **51***a* and provides a sealing lip **61** to engage the side wall **62** of a door **63** glazed as at **64** and controlling access to the interior of the drum **26** through the opening **52**. In accordance with existing

practice, the door is provided with the usual hinges, handle and yieldable latch means.

In order to charge the machine **20** with a supply of liquid and in order to supply a stream of rinsing liquid into the treatment zone, a fresh water inlet is indicated at **68** attached to the duct wall **59**. The fresh water inlet **68** is of the vacuum breaking type and includes a conduit adapted to be connected to a suitable source of water supply discharging as at **70** into a funnel-like device **71** which has at its bottom portion a spout **72** projecting inwardly through the opening **52** to supply a stream of water into the drum **26**.

It is contemplated, according to the present invention, that a very small amount of laundry liquid be used compared to the requirements of machines heretofore provided since the present invention does not require that a level of laundry liquid be established such that the lower portion of the rotatable drum will be immersed in a pool of liquid to a depth that the clothes to be washed need be substantially wholly immersed therein and carried therethrough by the rotative action of the drum. Rather, the water charged into the machine is collected below the level of the treatment zone in the sump **24**.

As is clearly shown in Figure 2, the sump **24** has an outlet **73** upon which a suction is taken by a pump **74** drawing through a conduit **76**.

As shown in Figures 2, 7 and 8, the pump **74** has a two-way discharge controlled by an electric motor or solenoid-operated valve **77**, one of the discharges being provided by a conduit **78** carrying liquid from the sump **24** to a discharge outlet **79**, thereby to supply a stream of laundry liquid into the treatment zone and to direct it into the interior of the drum **26** for conditioning contact with the clothes contained therein.

The laundry liquid discharged at the outlet **79** drains from the drum **26** and is collected in a pool below the level of the treatment zone, thereupon the laundry liquid may be returned from the pool by the pump **74** through the conduit **78** and the outlet **79** to continuously supply the laundry liquid stream for conditioning contact with the clothes as they move past the stream and as the drum is rotated during the washing operation.

One of the advantages resulting from this invention is that the time required for filling and draining the machine does not add to the total time cycle since it can occur simultaneously with other functions. For example, if water and detergent are used as a cleansing agent, as soon as introduction of water into the machine begins, the liquid finds its way into the sump and recirculation of the liquid can begin. The washing portion of the cycle can be immediately initiated without waiting for the full charge of water to be added. As soon as liquid reaches the sump recirculation begins, maximum effectiveness of the washing action is obtained.

Using the orientation of Figure 1, it will be appreciated that the drum **26** can be rotated counterclockwise, whereby the clothes contained in the drum **26** move through the stream of laundry liquid emanating from the discharge outlet **79**. This insures saturation of the clothes with laundry liquid prior to impact thereof against the wall of the drum near the lowermost portion of the drum so that flexure of the fibers will occur in the presence of the laundry liquid and so that laundry liquid will be present to replace that flushed from the clothes during the force of their impact.

It will be appreciated that the lowermost portion of the wall of the drum **26** is considerably above the level of the pool in which the laundry liquid is collected. Moreover, it will be further appreciated that the sump outlet **73** permits the pump **74** to take a suction upon the lower portion of the pool in sump **24**. This arrangement insures that any sudsing action will not interfere with any phase of the washing cycle since the suds will merely be harmlessly carried at the top of the pool but below the level of the rotating drum **26**.

Referring specifically to Figures 7 and 8, it will be noted that the valve **77** comprises a housing portion **77***a* having formed therein two separate valve seats **77***b* and **77***c* which are circumferentially spaced relative to a common axis **77***d*, which axis forms the pivot axis of a shutter **77***e*. The shutter **77***e* seats and closes the openings formed by the valve seat **77***b* and **77***c*, selectively, upon actuation of a lever arm **77***f*. The openings formed by the valve seats communicate with two separate passageways formed in the valve body **77***a* and indicated respectively at **77***g* and **77***h*.

To effect electrical actuation of the two-way valve **77**, a flange **77***i* is formed on the body portion **77***a* to which is attached an electrical actuating motor such as a solenoid indicated at **77***j*.

The movable solenoid plunger is indicated at **77***k* and is attached by means of a connecting bracket **77***l* and cotted pin **77***m* to a solenoid spring **77***n*, the other end of the spring **77***n* being connected as at **77***o* to the lever arm **77***f*. The valve **77** is also provided with an actuating spring **77***p* which biases the shutter **77***e* in one direction.

Upon completion of the washing cycle, the valve **77** may be actuated by energizing the control motor or solenoid **77***j* associated therewith whereupon the pump **74** will discharge laundry liquid collected in the sump **24** through a drain conduit indicated on Figure 2 at **85**.

Rinsing liquid is then supplied in the form of a stream discharged from the spout **72** and projected downwardly through the drum **26** for conditioning contact with the clothes contained therein. Since the clothes in the drum are not immersed in laundry liquid, introduction of rinsing liquid may be commenced before the laundry liquid is drained from the sump **24**, or while it is being drained therefrom with a resultant time savings as contrasted with machines in which all or a major portion of the laundry liquid must be drained away before the rinsing operation can be started. If desired, the rinsing liquid may be recirculated by the pump **74** after the laundry liquid has been drained from the sump.

The present invention is particularly characterized by the provision of a liquid-absorptive surface on the periphery of the drum **26**. Such a surface is conveniently provided by forming and providing a belt of a web-like material preferably taking the form of a woven fabric having suitable liquid-absorptive characteristics; by "liquid-absorptive" is meant any sorptive means, whether technically comprised of absorptive or adsorptive substance. A typical belt is indicated at **80** and it will be noted that the belt comprises a continuous annular member which extends between the front and rear walls **31** and **27**, completely encompassing the drum **26**.

Since the belt **80** is juxtaposed immediately concentrically adjacent the periphery of the drum **26**, substantial portions or areas of the belt **80** are exposed to the interior of the drum **26** through the open areas between the rods **36**. These areas of the belt **80** are impinged upon by the mass of clothes tumbling within the drum **26** and, depending upon the absorptivity of the belt **80**, liquid will be transferred from the clothes to the belt.

To assist in maintaining the belt **80** in position on the drum **26**, a plurality of confining rollers **81**, as shown in Figures 1 and 6, may be provided to engage the edge portions of the belt **80**.

Liquid is physically removed from the belt **80** to improve the absorptivity thereof according to the illustrative embodiment herein described by means of a suction manifold indicated generally at **82** and illustrated in detail in Figures 5 and 6.

Referring, therefore, to Figures 1 and 2 in conjunction with Figures 5 and 6, it will be noted that the walls **43** and **51** are provided with bearing blocks **83** and **84** fastened in place by suitable fastening means indicated at **85** and journaling therein a pair of pivot pins **86**, **86** to which

there is attached a front pivot arm 87 and a rear pivot arm 88.

The bearing blocks 83 and 84 are located generally superjacent the drum 26 with the pivot arms 87 and 88 depending towards the drum 26. Moreover, using the orientation of Figure 1, it will be noted that the entire suction manifold apparatus is located in the upper left quadrant relative to the rotational axis of the drum 26, which area is, under ordinary circumstances, not directly contacted by the tumbling clothes within the drum.

Extending between the pivot arms 87 and 88 is a suction pipe 89 having an elongate slot 90 formed therein establishing communication between the peripheral surface of the suction pipe and the hollow interior thereof. As shown in Figure 1, the suction pipe 89 preferably underlies the belt 80. Continuous biasing means in the form of a coil spring 91 are extended between the casing 22 and the pivot arms 87 and 88. For example, the coil spring 91 has one end attached to the casing 22 as at 92 and the opposite end of the coil spring 91 is attached as at 93 to a medial portion of a corresponding pivot arm 87 or 88. The continuous biasing force provided by the coil springs 91 tensions the belt 80 on the peripheral surface of the drum 26 and also affords good engagement between the belt 80 and the suction pipe 89. As will be noted upon referring to Figure 6, the slot 90 formed in the suction pipe 89 is so positioned that it will lie at the apex of the angle prescribed by the belt 80 as it passes over the suction pipe 89.

The pivot arms 87 and 88 are retained in firm assembly with the respective pivot pins 86 by means of fasteners indicated at 94.

In order to exhaust water or liquid from the suction pipe 89, the pivot arm 87 is provided with a manifold chamber 96 which is conveniently formed by wall means 97 spaced outwardly of the pivot arm 87 and establishing communication between a pair of spaced openings 98 and 99 formed near the end of the pivot arm 87. It will be understood that the suction pipe 89 is assembled in one of the openings, for example, the opening 98 and is firmly fixed in place with a leakproof joint such as a welded joint indicated at 100, thereby establishing good communication between the manifold chamber 86 and the interior of the hollow suction pipe 89. The opposite end of the suction pipe 89 is welded as at 101 to the pivot arm 88, thereby providing a closed end for the suction pipe 89.

Assembled to the pivot arm 87 at the other opening 99 is a nipple fitting 102. A welded joint 103 places the nipple joint 102 in firm assembly with the pivot arm 87 and a flexible conduit 104, such as a hose or the like is conveniently assembled on the nipple fitting 102 for the purpose of connecting the suction apparatus to a fluid exhausting means taking the form of a pump.

The conduit 104 is shown connected to a second two-way valve 75, similar to two-way valve 77 previously described, which in turn is connected to pump 74 which constitutes a means for applying a vacuum to the vacuum or manifold chamber 96 when the two-way valve 75 is open to hose 104, thus, in turn, applying a vacuum to the side of the belt 80 which contacts the clothes.

Since the pump 74 will create a partial vacuum in the suction pipe 89, air from the atmosphere will be drawn through the belt 80 and will carry with it liquid which has been transferred by contact from clothes impinging against the belt 80 through the slot 90 and into the suction pipe 89, through the chamber 96, the conduit 104, two-way valve 75 and to the pump 74 from whence the liquid will be discharged.

It will be appreciated that the placement of the suction pipe 89 on the underside of the belt 80 permits the apparatus not only to operate as a tensioning apparatus with respect to the belt 80 but also locates a liquid exhausing vacuum chamber, namely the hollow suction pipe 89, as the same side of the belt 80 as that which contacts the clothes inside of the drum 26. This makes it unnecessary for the liquid, which conceivably might have soil particles therein, to pass completely through the belt and minimizes the possibility of the belt 80 retaining soil and transferring the soil to succeeding clothes loads.

Referring to Figures 2 and 4, it will be noted that an electric motor is indicated at 106. A power take-off shaft extends out of opposite ends of the motor 106, one being adapted to rotatably drive the pumping units 74 and 105 and the other being adapted to drive a pulley system most clearly illustrated in Figures 2 and 4.

First of all, a drive pulley 107 is rotated by the electric motor 106. Spaced away from the motor 106 is an idler pulley 108 having a shaft 109 carried by a bracket 110 pivoted as at 111 to a frame support 112 carried by the casing 22.

The idler pulley 108 effects a speed reduction by the provision of a smaller diameter belt run 113 receiving a pulley belt 114 engaged with the pulley wheel 49 connected to the shaft 41 in driving relationship with the drum 26. The pulley belt 116 is trained over the pulley wheel 108 and the pulley wheel 107, thereby completing the drive connection between the electric motor 106 and the drum 26.

Under normal operations, the drum 26 is rotated continuously in one direction, thereby tending to elevate and drop the clothes.

In order to supply a stream of air into the treatment zone, additional structure is provided which can be noted upon making particular reference to Figures 1, 2, 3 and 4. There is attached to the back wall 43 of the casing 22 a duct 116. A bottom flange 117 terminates outwardly of the rear wall 43, thereby leaving a bottom opening indicated at 118 (Figure 2).

As shown in Figure 2, extending upwardly from the opening 118 is a baffle 119 generally angularly disposed to provide a front passage 120 and a rear passage 121 extending vertically through the duct 116.

Electrical heating coils 122 of a heater unit are indicated at 123, are carried by the baffle 119 and the duct 116 and are located in the rear passage 121. The baffle 119 is imperforate and forms a shield forwardly of the heating coils 122 to prevent suds or water that might perchance find its way from the treatment zone through the opening 124, described hereinafter, from contacting the heating coils 122.

At the top of the duct 116 but extending below the level of the baffle 119, the rear wall 43 is provided with a quadrant-shaped opening 124 having a plurality of generally vertically extending louvers 126 (Figure 1 and Figure 4).

In the front wall 51 on the opposite side of the treatment zone, there is provided a plurality of louvered openings 127 which establish communication between the duct 58 and the treatment zone in which the drum 26 is rotated.

Reference to Figure 1 in conjunction with Figure 2 will indicate that the louvered openings 127 are generally a series of circumferentially spaced arcuate slots extending through approximately 180° around the center opening 52 and the front wall 51 of the casing 22. Moreover, the louvered openings 127 are located radially inwardly of the bristles 57 of the brush 53 so that the flow of air between the duct 58 and the treatment zone will be principally through the drum 26.

Referring now specifically to Figure 3, it will be noted that the front wall 51 has an opening 128 formed therein in register with a rearwardly extending duct 129 which, in turn, terminates at a blower 130 having a discharge duct indicated at 131. The discharge duct 131 has a top opening 132 which may be utilized or, if desired, a side opening herein shown plugged as at 133 may be alternatively used.

A flow of air is induced through the treatment zone by operating the blower 130 to establish a low pressure in

the passage provided by the duct **129** whereupon air will be drawn upwardly through the opening **118** into the duct **116**. The air will move upwardly through the duct **116**, its flow being divided by the partition **119** so that a portion of the air passes through the outer passage **121** past the heating coils **122** and the balance of the air passes through the inner passage **120** over the partition **119** which is heated by the coils **122**. The air drawn upwardly through both passages will mix at the top of the partition **119** and will be drawn through the opening **124** for conditioning contact with the clothes contained within the drum **26**.

Having been temperature-conditioned, the air drawn into the drum will exhibit improved moisture-entraining properties and will entrain moisture in the mass of clothes tumbled within the drum **26** before passing from the drum and through the louvered openings **127** into the duct **58** and thence through the opening **128**, the duct **129** and out the pump discharge **131**.

The blower **130** may be conveniently driven by the same electric motor **106** as drives the drum **26**. To effect that end, the shaft of the motor **106** is provided with an additonal driving pulley **134** engaging a pulley belt **136** looped through the groove of a pulley wheel **137** connected for corotation with the shaft **138** of the blower impeller (not shown).

An idler pulley **139** is shown rotatably connected to the casing **22** to control the tension of the pulley belt **136**.

Although the blower **130** might be so connected as to be operated only during the drying cycle of the cleansing operation, this particular form of the invention shows an arrangement wherein the blower operates constantly. Accordingly, to prevent flow of air through the drum except as such flow may be desired, a valve indicated at **141** is provided for selectively opening and closing the opening **128**. As is shown in Figure 1 and Figure 3, the duct wall **59** has a spherical indentation **142** generally complementary in shape to the valve **141**, the valve being formed as a valve plate of a large enough size to close the opening **128** when seated therein. An actuating rod **143** is connected to the valve plate **141** and extends through the duct wall **59**. Motor operated means, such as a solenoid, can be incorporated in the control system of the laundry machine to open and close the valve **141** as desired.

The sump **24** may be equipped with a sump heater comprising an immersion-type heating coil **144**, whereby the liquid collected in the pool below the level of the treatment zone may have thermal energy transferred thereto. As has been pointed out above only a small amount of laundry liquid is required to carry out a washing cycle and thus permits use of cold water directly from the domestic supply, if desired, the heating coil **144** serving to heat the water to a temperature best suited for washing the fabrics and maintaining the water at an optimum temperature, all with a minimum of power consumption.

The structure hereinabove described adequately develops the steps of the novel process of the present invention. The drum **26** permits a mass of clothes contained within the drum to be acted upon to accumulate potential energy by effecting a change in the physical position of the mass whereupon the mass is released and subjected to gravitational acceleration to convert the potential energy of the mass into kinetic energy. The kinetic energy may then be advantageously used to flex the mass of clothes by abruptly checking the gravitational acceleration of the mass against an impact-resistance surface. Preferably, a stream of conditioning fluid is directed against the mass prior to impact flexure so that the fibers of the textile materials will be flexed while saturated with a laundry liquid or a cleansing agent, the impact of the mass against the impact surface serving to force a portion of the water, contained in the clothes, therefrom with a resulting flushing action, thereby conditioning the clothes to take on a new supply of laundry liquid displaced by the impact.

The elevating action on the mass of clothes is improved by the use of the fins or baffles **37** which physically lift the clothes from a lower position to the upper position in the drum.

Ideally, it is contemplated that the mass of clothes, or successive masses of clothes in a single batch, will leave the wall of the drum near the uppermost portion thereof and will fall generally downwardly towards the lowermost portion of the drum, whereupon the free fall of the clothes will be checked to abruptly change the gravitational acceleration thereof by impact against the belt **80** near the lowermost portion. In other words, if a circle were drawn at the point with its center on the axis of the drum **26** and in a plane perpendicular to that axis, the point of impact would preferably lie in the third quadrant of the circle between a portion corresponding to 180° and the bottom of the circle at 270°, or, in terms of clock teminology, between 6:00 o'clock and 9:00 o'clock.

During rinsing, the drum is preferably operated in the same manner as during the washing cycle so that the mass of clothes will be successively elevated to the uppermost portion of the drum and will be gravitationally accelerated towards the lowermost portion of the drum where the impact of the clothes against the belt causes maximum flexure and forces the water carried by the clothes out of the clothes to provide a flushing action and to condition the clothes to pick up clean rinse water for repetition of the cycle, thereby resulting in a highly efficient and thorough rinsing.

During the drying cycle, the drum is rotated in the same manner as during the washing and rinsing cycles and the tumbling action effected by the successive elevation of the clothes towards the uppermost portion of the drum and the subsequent gravitational acceleration of the clothes towards the lowermost portion of the drum effects a fluffing action and opens the clothes, which minimizes wrinkle formation and otherwise enhances the drying function.

The intermediate step of extraction is also carried on with the drum rotating in the same manner as during the washing and rinsing cycles. The tumbling action effects an impingement of the wet clothes against the liquid-absorptive belt **80**, whereafter the liquid is physically removed from the belt to maintain the absorptivity thereof. Moreover, since the present invention contemplates placement of the physical liquid-removing means on the same side of the belt as that which contacts the clothes, it is unnecessary for any soil-laden water to pass completely through the belt, and soil retention by the belt is thereby minimized. If desired, temperature conditioned air may be introduced at any time during the washing, rinsing and/or extraction cycles.

Those versed in the art will appreciate that all of the structural elements herein described can be effectively actuated and operated by means of a single control system which will insure successive initiation of the various cycles in a fully automatic manner.

By way of summarization, a typical laundering sequence will be described.

First of all, a quantity of soiled textile materials are placed within the interior of the drum **26** through the opening controlled by the door **63**. Electrical controls for the regulation of water temperature, and for control of the washing and drying cycles are preset in advance so that no further manual intervention will be required.

The washing cycle is initiated by the introduction of a charge of water from the fresh water inlet **68**. The water enters the conduit **69** through an electrically-operated thermostatically-controlled mixing valve (not shown) of a type well known to those versed in the art. A float switch **200** (Figure 4) is provided and so connected in the control circuit as to shut off the supply of water through the mixing valve when the level of the

water in sump 24 reaches a predetermined level. A suitable supply of detergent is introduced into the sump 24 by manual or automatic means, either while water is being supplied or after the desired level has been reached. The motor 106 is then energized to rotate the drum 26 in one direction. The clothes are elevated against the forces of gravity through an appreciable distance and thereafter fall subject to the forces of gravity through an appreciable distance.

Since the drum 26 confines the movement of the clothes during the elevating and than the falling motion thereof, the gravitational acceleration of the falling clothes will be abruptly checked by impact against the belt 80. During the washing cycle, the pump 74 will supply a continuous stream of laundry liquid through the discharge outlet 79, thereby saturating the clothes and insuring flexure of the textile fibers in the presence of an adequate supply of laundry liquid and resupply of laundry liquid to the clothes to replace that flushed from the clothes by their impact against the surface of the lower portion of the drum. The liquid leaving the drum is collected in a pool below the level of the treatment zone and laundry liquid from the pool is returned by the pump 74 to supply a continuous stream of laundry liquid into the drum during the washing portion of the cycle.

After the clothes have been washed in this manner, the laundry liquid is removed in an extraction cycle initiated by causing the pump 105 to exhaust the suction pipe 89 of liquid and to provide a partial vacuum which will facilitate passage of air from the atmosphere through the belt carrying water into the suction tube for discharge outwardly of the machine. The tumbling of the clothes against the liquid absorptive belt will physically remove a substantial portion of the liquid from the clothes by conductive absorption.

Following extraction of the laundry liquid, rinsing liquid is projected over the tumbling clothes, thereby rinsing away the laundry liquid and further contributing to the cleansing of the clothes. Rinsing liquid is introduced through the fresh water inlet 68, introduction of the rinsing liquid being commenced, if desired, before the laundry liquid in sump 24 is drained away. After the laundry liquid has been drained away, rinsing liquid can be collected in sump 24 for recirculation over the tumbling clothes to provide additional rinsing. An additional extraction cycle is utilized to remove rinsing liquid in the same manner as described above.

Either during or after the extracting cycle, a stream of air is supplied through the treatment zone by opening the valve 141 to permit air to be drawn through the drum 26 in conditioning contact with the tumbling clothes. It will be understood that during the drying operation the drum is rotated at the same speed as it is rotated during the washing, rinsing and extracting cycles. If it is desired to enhance the water-entraining properties of the air, the heating unit 123 is energized.

Having passed through the various stages of the laundering operation successively, the completely cleaned and dried clothes are now ready for removal from the machine.

Although various minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent warranted hereon all such modifications as reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. In a laundry machine for subjecting clothes to successive washing and drying operations, a generally horizontal drum, a belt surrounding said drum and forming a peripheral wall for the drum to confine clothes within the drum during washing and drying operations, and tensioning and water-removal means comprising a suction pipe underlying the belt to contact the surface of the belt impinged upon by the clothes, said tensioning and water-removal means further including pivot arms at opposite ends of said suction pipe, means for exhausting water and air from said suction pipe, and biasing means engaging said pivot arms to bias said suction pipe in one direction for tensioning the belt and maintaining a good contact between the belt and the suction pipe for removal of liquid from the belt.

2. In a laundry machine as defined in claim 1, said drum being rotated such that the clothes are elevated until near the uppermost portion of the drum, the uppermost portion of the drum on the side opposite the top of the drum being free of clothes by virtue of the falling action of the clothes to provide an unobstructed belt portion, and said suction pipe engaging said belt on the side thereof contacted by the clothes and at said unobstructed portion to physically remove water therefrom.

3. A laundry machine for washing and drying fabrics, comprising a rotatable container having a wall formed by a liquid sorptive belt, drive means rotating said container at a continuously constant speed about a generally horizontal axis at a tumbling speed to cyclically elevate and drop said fabrics, conduit means forming a laundry liquid circuit for said machine in which laundry liquid is collected below the level of said container and including a pump to keep the drum substantially free of excess liquid, thereby to flex said fabrics against the liquid sorptive belt by impact during both the washing and drying operations, said conduit means including a nozzle receiving laundry liquid discharged by said pump and said nozzle applying a continuous stream of cleaning fluid through the interior of said container into said fabrics prior to their impact with said liquid sorptive belt so that the flexure of said fabrics from said impact displaces absorbed laundry liquid from said fabrics in a flushing action, a suction pipe underlying said belt and engaging the inside surface of said belt contacted by said fabrics, means connected to said suction pipe applying a pressure differential across said liquid sorptive belt during the drying operation to withdraw liquid from the liquid sorptive belt, thereby improving the sorptivity thereof, pivot means including arms at opposite ends of said suction pipe, and spring means operatively connected to said arms and spring biasing said arms to tension the belt and maintain good contact at said suction pipe.

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