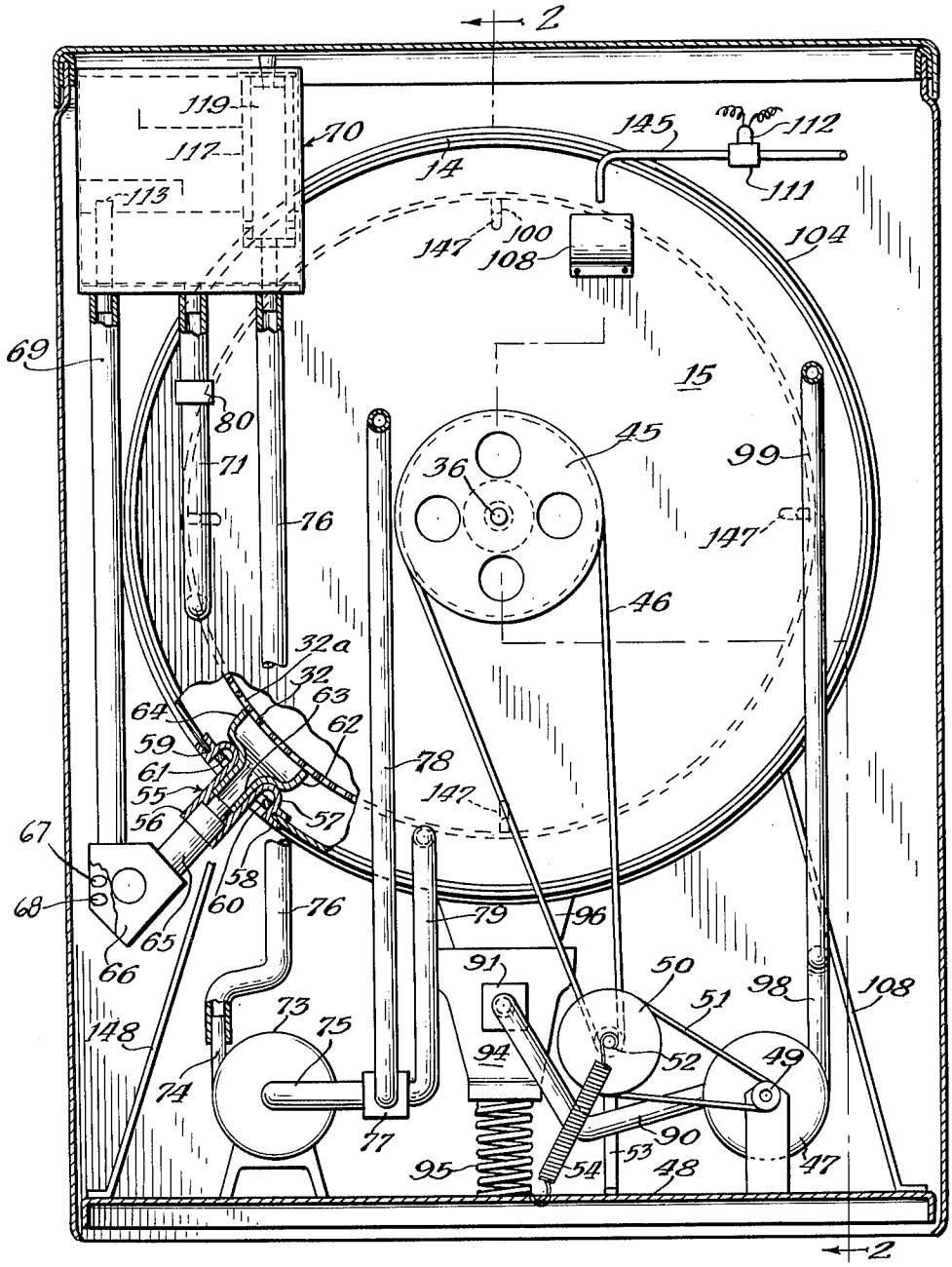
June 28, 1966 R. J. LACHAT ETAL 3,257,736

METHOD OF AND APPARATUS FOR LIQUID EXTRACTION

Filed Nov. 27, 1963 6 Sheets-Sheet 1

FIG. 1



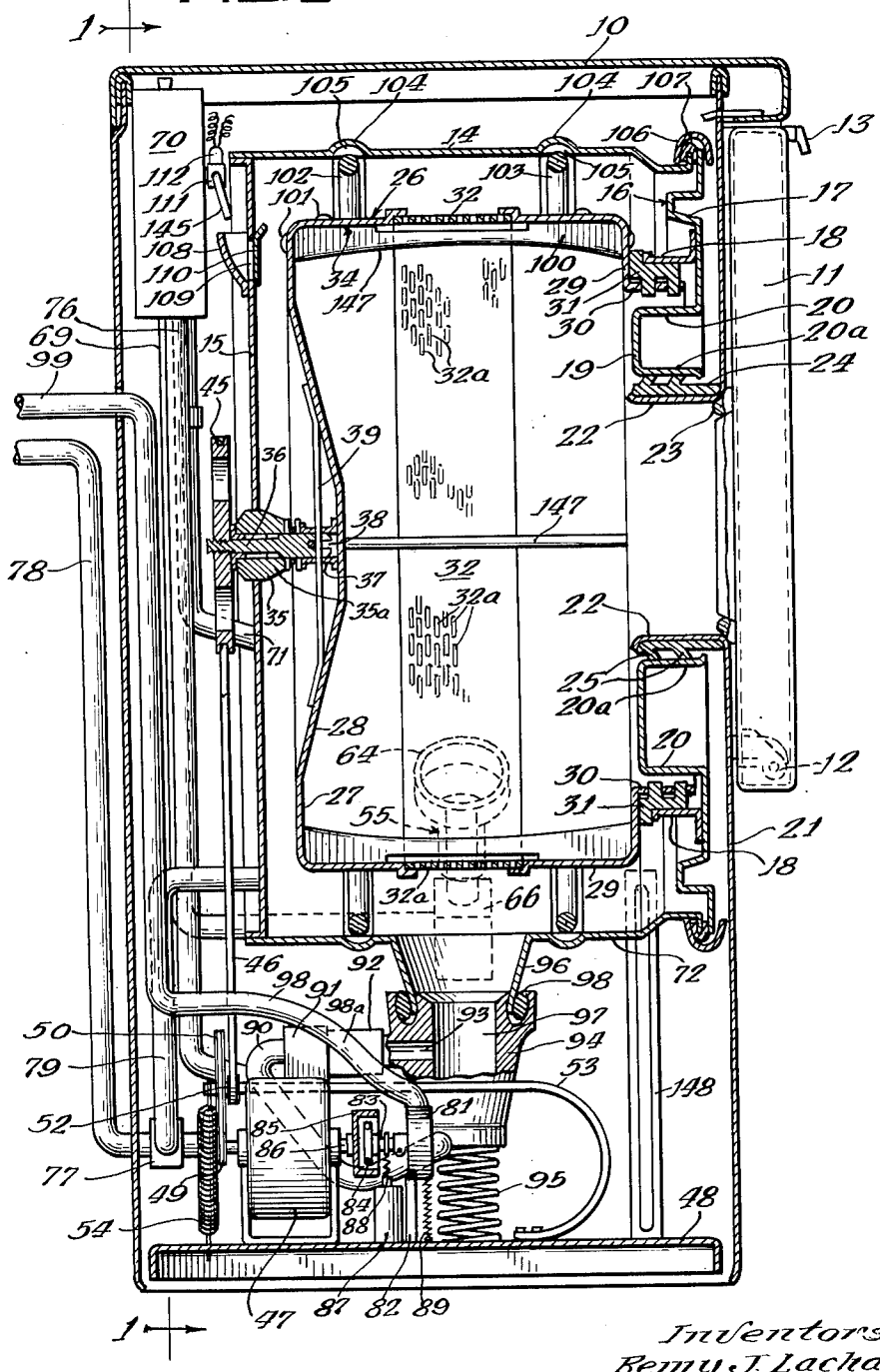
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METHOD OF AND APPARATUS FOR LIQUID EXTRACTION

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FIG. 2



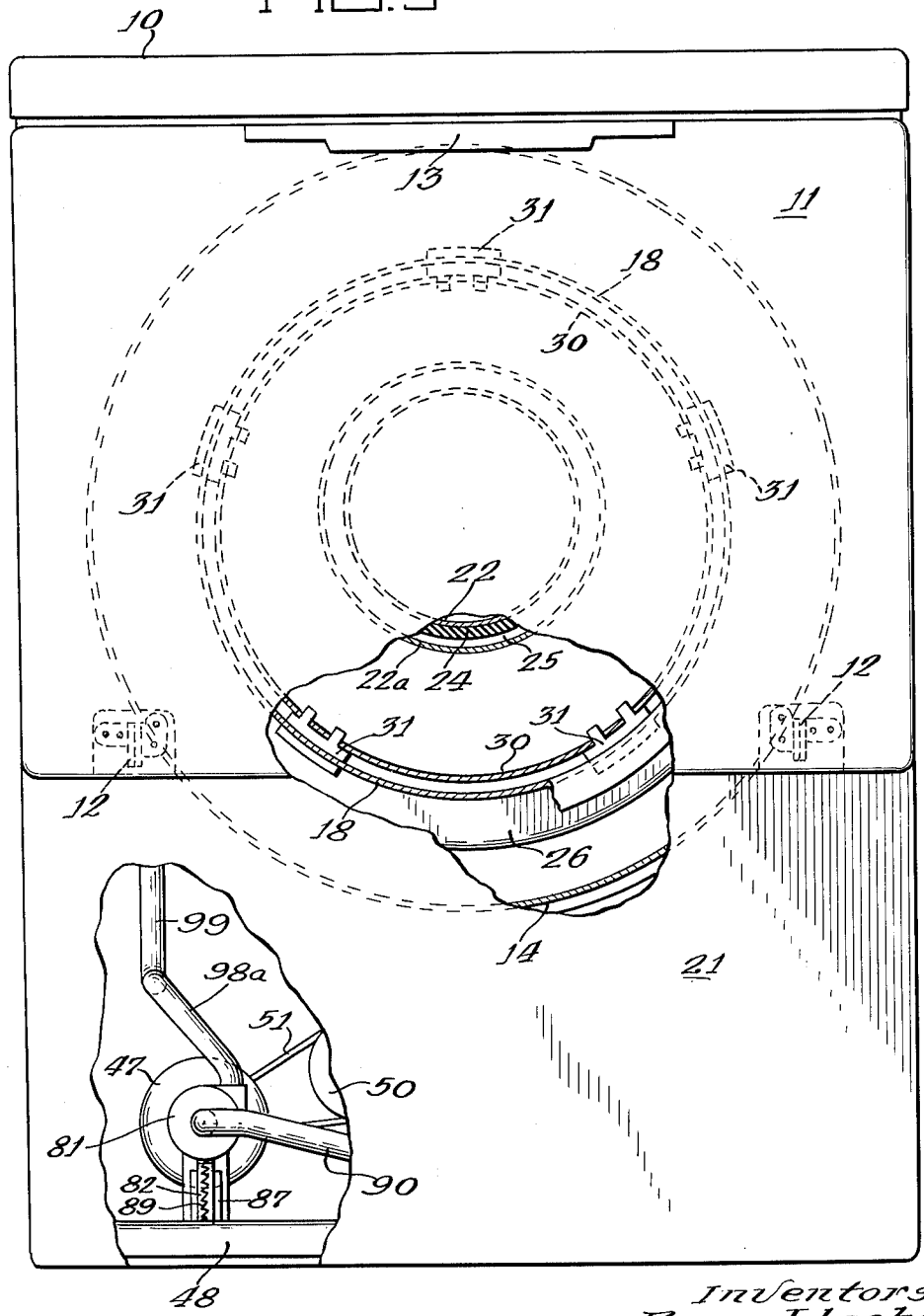
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METHOD OF AND APPARATUS FOR LIQUID EXTRACTION

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FIG. 3



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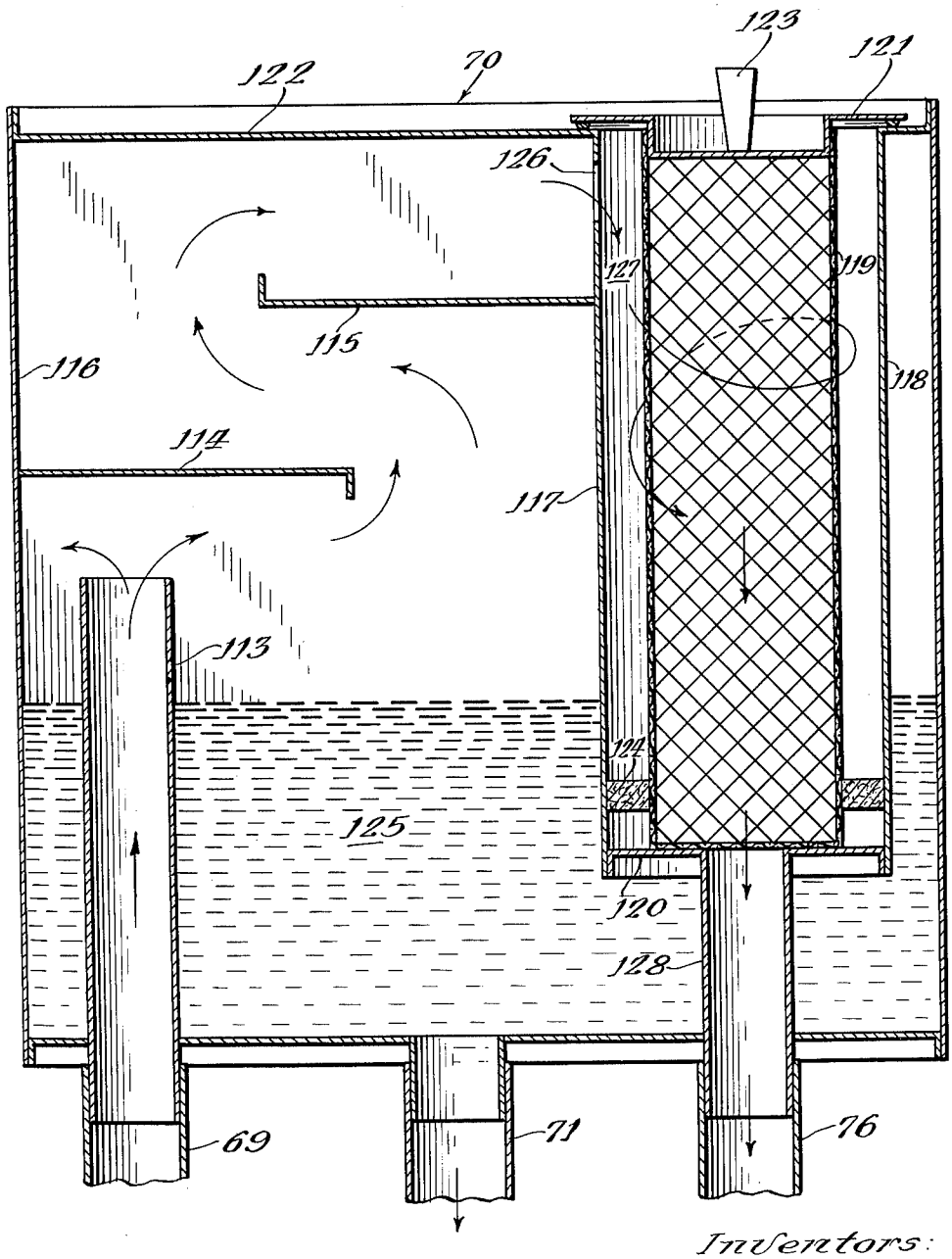
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METHOD OF AND APPARATUS FOR LIQUID EXTRACTION

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FIG. 4



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METHOD OF AND APPARATUS FOR LIQUID EXTRACTION

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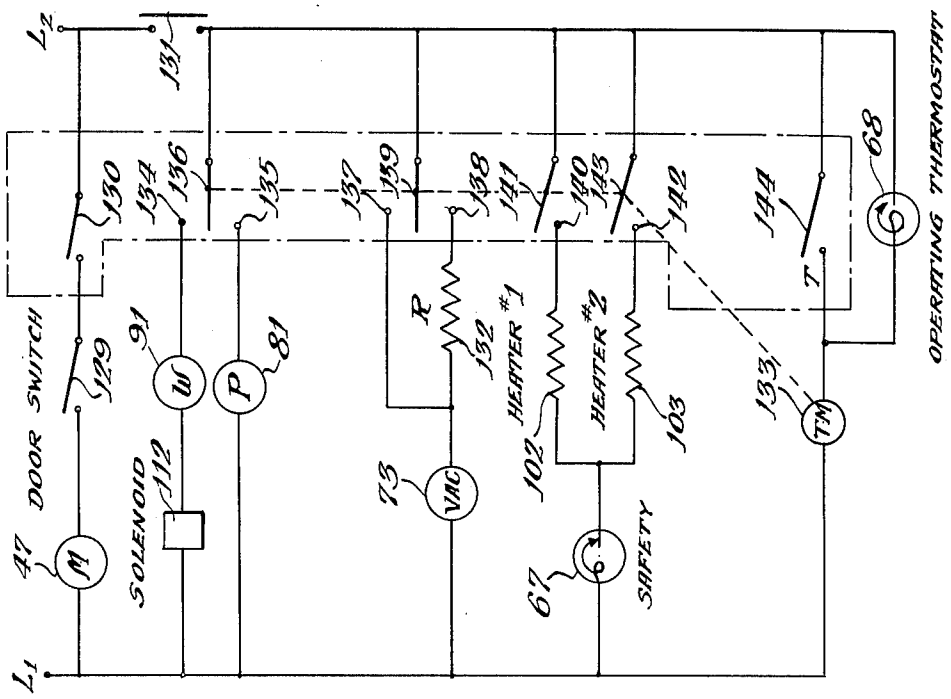


FIG. 7

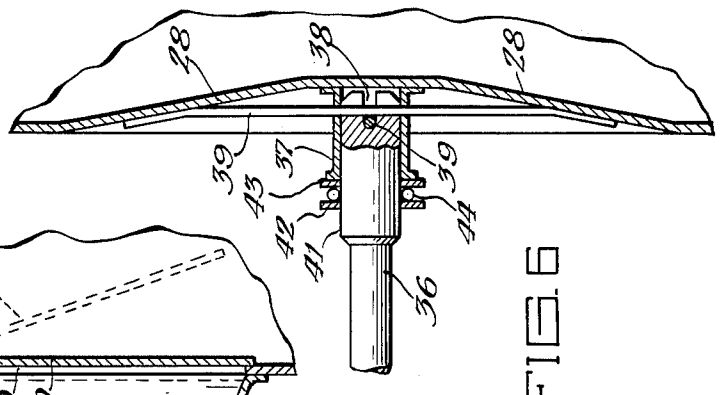


FIG. 6

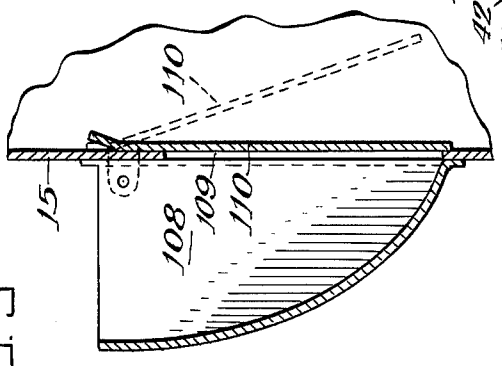


FIG. 5

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METHOD OF AND APPARATUS FOR LIQUID EXTRACTION

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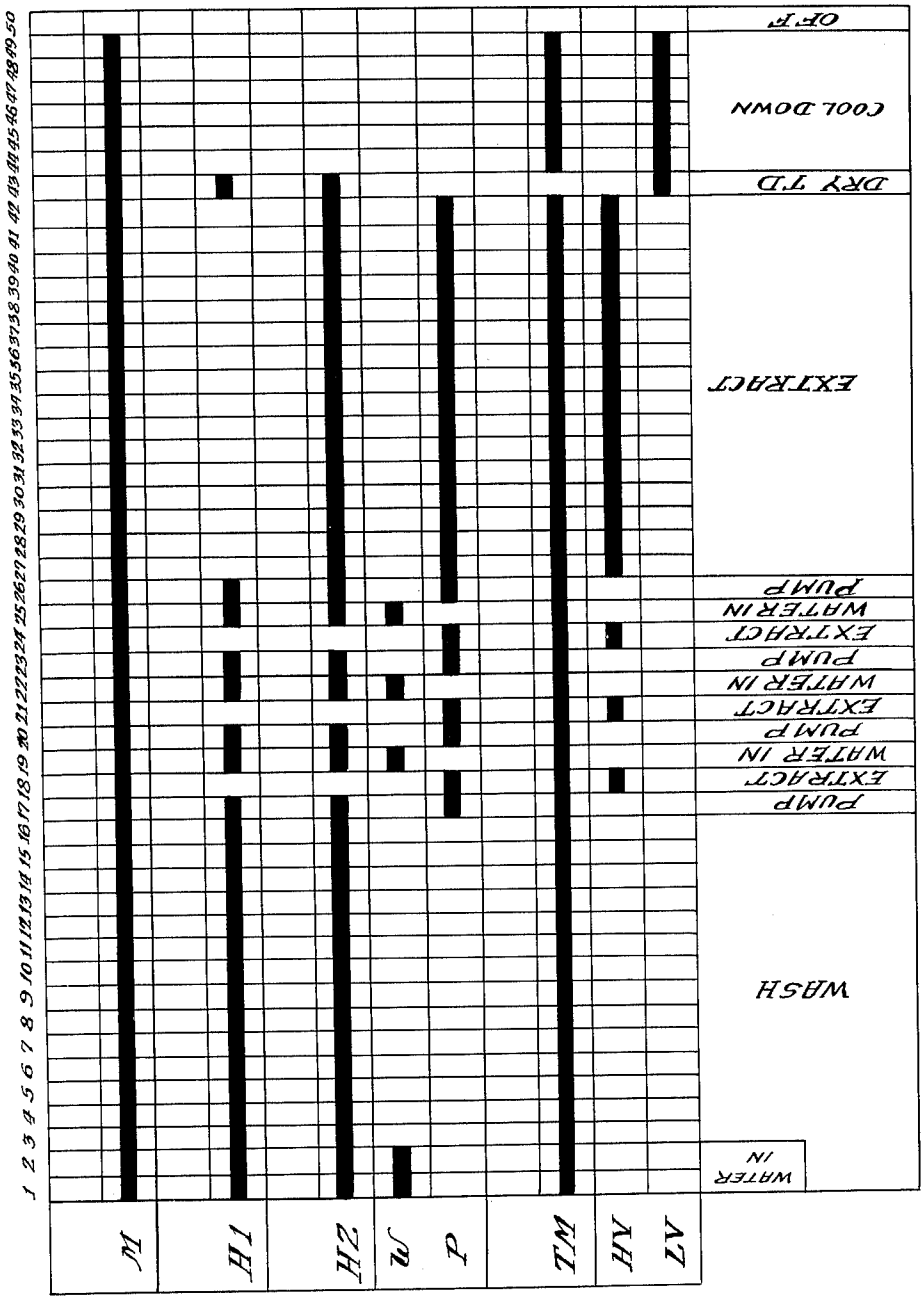


FIG. 8

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3,257,736

METHOD OF AND APPARATUS FOR LIQUID EXTRACTION

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Filed Nov. 27, 1963, Ser. No. 327,874
7 Claims. (Cl. 34—22)

This application is a continuation-in-part of our copending application Serial No. 59,237, filed September 29, 1960, now abandoned.

This invention relates to a liquid extraction apparatus for fabric.

The apparatus of this invention is usable, for example, either in a dryer to extract liquid, in the water extraction and drying cycle of a combined washer and dryer, or in the liquid extraction and drying cycle of a dry cleaning apparatus.

One of the features of this invention is to provide an improved liquid extraction apparatus for fabric comprising a rotatable drum with a substantially rigid perforate periphery of liquid impervious material, a liquid extracting suction nozzle bearing against a portion of this periphery and means for rotating the drum relative to the nozzle to tumble the fabric within the drum and present different areas of the fabric to the nozzle in order to aid in withdrawing liquid from the fabric and through the periphery into the nozzle.

Another feature is to provide such an apparatus in which the nozzle bears against the periphery at an area below the horizontal diameter of the periphery and upwardly of the lowest part of the periphery in the direction of rotation of the drum whereby the rotating drum lifts the fabric beyond the nozzle and then drops it below the nozzle to be dragged past the nozzle by the drum for liquid extraction through the nozzle.

A further feature of the invention is to provide such an apparatus in which a hollow flexible mounting member is provided on which the nozzle is mounted continuously urging the nozzle against the periphery with the interior of the mounting member being subjected to the suction and the exterior to the ambient atmosphere so that increasing the suction in the nozzle causes increasing pressure thereof against the periphery.

Another feature of the invention is to provide the improved apparatus of the first feature including an enclosing casing surrounding the drum having a substantially circumferential groove openly facing the drum and a substantially circumferential heating element in the groove substantially encompassing the drum.

Other features and advantages of the invention will be apparent from the following description thereof as illustrated in the accompanying drawings. Of the drawings:

FIGURE 1 is a sectional elevation of the rear of a washer-dryer combination embodying the invention with portions broken away for clarity of illustration, the section being taken substantially along line 1—1 of FIGURE 2.

FIGURE 2 is a sectional elevation taken substantially along line 2—2 of FIGURE 1.

FIGURE 3 is a front elevation of the apparatus partially broken away for clarity of illustration.

FIGURE 4 is a sectional view of a water and solids separator of the washer-dryer combination.

FIGURE 5 is an enlarged detail sectional view of a water and air inlet to the apparatus.

FIGURE 6 is an enlarged sectional view of a detail of the apparatus showing the method of mounting the drum for rotation.

FIGURE 7 is a wiring diagram for the apparatus of the invention.

FIGURE 8 is a chart illustrating the operating cycle of the illustrated embodiment.

The washer-dryer apparatus illustrated in the accompanying drawings as an embodiment of the invention comprises an outer cabinet 10 provided with an outwardly opening door 11 at the front thereof extending substantially the full width of the cabinet at the top thereof. The door is mounted on the cabinet on a plurality of hinges 12 and the door is spring urged toward closed position as shown in FIGURE 2. The top of the door is provided with a handle 13 for opening the door downwardly and outwardly about the hinges 12.

Located within the cabinet 10 is a generally cylindrical enclosing casing 14 having a rear wall 15 and a front wall 16. The front wall 16 is provided with a circular strengthening rib 17 near its outer circumference and located inwardly thereof is an inwardly directed cylindrical flange 18. Located inwardly of this flange 18 the front wall 16 is formed in outwardly opening annular U shape as illustrated at 19 to form an outer flange 20 and inner flange 20*a* that are arranged eccentrically to each other.

Positioned adjacent the outer surface of the front wall 16 is the front wall 21 of the outer cabinet 10. This front wall 21 is provided with a front opening defined by a cylindrical inwardly extending flange 22. This opening is normally closed by the door 11 with the door being provided with a circular rubber gasket 23 which seats against the circular flange 22 as illustrated in FIGURE 2.

The spacing between the cabinet flange 22 and the casing flange 21 is sealed by means of a generally cylindrical rubber gasket 24. This gasket 24 which is seated on the outer surface of the flange 22 has an inner diameter that is less than the outer diameter of the flange 22 when the gasket 24 is under no stress. Then, when the gasket 24 is placed on the flange 22 it is stretched so as to provide a snug fit. The gasket is provided with a pair of outwardly extending annular ribs 25 which bear against the outer surface of the flange 21 to complete the seal.

Located substantially concentrically within the casing 14 is a generally cylindrical rotatable drum 26. This drum is provided with a rear part that is dished inwardly as indicated by the portion 28 with this portion 28 being substantially symmetrical about the axis of rotation of the drum. The drum also includes a front part 29 that is provided with an outwardly extending cylindrical flange 30 located adjacent but spaced inwardly of the flange 18. The flange 30 carries a plurality of nylon shoes 31 which bear against the flange 18 as illustrated in FIGURE 2. The shoes 31 thereby provide bearing surfaces against the flange 18 when the drum 26 is rotated. Any suitable bearing material may be used in place of the nylon as desired.

Located between the rear part 27 and the front part 29 of the drum 26 is a cylindrical section 32 that is rigid and water impervious but is made of a material such as steel and which contains a plurality of perforations as illustrated at 32. These perforations may be any shape desired and as shown are elongated in the direction of the circumference of the section 32. The dimensions of these perforations are exaggerated for purposes of illustration. In the illustrated embodiment each perforation is $\frac{1}{16}$ by $\frac{3}{8}$ inch and they are spaced $\frac{3}{32}$ inch apart. Furthermore, as illustrated, they are staggered for additional strength.

As can be seen in FIGURE 2, the perforated section 32 is located at substantially the center of the cylindrical periphery 34 of the drum 26 and the section 32 is of substantially the same diameter as the remaining parts of the periphery of the drum 26.

As described above, the front of the drum 34 is sup-

ported by the bearing shoes 31. The rear of the drum is supported in a bearing 35 which extends through an opening in the rear wall 15 of the casing 14. Rotatable within the bearing 35 is a split shaft 36 which is illustrated most clearly in FIGURE 6. This shaft is located in a tube 37 and is provided with two splits 38 in its inner end located at right angles to each other. These splits embrace a pair of rods 39 also at right angles to each other with these rods being attached to the dished portion 28. Positioned on the enlarged portion 41 of the shaft are a pair of spaced parallel annular flanges 42 and 43 with the front flange 43 bearing against the outer end of the tube 37 and the other flange 42 bearing against the inner end of the bearing 35 as illustrated in FIGURE 2. These flanges 42 and 43 are held apart by means of a spacer ring 44.

Located on the outer end of the shaft 36 outwardly of the rear wall 15 is a drive pulley 45 that is driven by means of a belt 46 for rotating the drum 28. The drum 26 is rotated by means of an electric motor 47 which is mounted on the bottom 48 of the cabinet 10. This motor 47 drives a pulley 49 that is positioned on the motor shaft. The pulley 49 rotates a drive pulley 50 by means of a belt 51. The pulley 50 in turn drives a pulley 52 which is located concentrically with the pulley 50 for rotation thereof with the pulley 52 driving the belt 46 for rotation of the above-mentioned pulley 45. The various pulleys are arranged such that the drum 26 is rotated at relatively slow speed which in the illustrated embodiment is at a substantially constant speed of about 48 r.p.m. during washing extraction and drying cycles. The drive pulley 50 is mounted on a jack shaft 53 as illustrated in FIGURE 2 and the belts 46 and 51 are held in tension by means of a spring 54.

The cylindrical portion of the casing 14 is provided with an opening in the lower left quadrant thereof as viewed from the rear, as illustrated in FIGURE 1. Extending through this opening is a flexible rubber collar 55 having a cylindrical portion 56 and a flared portion 57. The flared portion which is on the inner end of the collar 55 is bent back upon itself to a peripheral portion 58 with the peripheral portion being grooved to embrace that portion of the casing 14 which defines the above-mentioned opening 59. The flared portion 57 adjacent the peripheral portion 58 is urged outwardly into close contact with the edge defining the opening 59 by an expansion ring 60. The ring is spaced from the cylindrical portion 56 so as to provide an annular spacer 61 that is open to the atmosphere. The collar 55 serves not only as a seal but also as a positioner for the nozzle 62. The nozzle 62 is preferably located substantially at the area of impact where the tumbled clothes drop onto the inner surface of the drum.

Held within the collar 55 at the inner end thereof is a suction nozzle 62 having a cylindrical outer end 63 and a cup-shaped inner end 64, the edges of which conform to and bear loosely against the outer surface of the perforated section 32 as illustrated in FIGURES 1 and 2. Under suction the nozzle is drawn securely against the section 32.

Thus, as viewed in FIGURE 1 of the drawings, with the drum rotating clockwise the fabrics on the interior of the drum are dragged past the nozzle 62 by the rotating drum, raised to approximately the upper left-hand quadrant above the nozzle and then dropped across the interior of the drum to fall on the lower right-hand quadrant or upstream from the nozzle where they are again dragged past the nozzle.

In a typical embodiment the nozzle 62 was made of rigid nylon with a smooth edge closely fitting the exterior surface of the periphery of the perforate section 32 and with a cross sectional area of about 4 square inches at the end bearing against the periphery. This nozzle was subjected to an internal vacuum of about 55–60 inches of water (sealed vacuum).

The cylindrical portion 56 of the collar 55 is held on the outer end of a conduit 65. The other end of this conduit 65 communicates with a thermostat housing 66 in which are located a pair of thermostats 67 and 68. The housing 66 is also joined by a second conduit 69 to a liquid and solid material separator 70. From the separator 70 to a third conduit 71 extends and communicates with the casing 14 below the horizontal diameter thereof and adjacent the cylindrical wall 72 of the casing.

In order to establish a suction in the nozzle 62 there is provided an electrically operated vacuum pump 73 mounted on the bottom 48 of the cabinet 10. This vacuum pump 73 is provided with an inlet 74 and an outlet 75. The inlet is connected by means of a fourth conduit 76 to the separator 70.

The outlet 75 of the vacuum pump 73 is connected to an electrically operated two-way valve 77, one branch of which is connected to an exhaust conduit 78 leading to a drain or the like, with the other branch being connected to a conduit 79 which leads back to the casing 14 near the bottom thereof. Thus a closed circuit is provided which has an important advantage of materially reducing the noise level. The third conduit 71 is also provided with an electrically operated valve 80.

Mounted on the bottom 48 of the cabinet 10 is a liquid pump 81. This pump is pivoted on a support 82 and is provided with a shaft 83. The end of the drive shaft 83 opposite the pump 81 is provided with a concentric friction collar 84 of rubber or the like which is located within a cup 85. This cup is mounted on the shaft 86 of the motor 47. As can be seen in FIGURE 2, the motor shaft 86 extends from opposite ends of the motor 47 and the cup 85 is on the end opposite to the drive pulley 49. When the pump 81 is not operating it is in the position shown in FIGURE 2. However, when it is desired to operate the pump a solenoid 87 is energized and this operates through a V rod spring 88 to rock the pump 81 and shaft 83 in a counterclockwise direction as viewed in FIGURE 2 to contact the drive collar 84 with the cup 85 so as to drive the pump 81. The pump when not operating is held in the position shown in FIGURE 2 by a biasing spring 89. The pump 81 is connected by means of a conduit 90 through a water level switch 91 and a flexible collar 92 to the side passage 93 of a trap 94. This trap 94 which is commonly called a button cup is pressed by means of a compression spring 95 to the bottom of a downwardly extending short tapered conduit 96. The bottom end of this conduit 96 extends into a groove 97 in the top of the conduit 94 and the two are sealed together by means of an annular rubber gasket 98. The conduit 90 leads to the inlet of the liquid pump 81 and is flexible while the outlet of the pump is connected by means of a flexible conduit 98*a* to an upwardly extending outlet conduit 99. This outlet conduit 99 extends upwardly to a point above the maximum liquid level within the casing 14.

The interior of the drum shaft 26 is provided with a plurality of inwardly extending baffles 100, here shown as four, each bolted to the inner surface of the cylindrical periphery 34 of the drum as by bolts 101, which serve to held the parts 27, 29 and 32 of the drum 26 in assembled relationship. As viewed in FIGURE 2, baffles 100 have arcuate edges 147 with their centers being of shorter height than their end portions. The minimum height of baffles 100 is located substantially over the centerline of nozzle 62. The baffle construction minimizes the spacing between the perforate section 32 and fabrics bridging the baffles 100 and thereby serves to minimize loss of vacuum beneath the baffles during application of suction to perforate section 32.

Extending substantially around the entire internal circumference of the casing 14 are a pair of electrical heaters 102 and 103 in rod form. Each heater is positioned in a groove 104 and spaced therefrom by means of a plurality of embossments 105. During the wash cycle of the washer-dryer apparatus illustrated, heaters 102 and

103 are both in operation and act as water heaters. When extracting water from the clothes by means of this invention, heater 102 provides heat to vaporize moisture for increased extraction performance. During the dry cycle, heaters 102 and 103 tend to provide an even distribution of heat around the clothes for increased drying effectiveness. Both liquid and gaseous forms of the fluid retained by the fabrics are therefore removed from the fabrics by suction nozzle 62 during the extraction and drying operations.

It is believed that the fluid transfer effected by use of this invention is produced by a combination of direct suction to the fabrics and a localized high velocity air flow past their surfaces.

Fabrics falling on perforate section 32 and completely covering nozzle 62 are subject to the direct extraction but the edges of the fabrics which only partially cover nozzle 62 are subject to the localized high velocity transport effect created by a practically unimpeded air flow. Practically speaking, there is a continuously changing type of fluid transport during the entire extraction cycle due to the constantly tumbling fabrics within the drum. It is believed that this localized high air velocity transport may be especially beneficial at the initiation of the extraction operation when the fabrics are saturated. On the other hand, the direct suction is believed to be more efficient, when a lesser amount of moisture is present within the fabrics at the end of the extraction cycle. The suction applied to nozzle 62 during the tumbling operation is intermittent and pulsating due to the irregular distribution and tumbling patterns of the fabrics wtihin drum 26.

The front wall 16 of the casing 14 is a separate piece and has its peripheral edge bearing against a gasket 106 that is attached to the cylindrical portion 72 of the casing. This front wall is held against the gasket by means of a plurality of clamps 107.

The casing 14 and thus the drum 26 and associated parts are supported on spaced legs 148 which in turn are supported on the bottom 48 of the outer cabinet 10.

Adjacent the top of the rear wall 15 of the casing 14 is a funnel 108 in the shape of an upwardly opening cup on the rear surface of this rear wall. The cup communicates with an opening in the wall 15 which is normally closed by means of a hinged weighted door 110. A water valve 111 operated by an electric solenoid 112 is positioned to feed water into the cup 108 when the valve 111 is opened with the weight of this water being sufficient to force the weighted door 110 open to permit the water to enter the casing 14.

The details of the liquid and solid material separator 70 are illustrated in FIGURE 4. As is shown there, the inlet conduit 69 communicates with an upwardly extending pipe 113 within the separator with this pipe opening upwardly. A pair of spaced overlapped horizontal baffles 114 and 115 are provided spaced above the upper end of the pipe 113 with the baffle 114 being mounted on a side wall 116 of the separator and the baffle 115 being spaced on an intermediate wall 117 of the separator. Located between this wall 117 and a second wall 118 spaced therefrom is a cylindrical filter 119 made of wire cloth or the like. Extending between the bottom of the walls 117 and 118 is a closed bottom member 120 on which the bottom of the filter 119 rests when the filter is in place as illustrated in FIGURE 4. The top of the filter 119 is provided with an outwardly extending annular flange 121 which rests on a top wall 122 of the separator. The top of the filter 119 is provided with a handle 123 while adjacent the bottom of the filter there is provided a felt annular collar 124.

When the vacuum system is being used to extract water from fabric or other materials within the drum 26 the water is drawn up through the conduit 69 and collects in a pool 125 within the separator 70. Gaseous fluid including air and water vapor together with small particles or other solid materials flow upwardly around and between the baffles 114 and 115 which further aids in separating particles of water from this gaseous fluid. The fluid and any inturned solid particles such as lint then flow through an opening 126 in the wall 117 above the baffle 115 and into the space 127 between the filter 119 and the walls 117 and 118. The gaseous fluid flows through the filter 119 and the filter serves to catch particles of lint and such solid materials. The filter can be withdrawn from time to time by means of the handle 123 for cleaning.

The gaseous fluid on the interior of the filter 119 then flows down through a pipe 128 which communicates with the conduit 76 which leads to the inlet 74 of the vacuum pump 73.

The wiring diagram of this embodiment of the invention is illustrated in FIGURE 7. In addition to elements already described, as indicated thereon, there is provided a normally closed door switch 129, switch 130, a centrifugal switch 131, a resistance 132, the electric motor operated timer illustrated schematically at 133 and timer operated switches. One of these timer switches has a pair of contacts 134 and 135 and a movable contact member 136. The second timer operated switch has a pair of contacts 137 and 138 and a movable member 139. A third switch has a single contact 140 and a movable contact member 141 while another switch has a contact 142 and a movable contact member 143. The timer 133 is operated by means of a timer switch 144. As will be noted in this wiring diagram, the one thermostat 67 which is indicated to be a safety thermostat is normally closed. The other thermostat 68 which is in circuit with the timer 133 and which by-passes the timer switch 134 is normally open.

FIGURE 8 illustrates a typical control diagram for the washer-dryer combination. The symbols at the left-hand margin of the diagram indicate the following elements:

M Motor (47)
H1 Heater #1 (102)
H2 Heater #2 (103)
W Water in (111)
P Pump (81)
TM Timer Motor (133)
HV High Vacuum
LV Low Vacuum

The numbers in parentheses indicate the above described pertinent elements of the washer-dryer. The words at the bottom of the diagram of FIGURE 8 illustrate what is happening at each of 50 intervals. These intervals may of course be any time desired but in this embodiment each equals 30 seconds.

The operation of the washer-dryer combination of the illustrated embodiment is as follows: During the first 49 intervals the motor 47 is operating as soon as the door switch 129 is closed by closing the door 11 and as soon as the motor switch 130 is closed by operation of the timer 133. When the motor is first operated it builds up to a speed where the centrifugal switch 131 is closed to place all of the elements in electrical circuit. The circuit is supplied with power from leads L1 and L2. During the first two intervals contact member 136 is moved to close the circuit with contact 134 which thereupon energizes the solenoid 112 to open the water inlet valve 111. Water thereupon flows through pipe 145 into the cup 108 and through the opening 109 and past the door 110 into the interior of the casing 114. As the water falls into the sump portion of the machine, defined by the trap 94 and conduit 96, the water level switch 91 begins to sense the amount of water in the casing. This incoming water runs into the bottom cup 94 through conduit 90, pump 81, conduit 98*a* and conduit 78 where it seeks its level. This water level which in the illus-

trated embodiment is a maximum of 5½ inches in casing **14** measured on the vertical center line never reaches the top of the vertical portion of water outlet conduit **99**. At the end of the first two intervals the contacts **134** and **136** are broken so as to close the valve **111** and stop the inflow of water.

During these first two intervals the two heaters **102** and **103** are energized and this continues through the first seventeen intervals. Similarly, the timer **133** is energized by closing of the switch **144** to begin the cycle and this closing may be done manually. The closing of the timer continues through the first forty-two intervals.

The closing of the circuit to the motor **47** causes rotation of the drum **26** and this rotation continues through the first forty-nine intervals or through the entire cycle of operations. During the rotation of the drum **26** the baffles **100**, each of which has an arcuate edge as indicated at **147**, pick up the clothes or material being treated and drops them into the water solution. The baffles also serve to drag the materials through the water. The washing cycle continues through the first sixteen intervals at the end of which the timer closes the switch **135–136** to the pump **81**. This circuit to the pump is closed throughout interval seventeen and interval eighteen. During this operation of the pump the water is pumped through the conduits **98***a* and **99** to a point of disposal which may be a kitchen sink or conventional laundry drain.

At the end of interval seventeen the circuit to the pump is continued for another interval, and the circuit to the vacuum pump **73** is completed on high vacuum by closing contacts **137** and **139**. This serves to set up a vacuum in the nozzle **64**, in the manner previously described, to extract water from the fabrics as the rotating drum passes them over the nozzle. The rotating drum tumbles the fabrics, dropping them onto the perforate section beyond the nozzle. Those fabrics that are dropped beyond the nozzle are dragged past the nozzle by the rotating drum. Because of the construction of the flexible support member **55**, increasing vacuum within the system causes air pressure operating through the opening **61** to press nozzle **62** against drum **26** so that the mating portions of nozzle **62** and the perforate drum section **32** are pressed together during the application of suction to nozzle **62**.

At the end of interval eighteen the circuit to the vacuum pump **73** is broken by moving the movable member **139** to its initial position as shown in FIGURE 7. Similarly, the circuit to the pump **81** is broken by returning the movable contact member **136** to its initial position. At the same time through the duration of interval nineteen the circuit to the solenoid **112** is closed by closing contacts **134** and **136** to permit more water to flow into the drum **26**. At the end of this seventeenth interval the heater circuits are broken by opening the circuits **140–141** and **142–143**. However, at the beginning of the nineteenth interval these are again closed to re-energize the heaters during the nineteenth and twentieth intervals.

During the twenty-first interval the circuits to the heaters **102** and **103** are again broken, while the circuit to the pump is continued and the circuit to the vacuum pump is continued so as to extract this rinse water.

During interval twenty-two and interval twenty-five two additional batches of rinse water are supplied in the same manner with each rinse water being withdrawn in the manner described.

At the end of the twenty-seventh interval when the last batch of rinse water has been withdrawn the vacuum pump **73** continues to be operated by closing of the contacts **137–139** from the beginning of the twenty-seventh interval until the end of the forty-second interval. During the same period the pump **81** continues to be energized so that the combination of the relatively high vacuum and the pumping serves to extract moisture. During this period one of the heaters **102** is de-energized as by opening the switch **140–141**, while the other heater **103** continues to be energized by continued closing of the switch **142–143**.

At the end of the forty-second interval the circuit to the pump **81** is broken, the circuit to the timer is broken and the switch **137–139** in the vacuum pump circuit is opened. Because of the opening of the circuit to the timer continued operation through the variable interval forty-three is controlled solely by the thermostat **67**. Thus contrary to the situation as indicated on FIGURE 8 interval forty-three is not of fixed time such as thirty seconds but is of variable time depending upon the length of time required to dry the materials such as clothes that are being dried.

During this variable or time delay interval forty-three the vacuum pump **73** is operating on low vacuum by reason of closing of the switch **138–139** to include the resistance **132** in the vacuum pump circuit. This low vacuum operation continues until the end of the operation. Similarly, during this variable interval forty-three, both heaters **102** and **103** are energized while the circuit to the motor is continued to be energized to cause continued rotation of the drum **26**. In the illustrated embodiment of the invention the resistance **132** serves to reduce the speed of the vacuum pump motor (not illustrated) from 17,000 r.p.m. to about 3,000 r.p.m. During maintenance of the vacuum conditions ambient air is drawn into the casing **14** through the cup **108** by reason of the vacuum within the casing serving to draw air in the opening **109** and past the weighted door **110**. This air travels into the casing **14**, into the drum **26** through hte perforate section **32**.

The moisture laden air passes through the thermostat housing **66** where the control thermostat **67** senses the temperature of the air. Because the circuit to the timer has been broken the entire operation is regulated by the thermostats. As the temperature of the air increases it indicates that the load within the drum is becoming drier and drier. When the load reaches a predetermined temperature such as 165° F. which is known to be the result of a relatively dry condition in the clothes the thermostat **67** opens to break the circuit to the heaters **102** and **103** and stop the heating operation. At this same temperature or slightly less the thermostat **68** closes to close the electrical circuit to the timer **133**. This moves the operating cycle from the variable thermostat controlled interval forty-three through intervals forty-four to forty-nine inclusive. During this period which is a cool-down period the vacuum pump **73** continues to operate with the resistance **132** in the circuit to provide low vacuum and the motor **47** continues to operate to rotate the drum **26**. At the end of interval forty-nine all circuits are broken to stop the operation of the device.

During the extraction operation the water is pumped from the apparatus in the manner described to the point of disposal. Moisture laden air is drawn through the nozzle **64** and circulated in a closed circuit including the conduit **65**, housing **66**, conduit **69**, separator **70**, conduit **76**, vacuum pump **73**, conduit **79** and casing **14**.

The moisture and water in the air is trapped in the separator **70**, as previously described. At a timed interval, which is not illustrated in the diagram of FIGURE 8, the valve **80** is opened to permit this water to drain through the conduit **71** into the casing **14** and into the sump **94–96**. The valve **80** is otherwise closed, however, during the drying cycle. During the drying cycle valve **77** at the exit of the vacuum pump **73** directs all of the gaseous fluid including air and moisture through the conduit **78** to a point of disposal such as the exterior atmosphere. However, during the extraction cycle valve **77** recirculated this gaseous fluid by directing it through the conduit **79** into the interior of the casing **14**. This can be done because the water extraction from the clothes is a physical pulling of the water from the clothes and thus the extraction does not depend upon the moisture content of the air being passed through the clothes.

When it is desired to remove solid foreign bodies such as buttons from the cup **94** it is only necessary to press the cup **94** downwardly against the spring **95** to withdraw the cup from the conduit **96**. Because of the flexibility of the collar **92** the cup **94** may then be moved out from under the conduit **96** for removal of this foreign material.

The recirculation of the moisture laden air during the extraction of liquid serves to cut down the noise of operation particularly the noise of the vacuum pump. In addition sound deadening material (not shown) may be provided in the customary manner to further cut down noise.

Although the specific embodiment of nozzle **62** is substantially circular and bears against a perforate section occupying only a portion of the drum circumference, tests have shown that the nozzle may be any shape desired such as oval, rectangular and the like. Furthermore, if desired, the perforate section may occupy the entire drum circumference or any fraction thereof.

Having described our invention as related to the embodiment shown in the accompanying drawings, it is our intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

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

1. Liquid extraction apparatus for fabric, comprising: a rotatable drum for receiving and tumbling fabric placed therein, said drum having a substantially rigid perforate periphery of liquid impervious material; a plurality of spaced longitudinal, inwardly extending baffles at the inner surface of said drum, each baffle being higher at the ends than at an intermediate portion between the ends; a liquid extracting suction nozzle bearing against a portion of said periphery outwardly of the drum; means for applying a liquid extracting suction to said nozzle; and means for rotating said drum relative to said nozzle to tumble said fabric within said drum and present different areas of said fabric to said nozzle, thereby aiding in withdrawing liquid from said fabrics and through said periphery and nozzle.

2. Liquid extraction apparatus for fabric, comprising: a rotatable drum for receiving and tumbling fabric placed therein, said drum having a substantially rigid perforate periphery of liquid impervious material; a rigid liquid extracting suction nozzle bearing against a portion of said periphery outwardly of the drum; means biasing said nozzle toward said drum; means for applying a liquid extracting suction to said nozzle; and means for rotating said drum relative to said nozzle to tumble said fabric within said drum and present different areas of said fabric to said nozzle, thereby aiding in withdrawing liquid from said fabric and through said periphery and nozzle.

3. Liquid extraction apparatus for fabric, comprising: a rotatable drum for receiving and tumbling fabric placed therein, said drum having a substantially rigid liquid impervious perforate periphery; a liquid extracting suction nozzle bearing against a portion of said periphery outwardly of the drum at an area below the horizontal diameter of said periphery and upwardly of the lowest point of said periphery in the direction of rotation of said drum; means for applying a liquid extracting suction to said nozzle; and means for rotating said drum relative to said nozzle to tumble said fabric within said drum and present different areas of said fabric to said nozzle, thereby directly extracting liquid from said fabric and through said periphery and nozzle, said rotating drum lifting the fabric beyond the nozzle in said direction of rotation and dropping the fabric below the nozzle to be dragged past the nozzle by said rotating drum.

4. Liquid extraction apparatus for fabric, comprising: a rotatable drum for receiving and tumbling fabric placed therein, said drum having a substantially rigid perforate periphery of liquid impervious material; a liquid extracting suction nozzle bearing against a portion of said periphery outwardly of the drum; means for applying a liquid extracting suction to said nozzle; a hollow flexible mounting member on which said nozzle is mounted continuously urging said nozzle against said periphery, said mounting member having interior and an exterior, said interior being subjected to said suction and said exterior to ambient atmosphere whereby increasing suction causes increasing pressure of the nozzle against said periphery; and means for rotating said drum relative to said nozzle to tumble said fabric within said drum and present different areas of said fabric to said nozzle, thereby aiding in withdrawing liquid from said fabric and through said periphery and nozzle.

5. Liquid extraction apparatus for fabric, comprising: a rotatable drum for receiving and tumbling fabric placed therein, said drum having a substantially rigid perforate periphery of liquid impervious material; a liquid extracting suction nozzle bearing against a portion of said periphery outwardly of the drum at an area below the horizontal diameter of said periphery and upwardly of the lowest point of said periphery in the direction of rotation of said drum; an enclosing casing surrounding said drum; fluid passage means having one end communicating with said nozzle and another end communicating with said casing to provide a closed circuit comprising said nozzle, fluid passage means, casing and drum; suction producing means in said passage means for creating a suction in said nozzle and causing fluid flow from said drum, to said nozzle, and back to said drum by way of said casing; means in said fluid passage means for separating liquid and solid matter drawn through said nozzle from gaseous matter; a hollow flexible mounting member on which said nozzle is mounted continuously urging said nozzle against said periphery, said mounting member having an interior and an exterior, said interior being subjected to said suction and said exterior to ambient atmosphere whereby increasing suction causes increasing pressure of the nozzle against said periphery; and means for rotating said drum relative to said nozzle to tumble said fabric within said drum and present different areas of said fabric to said nozzle, thereby aiding in withdrawing liquid from said fabric and through said periphery and nozzle, said rotating drum lifting the fabric beyond the nozzle in said direction of rotation and dropping the fabric below the nozzle to be dragged past the nozzle by said rotating drum.

6. The method of removing liquid from fabrics comprising the steps of: firstly extracting initial quantities of liquid from said fabrics by subjecting them to a direct, relatively high localized suction applied successively to different increments of said fabrics while agitating said fabrics; and subsequently extracting residual liquid from said fabrics by subjecting them to a direct, lower localized suction applied successively to different increments of said fabrics while concurrently heating and agitating said fabrics.

7. Liquid extraction apparatus for fabrics comprising: a rotatable drum for receiving and tumbling fabrics placed therein and having a substantially rigid liquid impervious perforate periphery; a liquid extraction suction nozzle bearing against a portion of said periphery outwardly of said drum; means for applying a liquid extracting suction to said nozzle; means for rotating said drum relative to said nozzle to tumble said fabrics within said drum and present different areas of said fabrics to said nozzle, thereby directly extracting liquid from said fabrics and through said periphery and nozzle; liquid conduit means communicating with said nozzle and leading to a place of disposal for the liquid extracted from said fabrics; a pump in said liquid conduit means; and fluid separating means in said liquid conduit means upstream of said pump for removing gas from said liquid conduit means.

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