APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

Original Filed Sept. 7, 1951 20 Sheets-Sheet 1

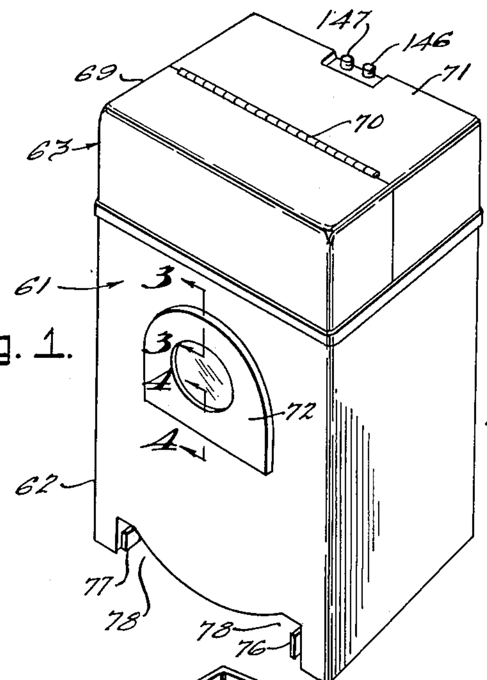

FIG. 1.

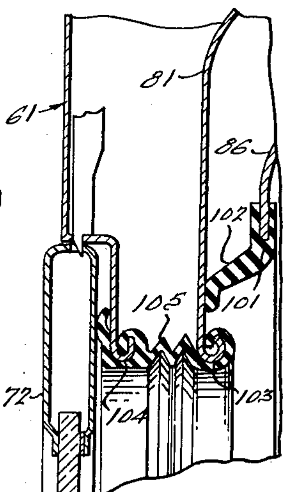

FIG. 3

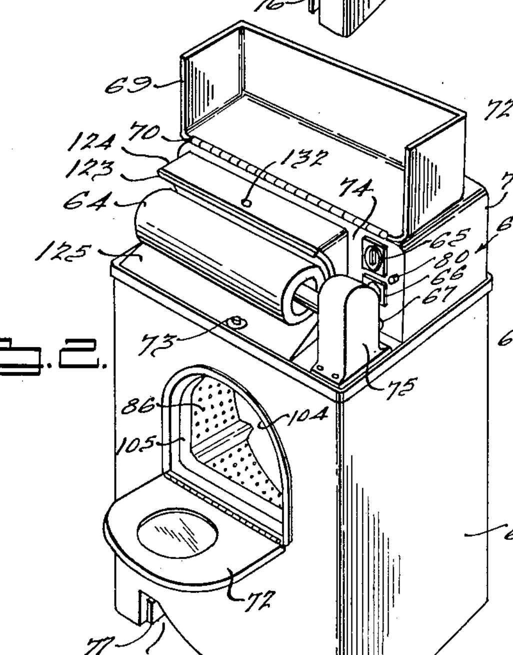

FIG. 2.

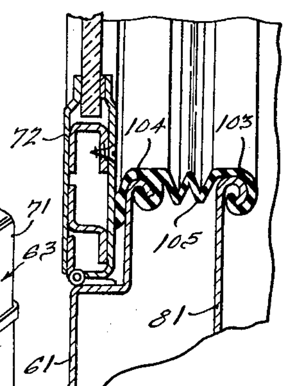

FIG. 4

Inventor
William E. Stilwell, Jr.
BY
Harness, Dickey & Pierce
Attorneys.

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APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

Original Filed Sept. 7, 1951 20 Sheets-Sheet 2

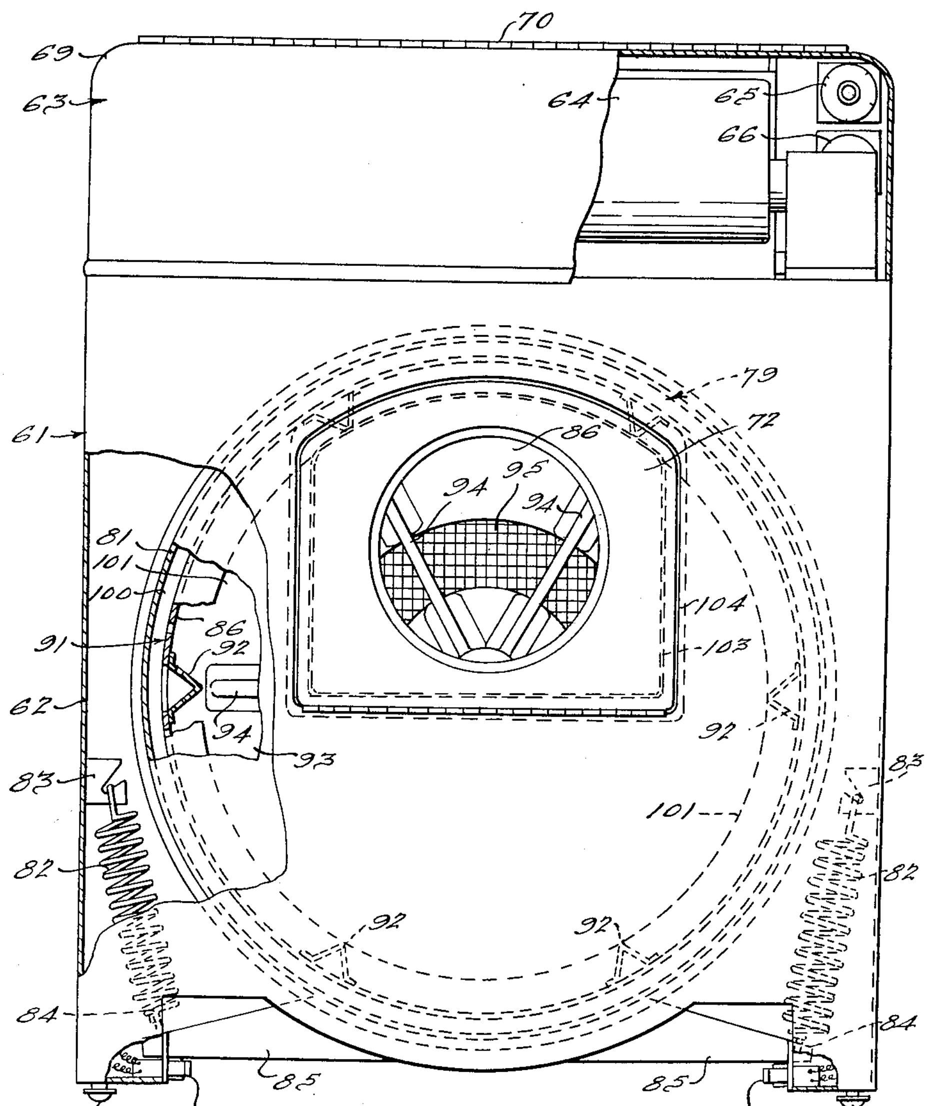

FIG. 5.

Inventor
William E. Stilwell, Jr.

By
Harness, Dickey & Pierce
Attorneys

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APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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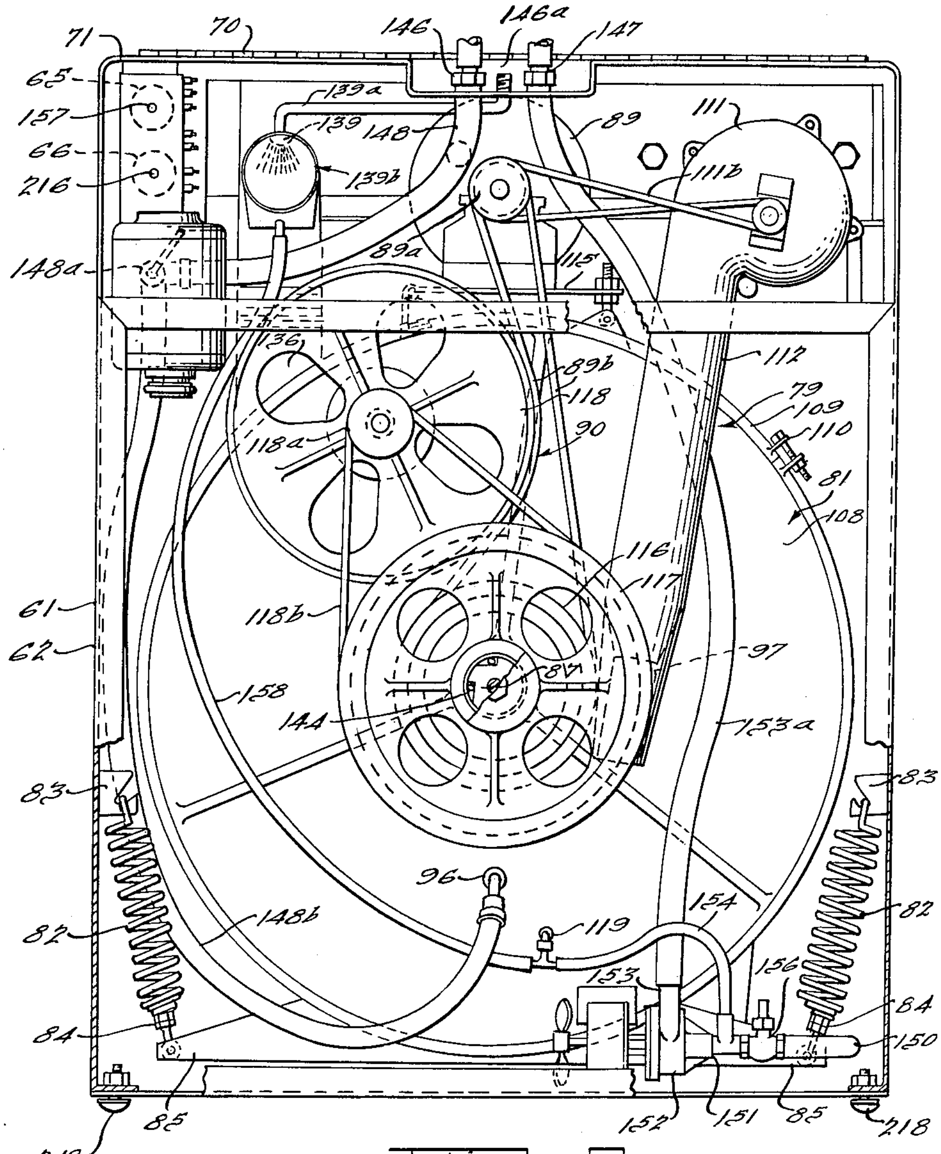

FIG. 6.

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys

APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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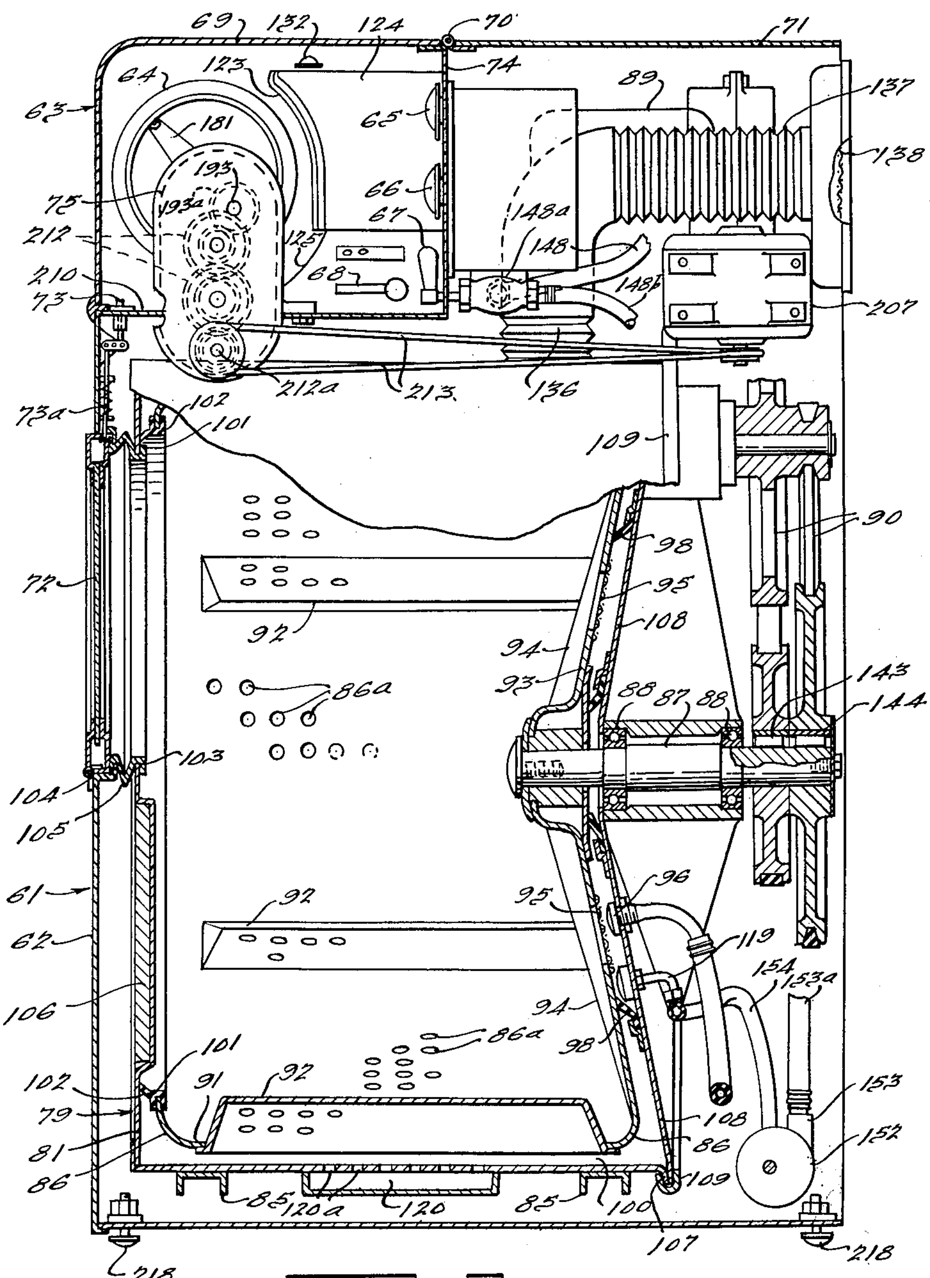

FIG. 7.

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys

APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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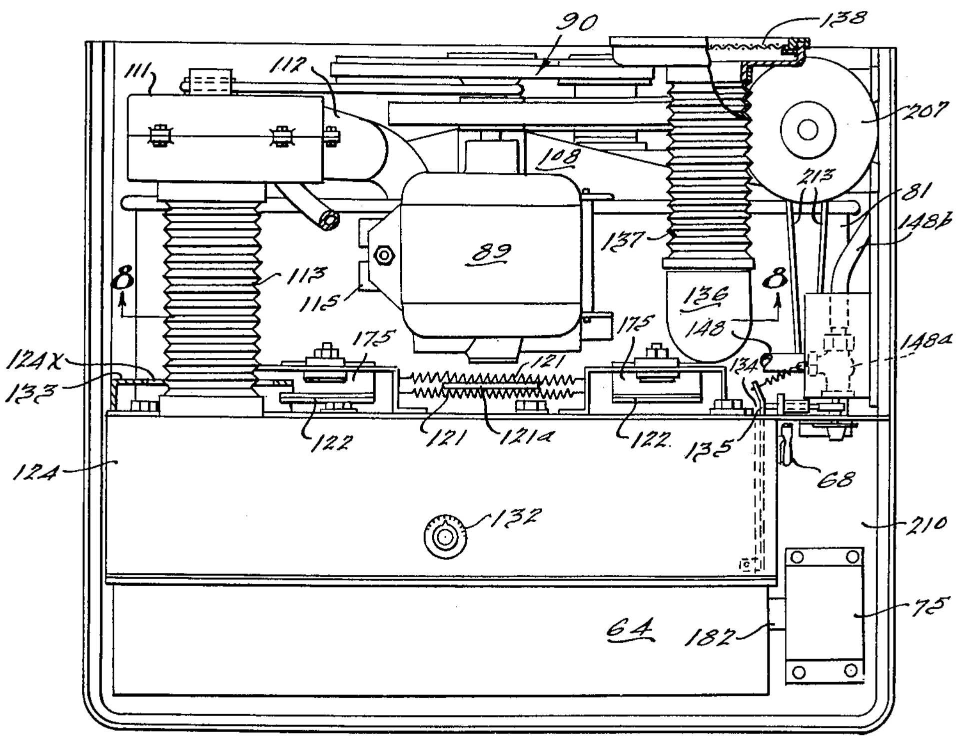

FIG. 8.

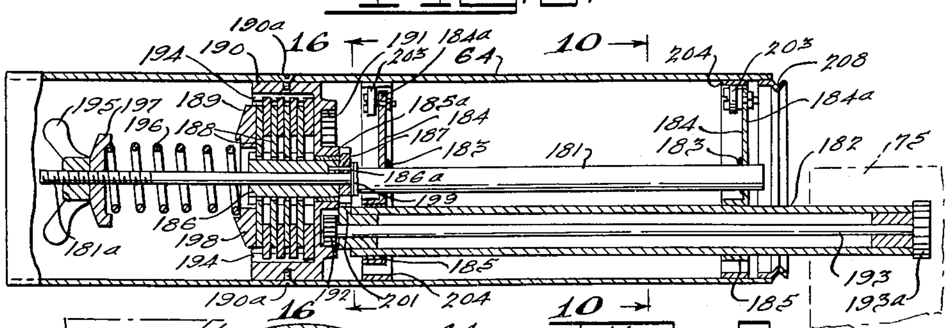

FIG. 9.

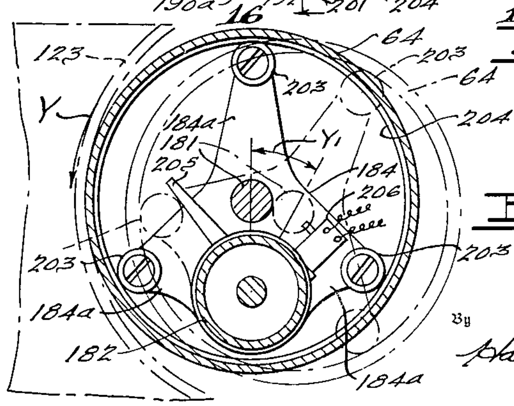

FIG. 10.

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys.

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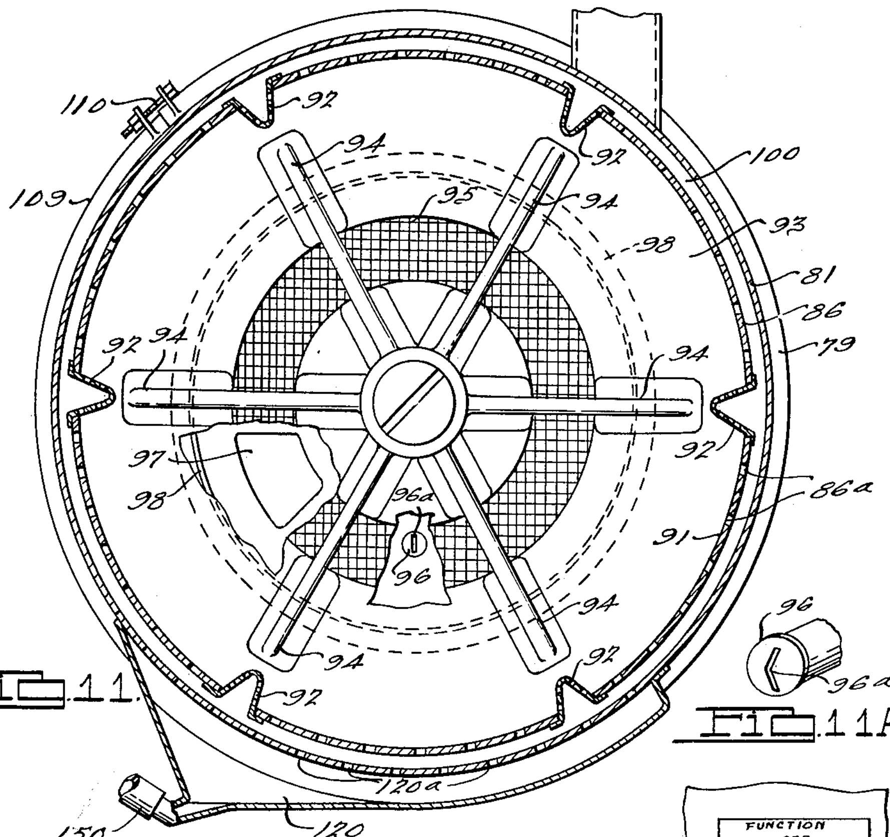
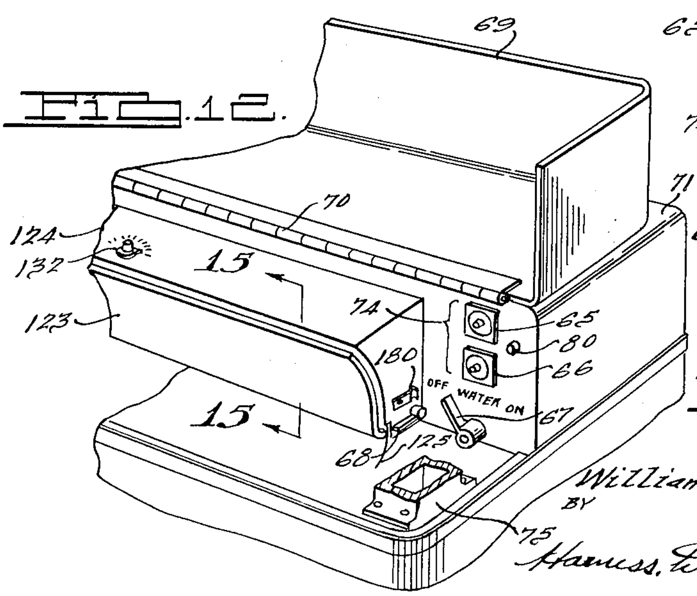


FIG. 11.

FIG. 11A

FIG. 12.



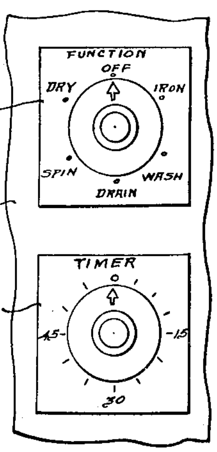


FIG. 12A

Inventor
William E. Stilwell, Jr.
BY
Harness, Dickey & Pierce
Attorneys

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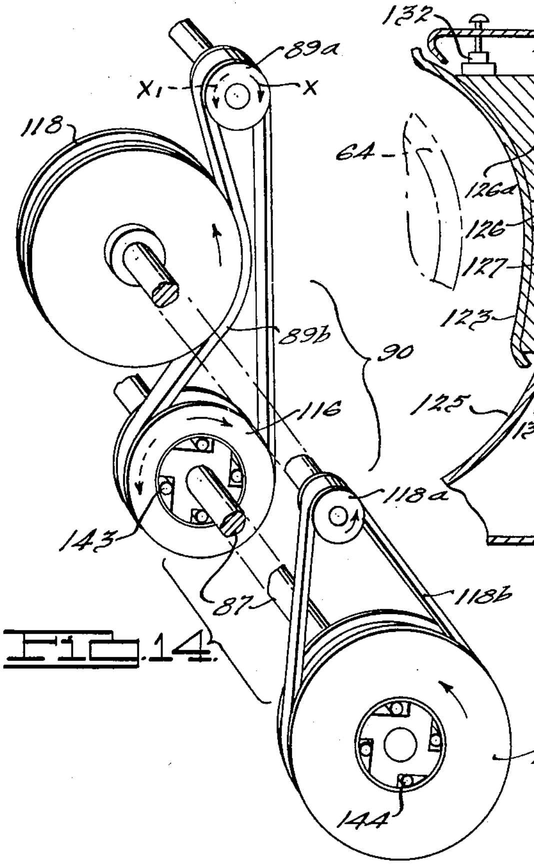

FIG. 14.

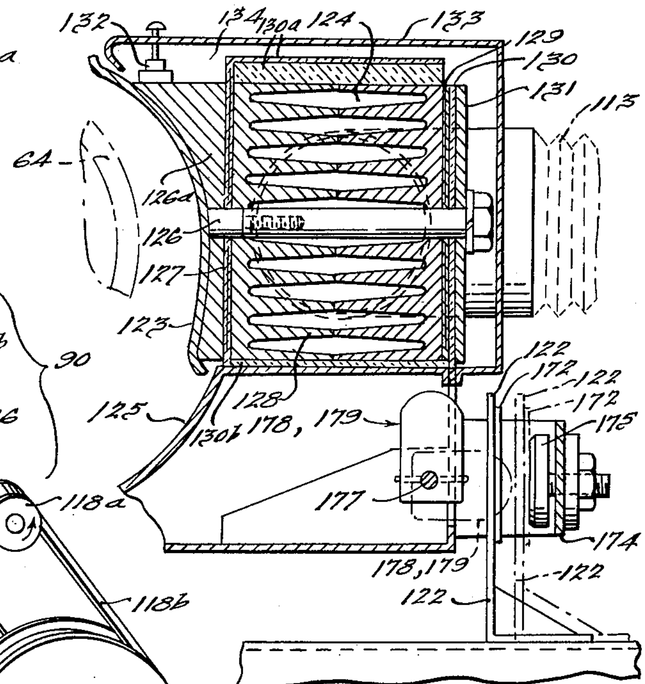

FIG. 15.

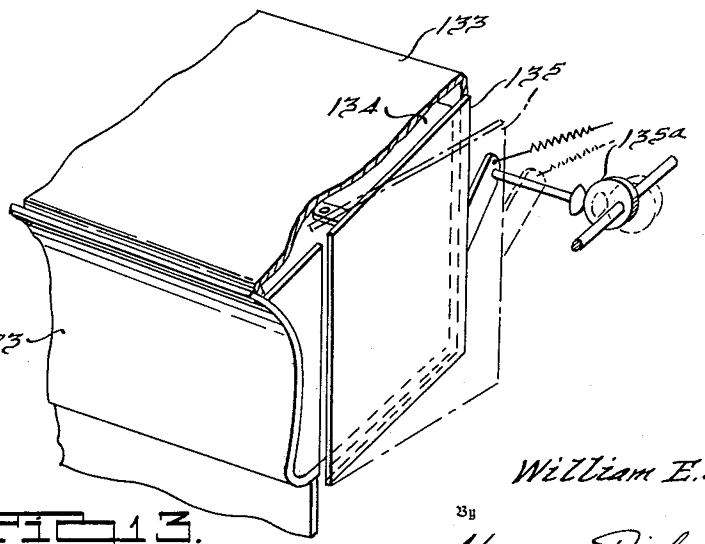

FIG. 13.

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys.

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APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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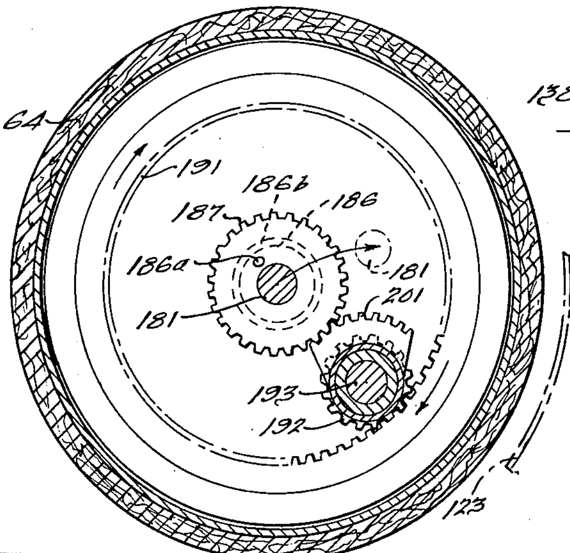


FIG. 16.

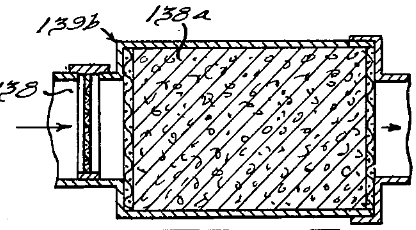


FIG. 19.

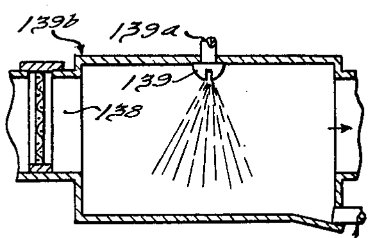


FIG. 20.

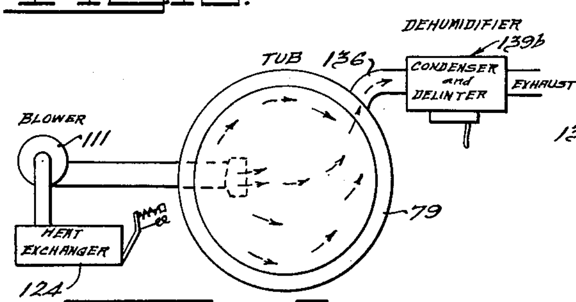
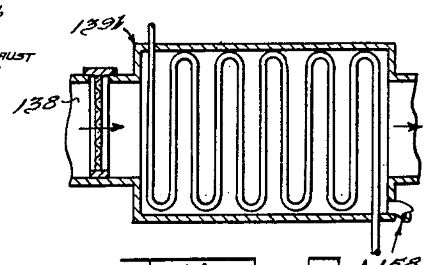


FIG. 18.



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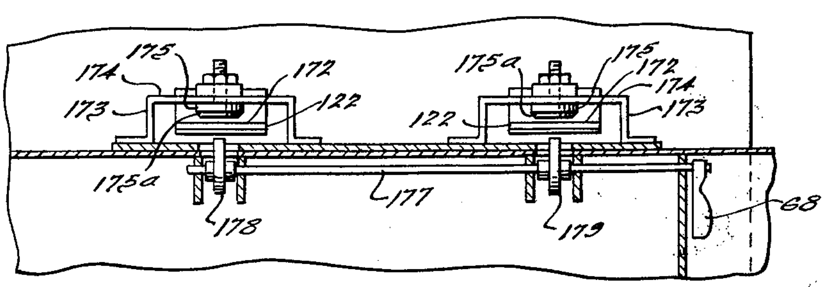

FIG. 17.

Inventor
William E. Stilwell, Jr.

By
Harness, Dickey & Pierce
Attorneys.

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APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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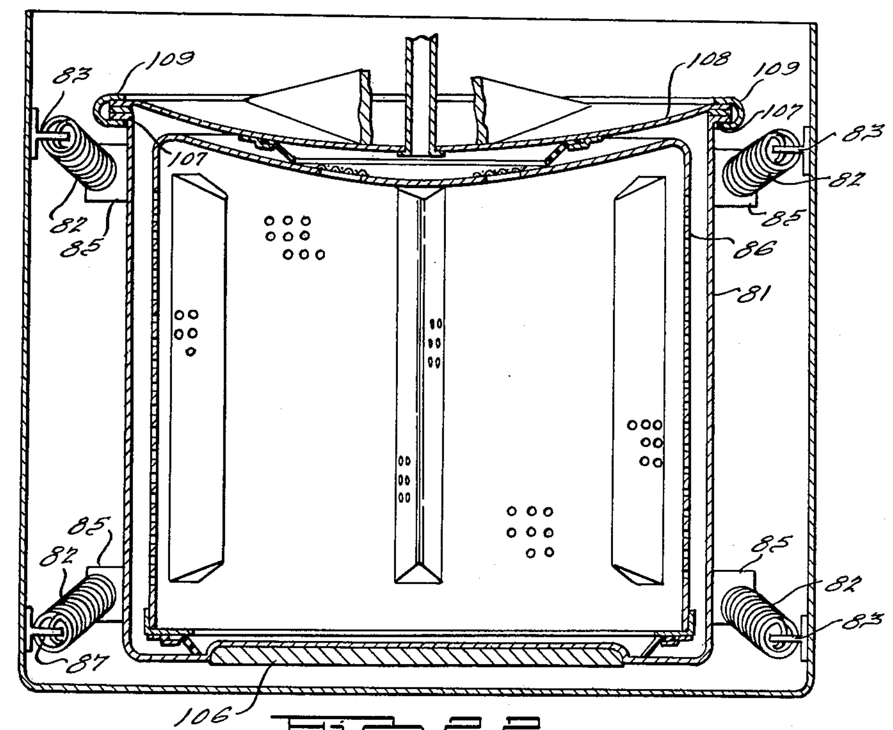

FIG. 22.

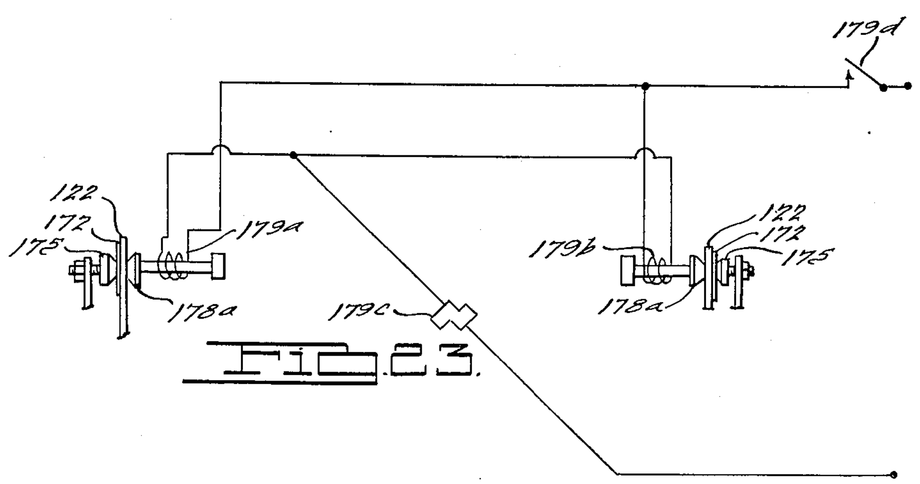

FIG. 23.

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys.

APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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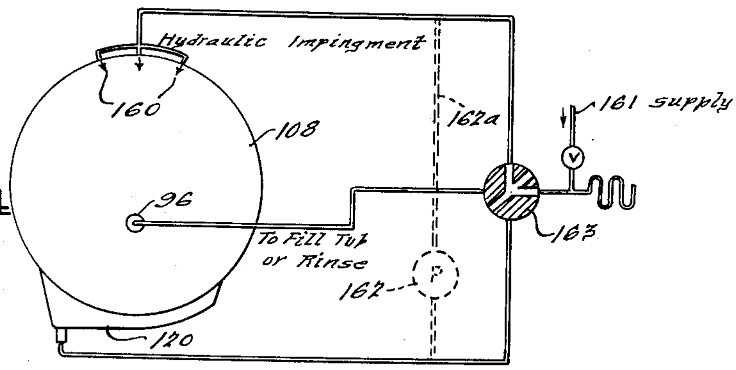
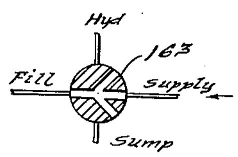


FIG. 24



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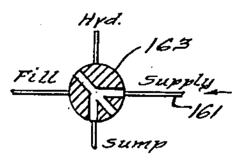

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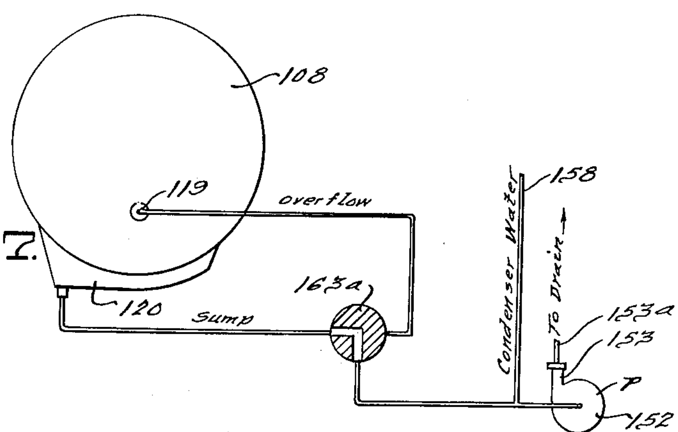

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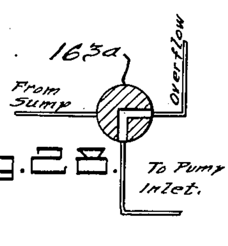

FIG. 28.

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys.

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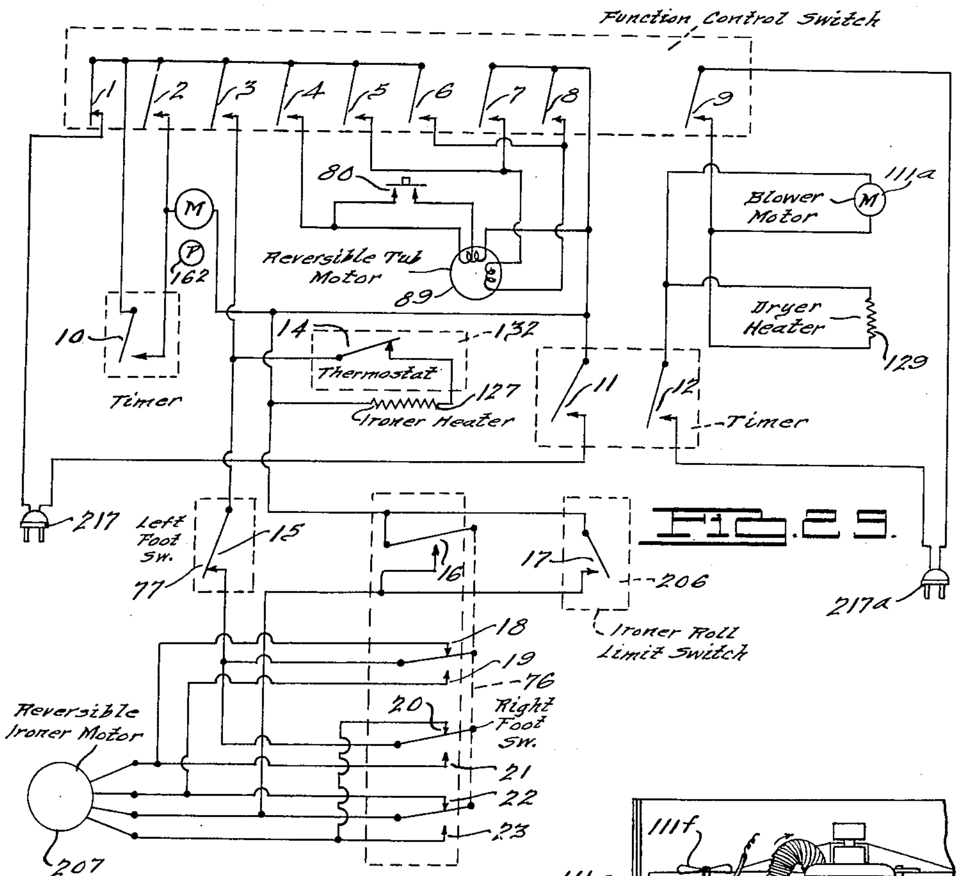

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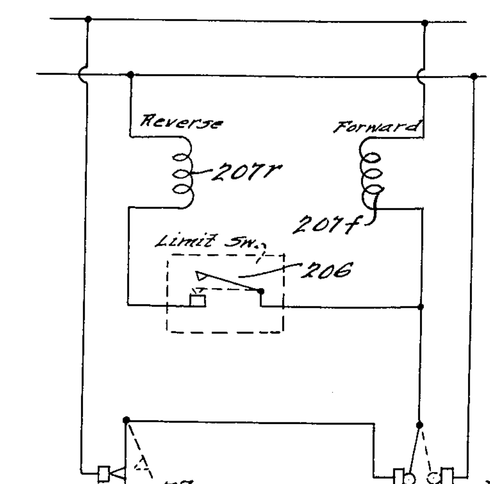

FIG. 30.

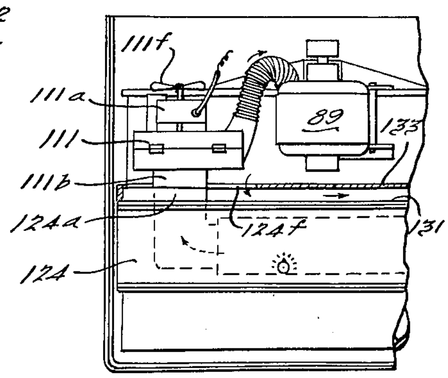

FIG. 31.

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys.

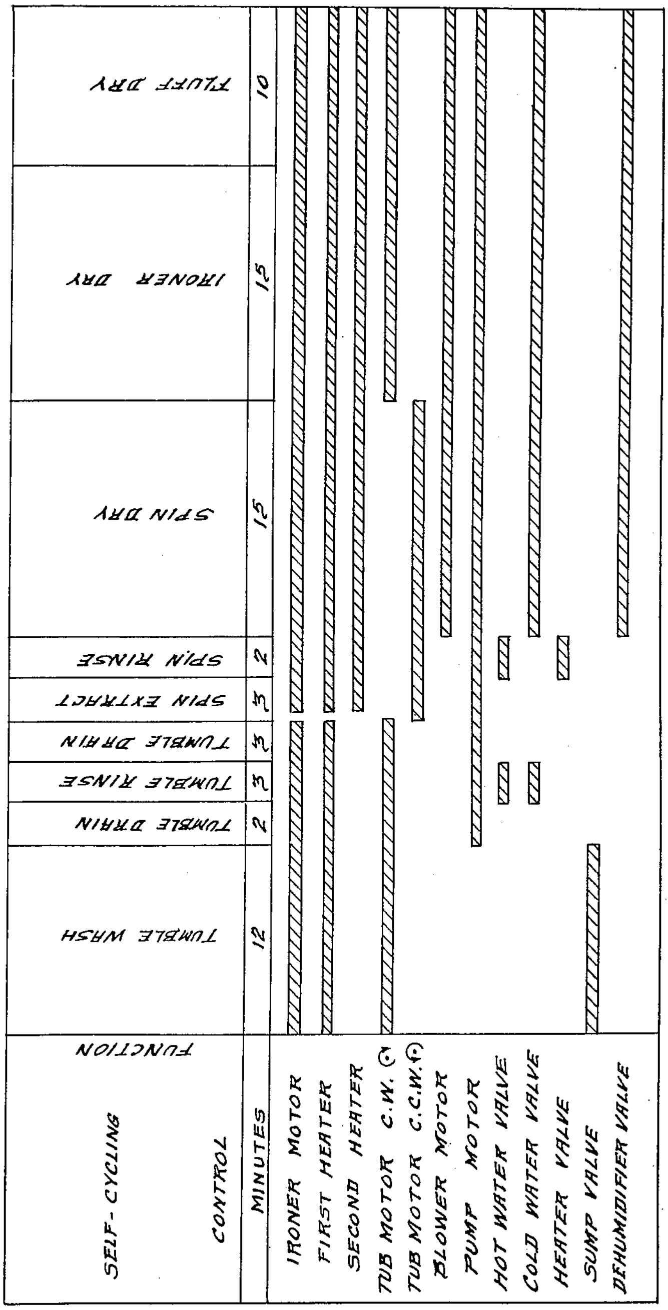

FIG. 32

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys

APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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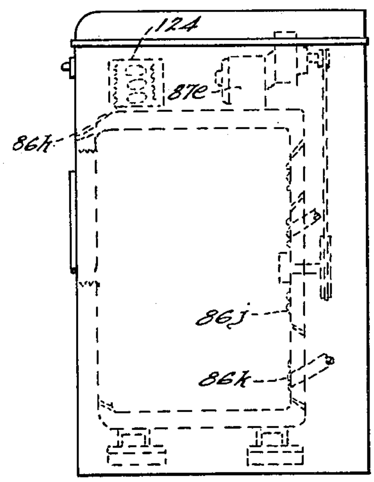

FIG. 39.

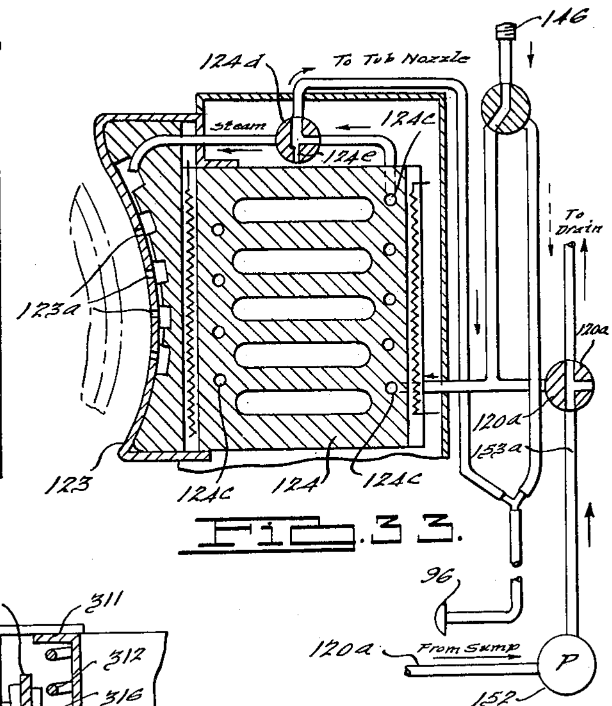

FIG. 33.

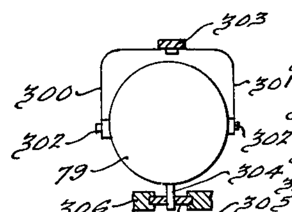

FIG. 35.

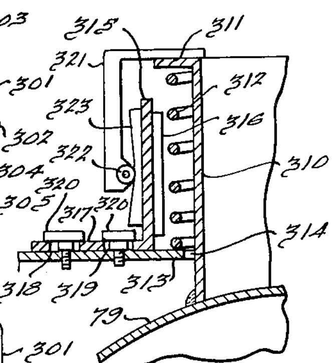

FIG. 38.

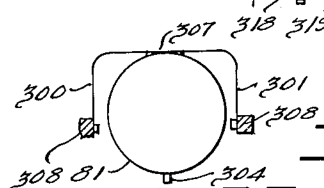

FIG. 36.

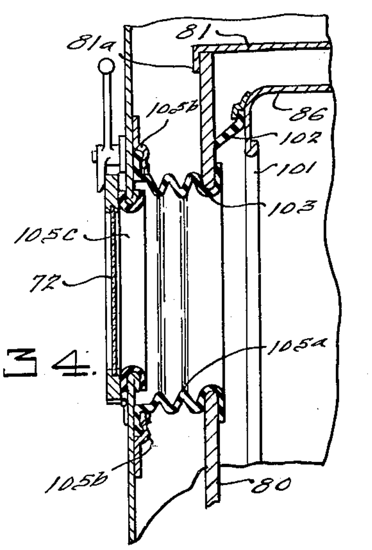

FIG. 34.

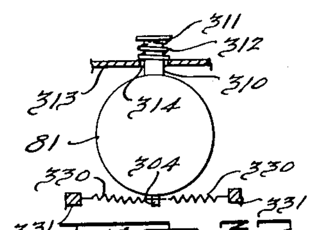

FIG. 37.

Inventor
William E. Stilwell, Jr.

By
Harness, Dickey & Pierce
Attorneys.

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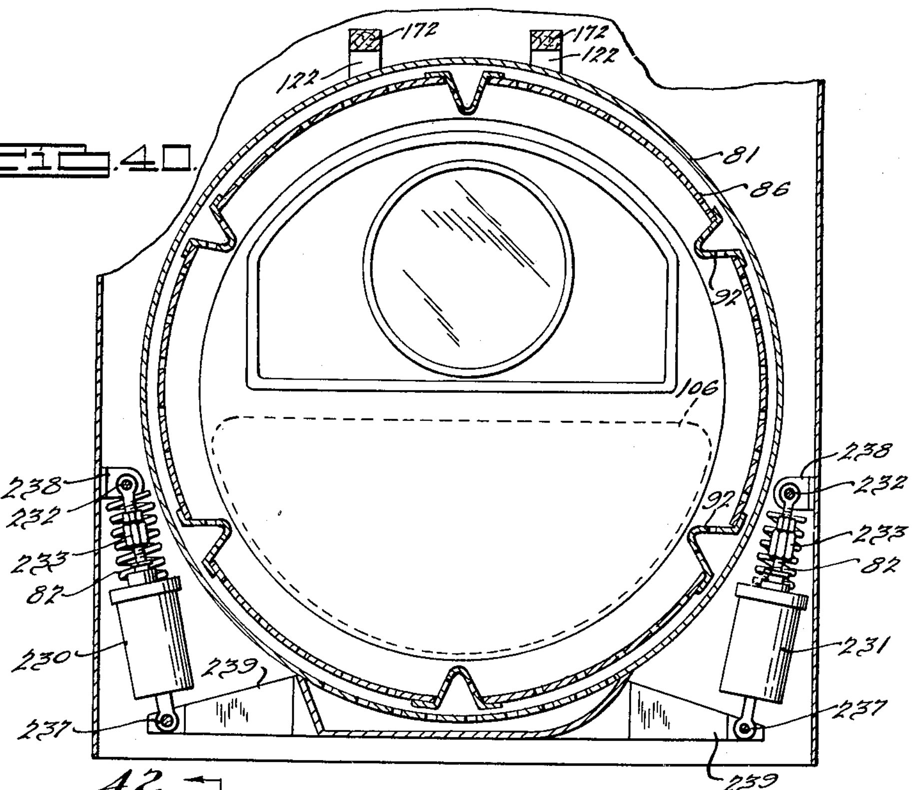
FIG. 40.



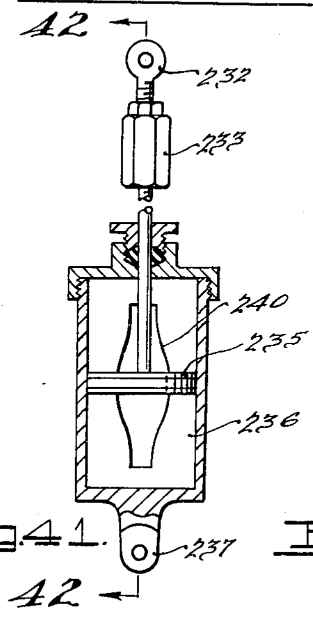


FIG. 41.

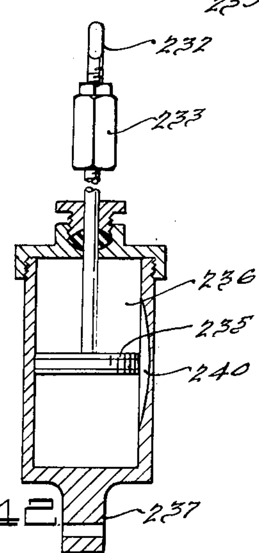


FIG. 42.

Inventor

William E. Stilwell, Jr.

By

Harness, Dickey & Pierce

Attorneys.

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APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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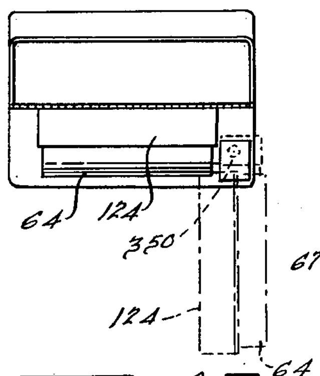

FIG. 45.

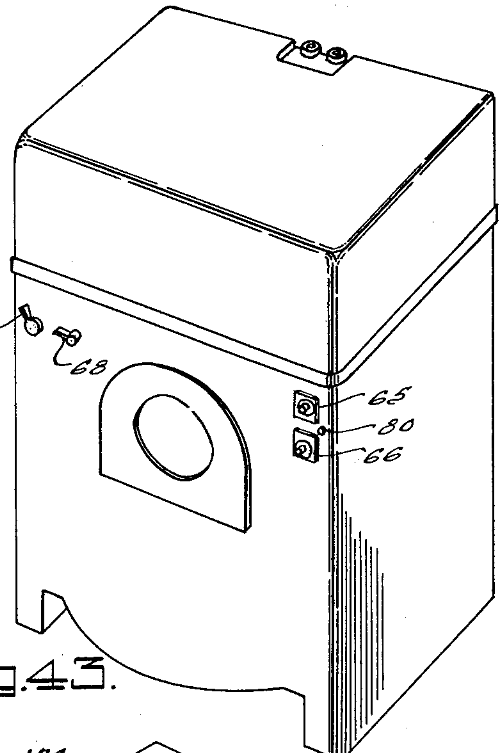

FIG. 43.

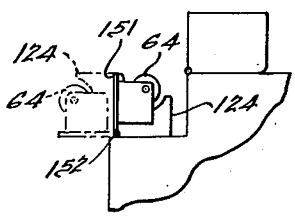

FIG. 46.

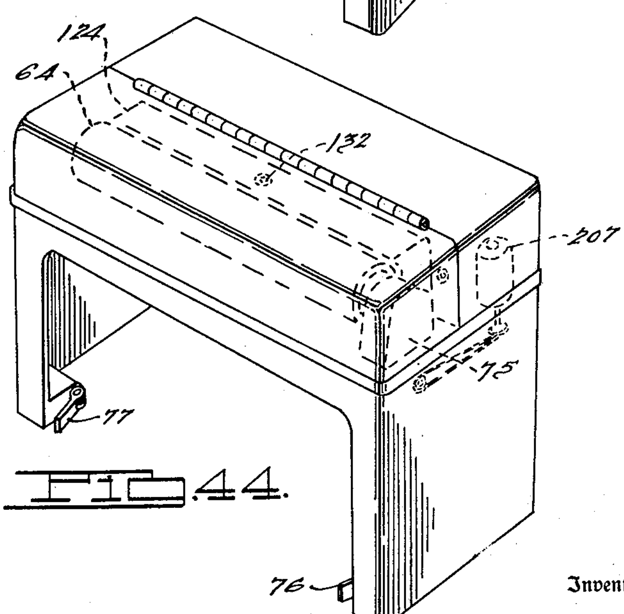

FIG. 44.

Inventor

William E. Stilwell, Jr.

By

Harness, Dickey & Pierce

Attorneys.

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APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

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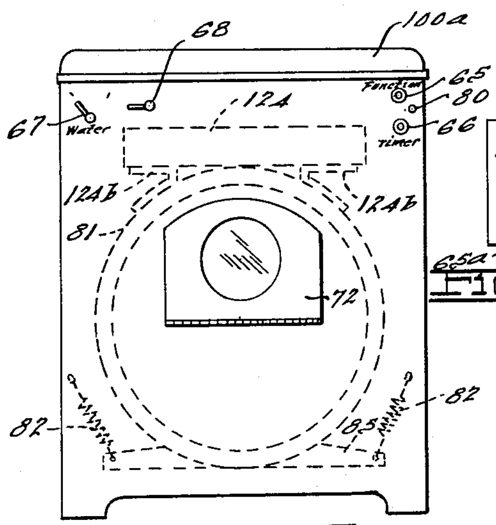


FIG. 47.

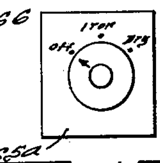


FIG. 48A

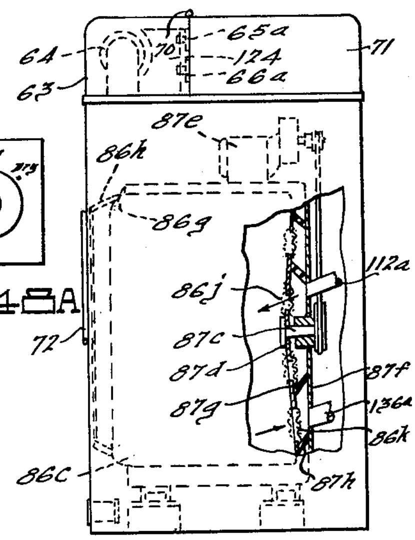


FIG. 48.

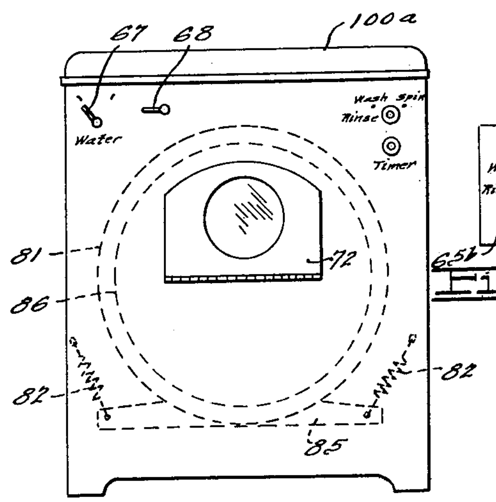


FIG. 50.

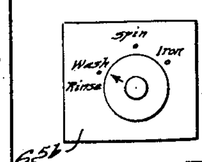


FIG. 49A

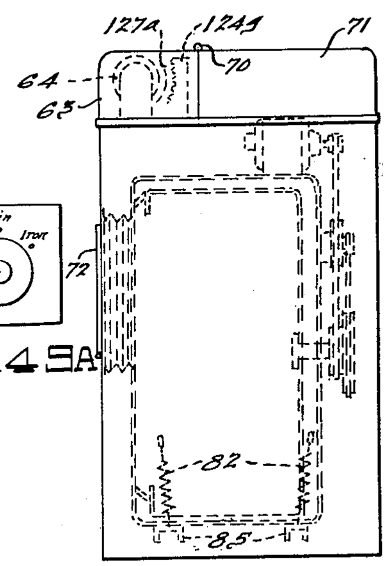


FIG. 49.

Inventor
William E. Stilwell, Jr.
By
Harness, Dickey & Pierce
Attorneys.

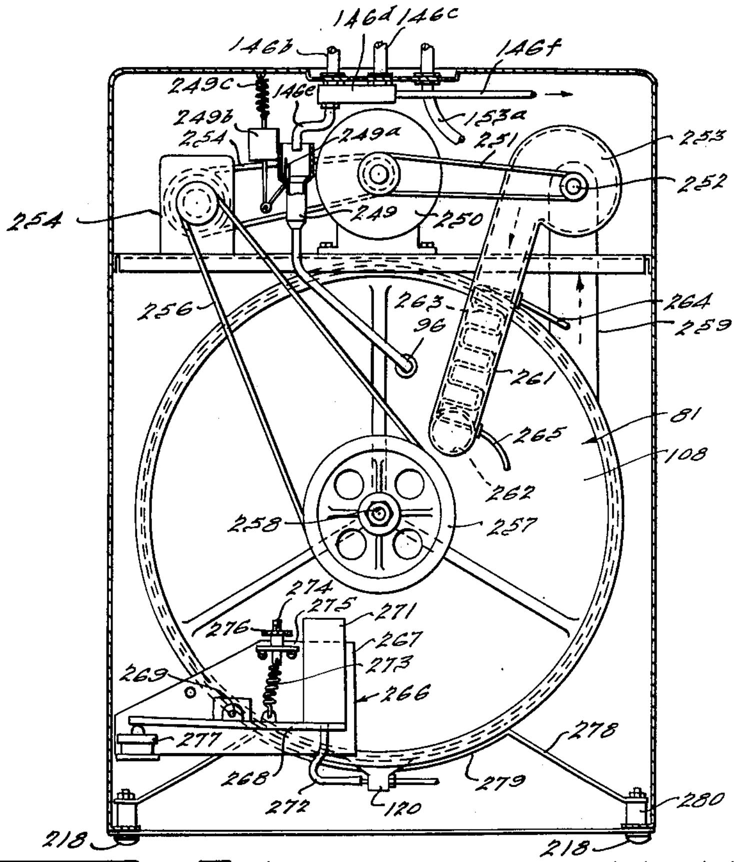


FIG. 51.

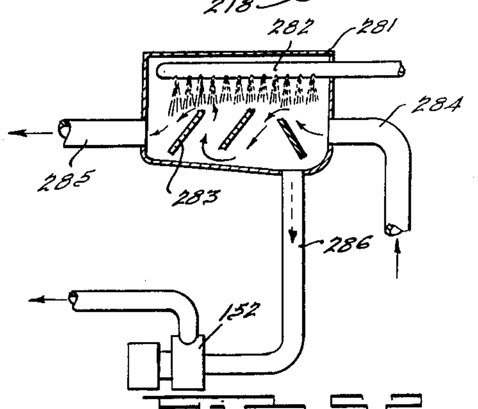
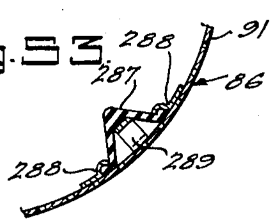


FIG. 52.

FIG. 53.



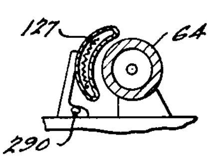


FIG. 54.

INVENTOR.
William E. Stilwell, Jr.
BY
Harness, Dickey & Pierce
ATTORNEYS.

FIG. 55.

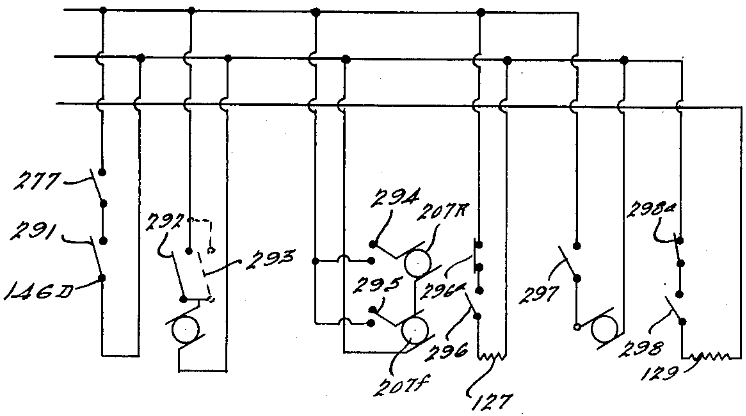
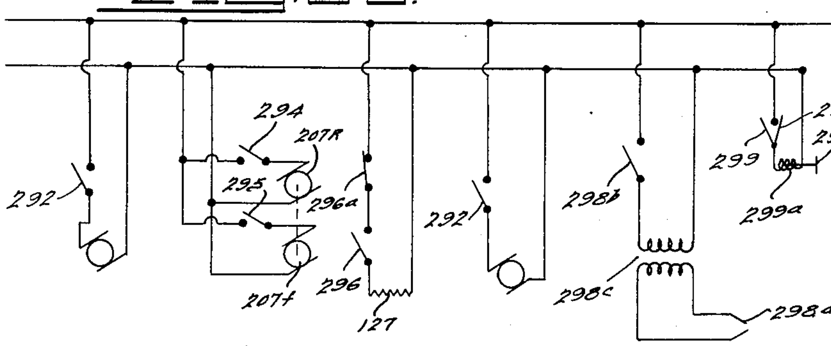


FIG. 56.



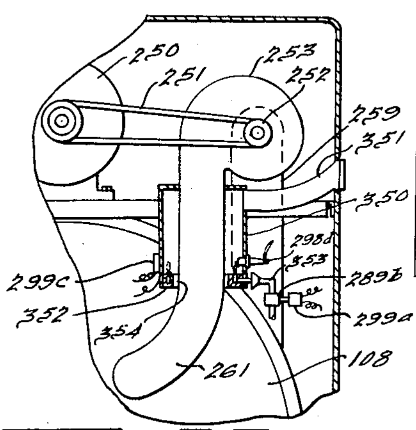


FIG. 57.

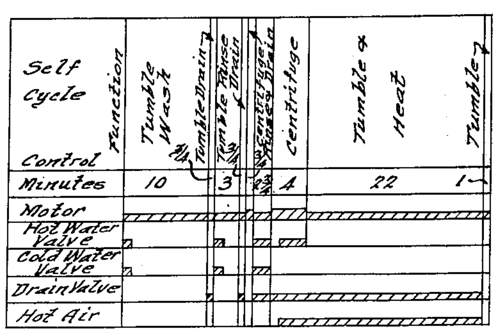


FIG. 61.

INVENTOR.
William E. Stilwell, Jr.
BY
Harness, Dickey & Pierce
ATTORNEYS.

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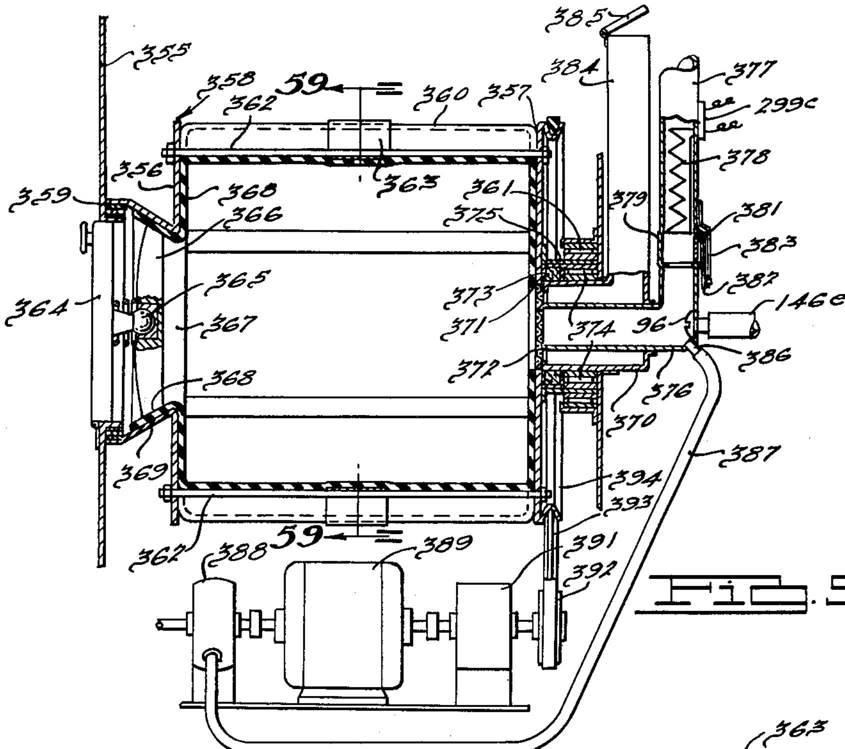


FIG. 58.

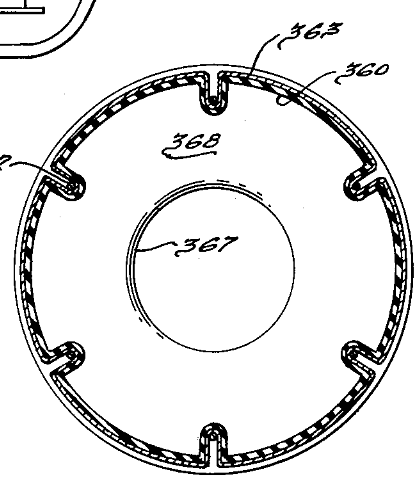


FIG. 59.

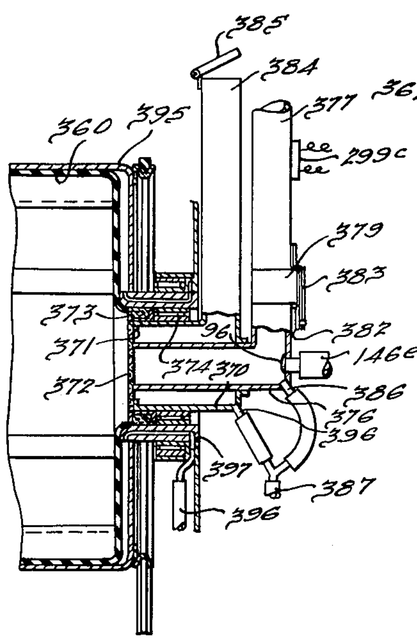


FIG. 60.

INVENTOR.
William E. Stilwell, Jr.
BY
Harness, Dickey & Pierce
ATTORNEYS.

May 14, 1963 W. E. STILWELL, JR 3,089,327

APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

Original Filed Sept. 7, 1951 20 Sheets-Sheet 20

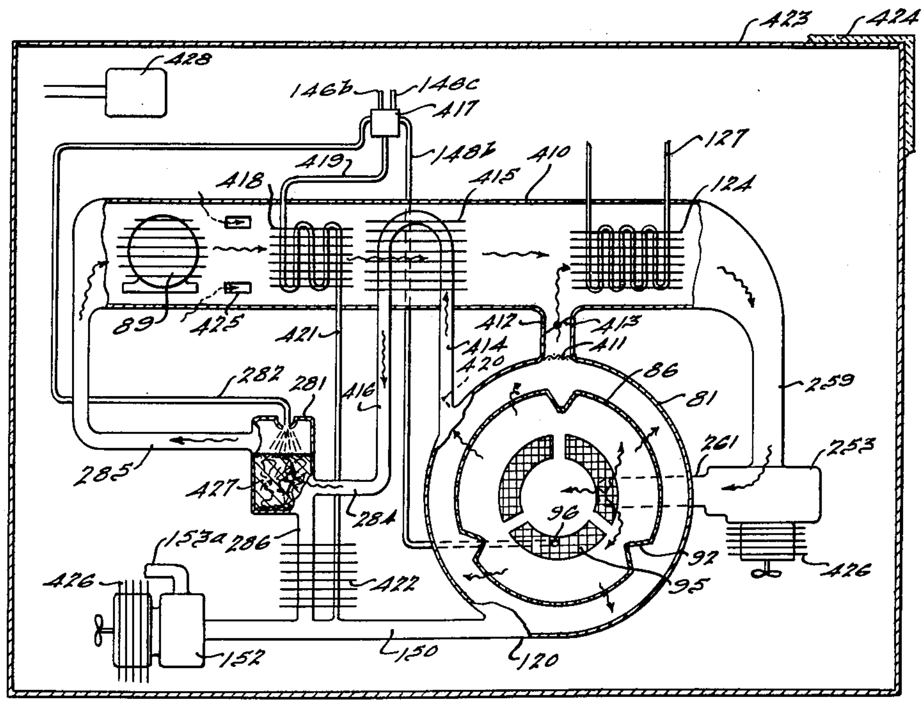
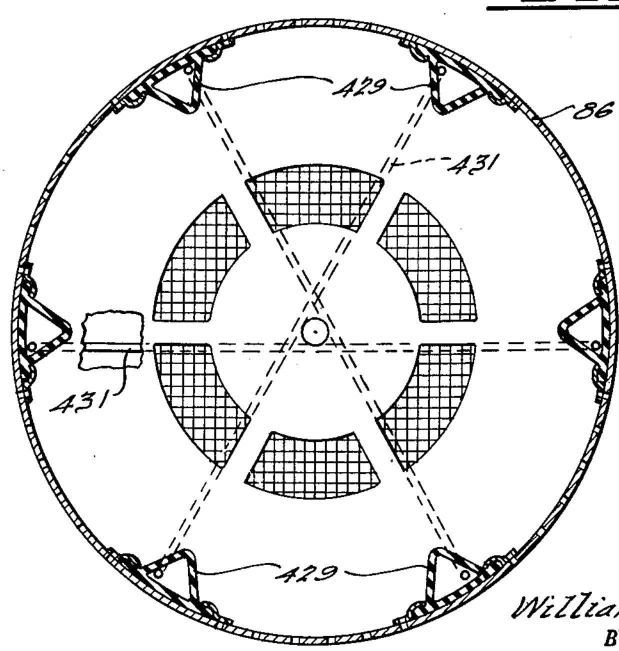


FIG. 62.



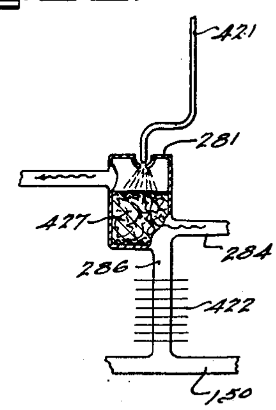


FIG. 63.

FIG. 64.

INVENTOR.
William E. Stilwell, Jr.
BY
Harness, Dickey & Pierce
ATTORNEYS.

United States Patent Office

3,089,327

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3,089,327
APPARATUS FOR THE COMPLETE LAUNDERING OF FABRICS

William E. Stilwell, Jr., Glendale, Ohio, assignor to The Murray Corporation of America, Detroit, Mich., a corporation of Delaware

Original application Sept. 7, 1951, Ser. No. 245,585, now Patent No. 2,960,780, dated Nov. 22, 1960. Divided and this application Nov. 15, 1960, Ser. No. 69,407
3 Claims. (Cl. 68—139)

My invention relates to laundering machines, and particularly to a machine in which fabrics to be laundered may be washed, rinsed, damp-dried, completely dried and ironed, and is a division of Serial No. 245,585, filed September 7, 1951, which has now issued into Patent 2,960,780, dated November 22, 1960.

The primary objects of my invention are: to provide a unit washing, drying and ironing machine capable of processing a standard loading of soiled fabrics yet dimensioned within the limits conventionally established by single purpose machines; to utilize the common and concurrent mass, means and energies of one laundering subfunction to assist the operation and the results produced by one or more other laundering subfunctions; to locate the access opening to the laundering machine, the operating controls therefor and the ironer components adjacent to each other to permit the entire laundering operation of washing, drying and ironing to be conducted by the operator while in a single sitting position; to provide thermal energy accumulating means which is so utilized that the thermal power requirement rating is substantially less than in conventional laundering machines; to provide means for heating, circulating, delinting and/or dehumidifying the circulated air not only for the purpose of evaporatively drying the clothes but also for heating the clothes and the water during the washing, rinsing and extracting cycles; to provide novel washing, rinsing, extracting, drying and ironing mechanism in combination with novel transmission, control, mounting and vibration isolation structure in a single laundering machine; to provide a novel laundering machine having a receptacle which, when loaded with fabrics in accordance with the requirements of the evaporative drying cycle, provides better washability than when said receptacle is conventionally loaded in accordance with the requirement of the washing cycle; and, in general, to provide a laundering machine of the multipurpose type which is simple in construction, positive in operation and economical of manufacture.

Other objects and features of novelty of the invention will be specifically pointed out or will become apparent when referring, for a better understanding of the invention, to the following description taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a perspective view of a laundry unit constructed according to my invention, with the ironer cover and loading door closed;

FIG. 2 is a perspective view of the laundry unit, with the ironer cover and loading door in open positions;

FIG. 3 is an enlarged fragmentary sectional view, taken on the line 3—3 of FIG. 1;

FIG. 4 is a similar view taken on the line 4—4 of FIG. 1;

FIG. 5 is a front view in elevation, with a part of the cabinet structure broken away to show the inner and outer tubs, the baffles and part of the spring suspension;

FIG. 6 is a rear view in elevation of the machine;

FIG. 7 is a side view in elevation of the machine, showing the tub assembly, with parts in section and parts broken away;

FIG. 8 is a top plan view of the machine, with the top of the cabinet removed;

FIG. 9 is an enlarged vertical sectional view through the ironer roll and its cantilever beam support;

FIG. 10 is an enlarged end sectional view, taken along the line **10—10** of FIG. 9;

FIG. 11 is a vertical sectional view through the tub assembly;

FIG. 11*a* is an enlarged fragmentary perspective view of the nozzle illustrated in FIG. 11;

FIG. 12 is an enlarged broken view of FIG. 2, illustrating the control elements;

FIG. 12*a* is a further enlarged view of the function-timer dials illustrated in FIG. 12;

FIG. 13 is an enlarged perspective view showing the damper and operating mechanism as employed on the heat exchanger;

FIG. 14 is an enlarged exploded view of the driving mechanism for the receptacle;

FIG. 15 is an enlarged vertical sectional view through the heat exchanger, taken along line **15—15** of FIG. 12;

FIG. 16 is an enlarged sectional view through the ironer roll, taken on line **16—16** of FIG. 9;

FIG. 17 is an enlarged top plan view, partly in section, of the vibration isolator friction dampers illustrated in FIG. 8;

FIG. 18 is a diagrammatic view illustrating the air and thermal circulatory system for the drying cycle;

FIG. 19 is an enlarged vertical sectional view of a desiccant dehumidifier;

FIG. 20 is an enlarged vertical sectional view of a water spray dehumidifier;

FIG. 21 is an enlarged vertical sectional view showing a condenser type dehumidifier;

FIG. 22 is a horizontal sectional view of the machine, showing the tub assembly and spring suspension;

FIG. 23 is a diagrammatic view, including the wiring diagram for providing the automatic operation of the friction dampers;

FIG. 24 is a diagrammatic view of structure illustrating the water circulatory system;

FIG. 25 is a diagrammatic view of the supply valve shown in the tub-filling position;

FIG. 26 is a diagrammatic view of the supply valve shown in the overflow rinsing position;

FIG. 27 is a diagrammatic view of structure illustrating the overflow and the sump circulatory system;

FIG. 28 is a view showing an alternative position of the valve of FIG. 27;

FIG. 29 is a view of a wiring diagram showing the electrical circuits for semi-automatic and automatic operations of the machines;

FIG. 30 is a view of a wiring diagram showing a two-motor control for the ironer roll;

FIG. 31 is a fragmentary view of structure, similar to that illustrated in FIG. 8, showing an alternative arrangement of the blower;

FIG. 32 is a time cycle diagram for automatic self-cycling operation of the machine;

FIG. 33 is an enlarged semidiagrammatic view, in section, of the heat exchanger and ironer shoe showing the water and steam circulatory system thereof;

FIG. 34 is a sectional view of structure, similar to that illustrated in FIGS. 3 and 4, showing another form thereof;

FIGS. 35, 36 and 37 are diagrammatic views of structure, illustrating three alternative methods of spring support for the tub;

FIG. 38 is an enlarged detailed fragmentary sectional view, illustrating a vibration damper which may be employed with the structure of FIG. 37;

FIG. 39 is a view in side elevation of a single-purpose machine for drying fabrics;

FIG. 40 is a vertical sectional view of the machine illustrated in FIG. 5, showing a modified form thereof;

FIG. 41 is a sectional view of structure, taken along line 41—41 of FIG. 40;

FIG. 42 is a similar view of structure, taken along line 42—42 of FIG. 41;

FIG. 43 is a perspective view of a washer-dryer machine embodying my invention;

FIG. 44 is a perspective view of an ironer and cabinet embodying a form of my invention;

FIG. 45 is a plan view of the structure illustrated in FIG. 44, indicating an alternative mounting of the ironer;

FIG. 46 is a side view in elevation of the structure illustrated in FIG. 44, indicating another alternative mounting of the ironer;

FIG. 47 is a view in front elevation of a washer and dryer unit embodying features of my invention;

FIG. 48 is a view in elevation of a dryer and ironer unit embodying features of my invention;

FIG. 48*a* is a front elevational view of the function control dial employed in the machine illustrated in FIG. 48;

FIG. 49 is a view in side elevation of a washer and ironer unit embodying my invention;

FIG. 49*a* is a view in elevation of the function control dial employed in the machine of FIG. 49;

FIG. 50 is a view in front elevation, illustrating a washer unit of my invention;

FIG. 51 is a view of structure, similar to that illustrated in FIG. 6, showing a further form which the invention may assume;

FIG. 52 is a view of structure, similar to that illustrated in FIG. 20, showing a further form thereof;

FIG. 53 is a view of structure, similar to that illustrated in FIG. 11, showing another form thereof;

FIG. 54 is a diametric view of structure, similar to that illustrated in FIG. 2, showing a modified form thereof;

FIG. 55 is a view of a wiring diagram employed in the machine illustrated in FIG. 1;

FIG. 56 is a view of a wiring diagram, similar to that illustrated in FIG. 55, employed when gas heat is utilized for drying;

FIG. 57 is a broken view of structure, similar to that illustrated in FIG. 51, showing a gas heating element for heating the air for drying;

FIG. 58 is a sectional view of a machine for laundering clothes, showing a still further form which the invention may assume;

FIG. 59 is a sectional view of the structure illustrated in FIG. 58, taken on the line 59—59 thereof;

FIG. 60 is a broken view of the structure illustrated in FIG. 58, showing a still further form of the invention;

FIG. 61 is a self cycle time chart disclosing the steps employed in the unit having a closed air circuit;

FIG. 62 is a diagrammatic view of a cabinet having the washing and drying structure therein, embodying features of the present invention;

FIG. 63 is a broken view of the structure illustrated in FIG. 62, showing a modified form thereof, and

FIG. 64 is a sectional view of a fabric receptacle having flexible vanes on the inner wall thereof which produces the balance of the off-center load during the centrifuging cycle.

General Arrangement

FIGS. 1 and 2 illustrate the preferred embodiment of my invention, combining into a single appliance, with a view to maximum compactness and utility, all of the laundering functions of washing, drying and ironing. The cabinet 61 is in two main sections: the lower section 62 that houses the tub assembly, and the upper section 63 that houses the ironer component 64, the control elements 65, 66, 67 and 68 (better shown in FIGS. 12 and 12*a*), and the various prime movers and auxiliaries. The front top section 69 of the cabinet is hinged, as

shown at 70, to permit access to the ironer and the controls; the rear top section 71 is attached to the lower section 62 of the cabinet by screws or bolts (not shown) to permit easy removal for servicing. The tub filling or loading door 72, locked by a latch 73*a* which is actuated by a button 73, is located in the lower section 62 of the cabinet, immediately below the ironer roll 64, so that the control elements for both operations of ironing and of filling and emptying the tub are convenient to the housewife as she sits before the unit. The location of the control panel 74 rearward of the ironer roll support casting and gear box 75 and the location of the ironer foot switches 76, 77 at the sides of the two toe-recesses 78 in the bottom front edge of the cabinet, complete the operational accessibility and convenience of the preferred embodiment of my invention.

In FIGS. 12 and 12*a* are shown: the function control element 65 which is a dial marked off into the five subfunctions of "iron," "wash," "drain," "spin" and "dry"; the timer switch control element 66 is a dial marked off into the predeterminable minutes that each subfunction may persist before being shut off automatically; the motor brake push button 80; the control element 67 which is a handle for the water inlet valve; and the control element 68 which is a handle for the manual operation of a friction damper camshaft later to be described in detail.

FIGS. 5 and 6 illustrate the compact yet simple arrangement of the major elements of the preferred embodiment of my invention. All of the functions of washing, rinsing, draining, spin extracting, ironer-drying, and fluff-drying are performed within the single receptacle assembly 79 whose outer tub 81 is resiliently hung from the cabinet walls by four coiled springs 82, the upper ends of which pivot on stationary hooks 83 and the lower ends of which are screw-attached at 84 to U-shaped cradles 85 welded or otherwise suitably fixed to the bottom of the outer tub 81. There is a rotatable inner receptacle 86 whose single, cantilever shaft 87 (see FIG. 7) is supported by ball bearings 88, and which is power-rotated by the electric motor prime mover 89 and belt transmission 90, to be later described in detail. The lateral peripheral wall 91 of the receptacle 86 has baffles 92 thereon to assist in the tumbling action of the clothes and is perforated to provide for the air and the water circulation, to be described later. As best seen in FIGS. 7 and 11, the rear end plate 93 of the receptacle 86 has ribs 94 thereon for structural strength, and has a screened, segmented annular opening 95 to permit both the inlet water to enter the receptacle from the spray nozzle 96 and the heated, drying-cycle air to enter the receptacle through the venturi duct 97. The exterior side of the end plate 93 outwardly of the annular opening 95 is circumscribed by the wiping gasket 98 which assures that all of the hot air for the drying cycle and from the duct 97 will enter the receptacle and come into contact with the fabrics before escaping through the perforations in the peripheral wall of the receptacle and into the plenum chamber 100 formed by the clearance between the receptacle and outer tub which is preferably ¾″.

The front end of the receptacle has a concentric, circular opening 101 approximately equal to the diametral distance between opposing baffles 92; the edge of the receptacle defining the inner edge of this opening 101 supports a wiping gasket 102 which bears lightly against the inner, front wall of the outer tub, and which serves to prevent the fabrics from being caught between the rotating receptacle and the stationary outer tub.

In the illustrated embodiment of my invention, the perforations 86*a* of the receptacle are ¼″ holes on ⅝″ centers; there are six baffles 92 equally spaced, equilateral in section and 1¼″ radially high; the diameter of the receptacle at the base of the baffles is substantially 24″, and the axial length of the tub is approximately 16″. A receptacle so dimensioned and so configurated is adequate to handle the tumble, evaporative fluff-drying of substantially six pounds of clothes and the tumble washing of approximately fourteen pounds of clothes.

In order to increase the impact effect at the terminus of the parabolic trajectory of the fabrics as they are tumbled in the receptacle, the trailing surfaces of the baffles 92 or other lifting means are angled normal to the trajectory.

The outer tub 81 is illustrated as being a wrap-around type approximately 1½″ greater in diameter than the inner receptacle. Its front opening 103 is eccentrically positioned and registers with the eccentrically positioned opening 104 in the lower cabinet section 62. The fabric filling opening is not only well above the working water level but also is within convenient reach of the operator when seated before the machine. The openings 103 and 104 are aligned with the upper half of the opening 101 in the receptacle. As best shown in FIGS. 3 and 4, a bellows-type, watertight, throat gasket 105 connects the outer tub opening 103 with the cabinet opening 104, and the cabinet door 72 seals against the gasket 105 in the closed position. The gasket is formed with convolutions to permit maintenance of the watertight seal despite the various gyrating movements of the outer tub during the spin-extracting cycle. FIG. 34 shows an alternate arrangement wherein a bellows-type gasket 105*a* is employed between the front opening 103 of the outer tub 81 and the front wall of the cabinet. A suitable channel 105*b* is provided on the cabinet wall for receiving the gasket. With this arrangement, a separate gasket 105*c* is used for sealing the cabinet door 72 in its closed position.

Referring again to FIG. 7, there is recessed within the front face of the outer tub a counterweight 106 which serves to locate the front-to-back static center of the tub assembly approximately midway the axial depth of the inner tub. This results in better control of the excursions of the tub assembly during the spin-extracting cycle.

In FIG. 34 the front end plate 80 is constructed of heavier gauge metal than the rest of the tub to provide static weight at the forward end of the tub to balance the tub at about one-half the axial depth of the inner receptacle. The balancing of the tub assembly in either manner helps to equalize the loading on the resilient mounting means.

The rear of the outer tub is open and flanged outwardly as at 107 for its full diameter, not only to receive the inner recepetacle but also the coned and ribbed bearing support plate 108. The plate 108 serves as the rear wall of the outer tub and is rigidly held to the flange 107 with a sealing gasket therebetween by a clamp ring 109 that is demountable by means of a threaded connector 110 (FIG. 6). Preferably the plate 108 is drawn from metal and is embossed with ribs and a central cup to serve as a bearing housing.

Several auxiliaries are attached to the outer surfaces of this double tub assembly. The centrifugal blower 111 (FIG. 6), the blower discharge duct 112, the venturi duct 97, the tub air discharge duct 136, the flexible blower inlet duct 113 (FIG. 8), the capacitor start motor 89 with its adjustable bracket 115, the high speed unidirectional driven pulley 116 and the low speed unidirectional driven pulley 117, the compound, intermediate pulley 118, the water inlet nozzle 96, the water overflow outlet 119, the sump 120 (FIG. 11), the suspension cradle 85, a centering member 121*a* (FIG. 8), and the friction damping blades 122.

The centering member 121*a* (see FIG. 8) is an upstanding blade fixed to the outer tub and positioned between a pair of tension springs 121 mounted on the frame. These springs acting on the blade 121*a* restrain undue oscillation of the tub assembly and maintain it in suitable operative relation with respect to the front and back of the cabinet when the friction damping blades 122 are not held against the stationary friction pads 175 by the cams 178 and 179 (see FIG. 17).

Heat Exchange Component

Immediately behind the ironer roll 64 (see FIG. 7), and both structurally and operationally associated therewith through the ironer shoe 123, is the heat exchanger 124, rigidly mounted to the cabinet on top of the clothes-return chute 125. Referring now to FIG. 15, in one embodiment of my invention the heat exchanger comprises a serrated or finned aluminum extrusion and heating element sandwich, all tightly bolted to the ironer shoe 123. In order of assembly, first comes the ironer shoe 123 with horizontally projecting, projection welded, screw studs 126, a spacer block 126*a*, then a mica-enclosed, resistance wire heating element 127, then the heat exchanger finned duct 128, then another mica-enclosed heating element 129, then a layer of thermal insulation 130, and finally a pressure plate 131. Insulating plates 130*a* are provided at the top of the assembly and an insulating plate 130*b* is provided at the bottom thereof. Midway of the length of the ironer shoe is a thermostat 132 that controls the first heating element 127. A cover or shell 133 surrounds, and is spaced a short distance away from the rear of the heat exchanger, thus forming an air duct. The incoming air enters the orifice 124*x* and is drawn through the duct, thus warming the primary air before it enters the inlet end 134 (see FIGS. 8 and 13) of the heat exchangers. At this inlet end there is a damper 135 actuated by a cam 135*a* by the operation of the function control dial 65. The output end of the heat exchanger (FIG. 8) is connected by a flexible duct 113 to the centrifugal blower 111.

The heat exchanger 124 may be made of cast iron instead of aluminum, and when of sufficient mass I have found it possible to eliminate the second heating element 129, and thus reduce the total connected wattage rating of the machine. The heat exchanger 124 may be so constructed as to contain anhydrous calcium sulphate or an equivalent desiccant and thus obtain three effects, thermal storage, thermal exchange and desiccation. The heat exchanger 124 (FIG. 47) may be mounted directly onto the outer tub 81, thus eliminating the need for any other counterweighting, such as the counterweight 106 previously described; such an arrangement is more readily adaptable, however, in the instance of a combination washer and dryer.

To increase the thermal pickup efficiency of the heat exchanger, the ambient input air is drawn over the blower housing and through the space separating the heat exchanger cover from the heat exchanger itself. Under such conditions, I prefer that the blower inlet port 111*b* (see FIG. 31) be integral with the heat exchanger outlet 124*a* and that the blower itself be driven independently by its own motor 111*a*; the operational control is more flexible and the motor cooling fan 111*f* results in added pressure and heat for the air entering the heat exchanger through the entrance orifice 124*f*. The storing of heat in the exchanger when wattage is available before and during the washing and rinsing operations provides initial high heat from the low wattage source at the beginning of the drying cycle when the fabrics are saturated with water. The high temperature of the stored heat progressively lowers as the moisture content of the fabrics becomes less and less so that the stored heat is expended by the time the fabrics are dried.

Waste Air Conditioner

Closely associated with the drying cycle use of the heat exchanger are the special means I provide for the treatment of the hot, humid output air, to eliminate the steaming of the room walls and windows, as well as the pollution of the room air by the inevitable lint from the clothes as they are being fluff-dried. The drying cycle output air leaves the confines of the tub assembly through the tube discharge duct 136 (FIG. 8) and thence into the flexible air hose 137. In the preferred installation of my machine, this outlet duct may be directly connected to another ducting that leads to the outdoors atmosphere. When this type of installation is not practicable, I provide a removable screen or delinter 138 in the air outlet duct and I may, in addition, provide alternative means (FIG. 19) for dehumidifying the output air either by desiccating it with anhydrous calcium sulphate 138*a* for example, or by lowering its temperature with a cold water jet 139 (FIG. 20) or a cold water condenser (FIG. 21). Thus I provide for the installation of the delinter 138 and/or dehumidifier either within the drying cycle output duct 137 or as a separate attachment mountable to the machine at the air discharge port.

In the event that a desiccant is used for dehumidifying the drying cycle output air, I provide for the desiccant itself to be housed within a removable, screened container. After any single use of the desiccant, the operator must remove the container and place it in a heated oven for approximately one hour at 450° F.; this effectively steams off the absorbed moisture and reactivates the sulphate to the anhydrous state. On the other hand, when a desiccant is used as part of the heat exchanger system, as explained above, the reactivating cycle can be carried on in the machine itself prior to the desiccating function, and such a procedure permits the desiccant to be used additionally as a heat accumulator.

Alternatively, in FIG. 51 I show a drying cycle air circulating system involving 100% recirculation. Between the blower inlet and the tub outlet I locate a cold water spray dehumidifier, as illustrated in FIG. 52. The tub output air is washed free of lint and its dew point is lowered. The lint and the condensate go down the drain. The system is designed for a 150° F. tub output air temperature and a blower inlet temperature of 110° F.

Tub Drive Means

The means illustrated in FIGS. 5, 6, 7 and 14 comprising belts and pulleys for driving the ironer tub at two different speeds (say 49 r.p.m. and 490 r.p.m.) deserves special attention. To minimize the shock loads generally inherent in all washing actions, I provide for a unique all-belt drive, having neither gears nor remotely operated clutches. I provide, instead, an electrically reversible motor 89 having a driver pulley 89*a* and a driving belt 89*b*, the inside edge of which directly rotates the high speed unidirectional, driven pulley 116 at 490 r.p.m. and the outside flat of which rotates, in a reverse direction, the flat, compound pulley 118 at 350 r.p.m.; the smaller pitch diameter pulley 118*a* of the compound pulley 118 drives the larger unidirectional driven slow speed pulley 117 at 49 r.p.m.; each of the two driven pulleys is mounted on the inner tub drive shaft 87 and connected thereto by overrunning, spring-urged, roller clutches 143 and 144, both of which are designed to drive the tube only in the desired direction; namely, counterclockwise, when viewed from the rear end of the unit. Referring specifically to FIG. 14, shaft 89*a* rotates clockwise, as indicated by the arrow X, driven pulley 116 likewise rotates clockwise and idles, not driving the shaft 87, but the compound pulley 118, 118*a* rotates counterclockwise and so through belt 118*b* rotates the driven pulley 117 counterclockwise, the direction of rotation for which the overrunning clutch 144 is designed to pick up and drive the tub shaft 87. Thus, the tub is driven at low speed. When the motor is reversed, as indicated by the dotted arrow X_1, the driven pulley 116 and the overrunning clutch 143 rotate counterclockwise to drive the tub at 490 r.p.m. while the other overrunning clutch 144 and pulley 117 idle. When the tub has been running at its top spinning speed, and when the motor is de-energized momentarily and reversed to the direction needed for the slow speed (49 r.p.m.) of the drying cycle, the tub will coast and will be activated by neither driven pulley until it reaches 49 r.p.m., at which speed the slow speed driven pulley 117 will take over.

Water Circulatory System

Since a desirable location for my combination laundering machine is in the kitchen, in alignment with other appliances or cabinets and against the wall, I provide plumbing connection in a recess at the top rear edge of the unit. As shown in FIGS. 1 and 6, there are two threaded connections; one, 146, is for the hot and cold water inlet hose that, preferably, is connectable to the swing faucet of the kitchen sink; the other connection, 147, is for the drain hose that may have a hooked end fastenable over the front edge of the kitchen sink. Such a plumbing arrangement is primarily for a manually operable or removable unit. It is to be understood that a hot and cold water mixing valve may be attached to the hose 148 and that the hose 153*a* may be directly connected to drain for permanent installation. A conduit 139*a* connects a spray nozzle 139*c* of the dehumidifier 139*b* to the cold water line at the connector end 146*a*.

The inlet water flows from connection 146 through the hose 148, the manually operated valve 148*a*, the hose 148*b* and then through the jet nozzle 96 located in the end plate 108 of the outer tub 81, radially inward to the fabric orbit or annulus. The jet nozzle 96 is slotted vertically, as shown at 96*a* in FIG. 11*a*, so that the water spray impinges against the full axial length of the tub; this assures a more thorough rinsing action during the spin-rinse cycle of operation.

In certain geographical localities, sanitary regulations require the use of a vacuum breaker (at or near the point where the tap water enters the closed container of an appliance) to prevent syphoning back into the service line. For a single-purpose washing machine, the incorporation of a vacuum breaker is relatively simple, but in a combination washer and dryer, the conventional type of vacuum breaker would be an uncontrollable source of air leaks during the drying cycle. Accordingly, I provide a vacuum breaker 249 having a closing damper 249*a* actuated by a solenoid 249*b* from the same servo-mechanism that closes the water inlet valve 146*d*. The damper, as illustrated in FIG. 51, is closed by the spring 249*c* when the switch 277 is opened by the water level determining means 266 which comprises, in part, a spring suspended container 271 that fills with water as the tub fills and trips the switch 277 when filled to the predetermined volume or weight of water; that is, both the inlet water valve and the vacuum breaker damper are closed when the tub is filled to its proper amount, generally one gallon of water for each pound of clothes (atmospheric weight).

The draining of the outer tub 81 and of the inner receptacle 91 through the latter's lateral perforations 86*a* is accomplished in a semiconventional fashion. I provide a sump 120 (FIG. 7) that covers a large part of the lower section of the outer tub and that accepts water from the tub assembly through the perforations 120*a*. A flexible drain hose 150 (FIG. 6) connects the sump 120 with the inlet port 121 of the motorized vane-type drain pump 152 through the optional valve 156. The discharge port 153 of the pump is connected by hose 153*a* directly to the drain connector 147 in the recess at top rear edge of the cabinet. In the event the valve 156 is eliminated, the draining of the tub is merely a matter of energizing the motorized pump 152. In the event that an overflow port 119 is installed at the working water level of the tub assembly and connected to the inlet of the pump by the flexible hose 154, the valve 156 is kept closed and the pump energized during the tub filling operation; as soon as water appears in the drain hose from the unit, the inlet water is turned off because then the tub has its proper water loading.

Drain hose 158 joins with the pump inlet hose 153 or the overflow port hose 154 (FIG. 6) to carry off the condensate and/or cooling water from the dehumidifier **139***b* located in the air output duct **136** from the outer tub. Several types of dehumidifiers are variously shown in FIGS. 19, 20, 21 and 52; they may be installed in a nonrecirculatory system (FIG. 18) or in a circulatory system (FIG. 57); they may be dispensed with entirely, letting the hot, moist, lint-laden air escape to the surrounding atmosphere or be piped to the out-or-doors through an auxiliary duct system; or, as in FIG. 8, the outer tub outlet duct **136** may be connected by a flexible duct **137** to and through a removable delinter screen **138**. In the event a cold water spray dehumidifier (FIGS. 20 and 52) is used, the delinter **138** may be eliminated since the water spray actually washes out the air suspended lint; thus the lint, the condensate and the cooling water are carried off by the drain hose **158**. FIG. 21 shows, in general, a condenser type dehumidifier in which the output air passes over internally-water-cooled surfaces. Since the cooling water is under tap pressure, it may be self-draining, or it may connect directly to the condensate drain hose **158**, or through an aspirator (not shown) it may serve as the draining medium for the condensate, thus eliminating the need for operating the drain pump **152** during the drying cycle. FIG. 19 shows the use of a desiccant (anhydrous calcium sulphate) for the removal of excess moisture from the drying cycle output air; the desiccant is held in a removable, screened container. It must be reactivated after each use either by supplying heat in situ when embodied in the heat exchanger **124**, or by heating in a separate appliance.

Alternatively, in the event of automatic self-cycling of the several laundering subfunctions, I provide for three hose connections as shown in FIG. 51: hot water **146***b*, cold water **146***c* and drain **153***a*. The hot and the cold water lines are connected directly to the mixing, distributing device shown in outline at **146***d*. The outlet **146***e* from the valve **146***d* connects directly with the inlet jet nozzle **96**. The second outlet **146***f* connects directly with the dehumidifier **139***b*. The distributor mixing valve **146***d* is appropriately operated by the self-cycling sequencing means and/or by the water level servo-mechanism.

Referring next to FIG. 24, a further arrangement involves a form of hydraulic impingement that comprises water jets **160** located in the upper section of the outer tub **81** and directed toward the inner receptacle **91** to assist in both the tumbling action and in the rinsing action. The jets may be connected to a forced circulatory washing solution system, as indicated by the dotted lines **162***a*, whereby a pump **162** circulates water from the sump **120** through the nozzles of the jets **160** or, as shown in full lines, the jets may be connected to the inlet supply line **161** by means of valves **163**.

FIG. 25 shows a position of the valve **163** whereby the supply water is directed to fill the tub.

FIG. 26 shows a position of the valve **163** whereby the supply water is directed into the sump line for the purpose of overflow rinsing.

FIGS. 27 and 28 show a valve **163***a* suitable for connecting the sump **120** to the drain pump P or, in its alternate position (FIG. 28) connecting the overflow **119** to the drain pump.

As a part of the water circulatory system and as illustrated in FIG. 33, I may provide a water heating or steaming means comprising a continuous passageway **124***c* formed in the heat exchanger **124**. A valve **124***d* diverts the input tap water, after it has passed through the heater, either to the outer tub nozzle **96** as superheated water and to the ironer shoe perforations **123***a* as steam, the valve **124***d* being provided with a reduced discharge orifice **124***e* employed in conjunction with the steam function.

The degree of opening of the valve **124***d* establishes the water (or steam) flow and temperature. In the event the operator wants to use the steam-ironing principle, the three-way valve is set to permit the steam generated in the passageway **124***c* to pass from the heater and thence through the perforations **123***a* in the leading edge of the ironer shoe **123**. Alternatively, I provide for the forced recirculation of the washing solution through the heating coils and thus benefit materially to the extent that washability is a function of water temperature. As shown, this recirculation may be readily arranged by means of a valve **120***a* provided in the drain line **153***a*; this valve may be set to divert the water normally flowing out of the drain, back to the heater **124**, whereafter the heated water may again be returned to the tub through nozzle **96**.

Friction Damping Means

Previously I have referred to the friction dampers that constitute an important part of the vibration isolation system. In FIGS. 17 and 40 these friction dampers comprise two rigid blades **122** mounted on the top outer section of the outer tub. The rearward faces of these blades are covered with suitable friction material **172**. The blades themselves are free to gyrate within the frameworks **173** that are rigidly mounted on the cabinet itself. In the rearward, vertical faces **174** of these brackets, are mounted adjustable buttons **175** having frictional material **175***a* secured to the faces thereof. Arranged to cooperate with these members is a horizontal shaft **177** carrying two cams **178**, **179** which are actuatable by the control handle **68**. In the "off" position these cams allow all of the freedom apparently necessary for the gyrating of the tub assembly during the spinning cycle. In the "on" position, as seen in dotted lines of FIG. 15, and as obtaining preferably only during the acceleration and deceleration of the rotating receptacle, these cams **178**, **179** lock the friction material faced blades **122** against the friction material faced buttons **175** and so imposed the friction damping needed to reduce the amplitudes of the spinning cycle vibrations—that is, while I provide damping preferably only when the receptacle is passing through its resonant velocity, I further provide a leaf spring locking clip **180** (FIG. 12) for holding the camshaft operating handle in the "on" position.

Although the preferred embodiment of my invention has two friction dampers **178** and **179** located as shown in FIG. 17, it is to be understood that a single damper may be located at the top center of the outer tub, or three dampers may be spaced about the full periphery of the outer tub. The resilient suspension means may also take forms other than that heretofore described. I have found that two curved, cantilever springs (FIG. 51), capable of deflection in the planes desired, function satisfactorily. The required resiliency can also be attained by a flexible bell crank type of support in which the flexing is accomplished by a spring or rubber restrained member coacting with the arms of the bell crank that are pivotably connected both at their juncture with one another and at their free ends between the outer tub and the supporting structure. The required friction damping can also be accomplished by a somewhat similar bell crank arrangement in which the resilient member is replaced by a friction member. Finally, both resiliency and damping will result if the bell crank type of tub support contains both friction and elastic members.

In order to obtain a difference in damping as between the applied and the resonant frequency periods of the centrifuging cycle, I provide, as shown in FIGS. 40, 41 and 42, two variable orifice hydraulic dampers **230** and **231** mounted to the cabinet brackets **238** by eyelets **232** and to the outer tub bracket **239** by eyelets **237**. The brackets are provided medially of the hooks **83** and brackets **85** for the springs **82** at each side of the tub. The brackets **239** are preferably attached to the ends of the sump **120** and are deflected inwardly toward each other and then outwardly to space the ends an amount to receive the eyelets **237** of the dampers **230** and **231**. A turn-buckle **233** serves as a means for adjustably centralizing the piston **235** with the maximum opening of the variable orifice **240** at the predetermined static loading deflection of the coiled springs **82** which are mounted in the manner illustrated in FIGS. 5 and 6. The hollow cylindrical housing **236** is filled with oil of the proper viscosity. The orifice **240** is so shaped that there is essentially no damping at the applied or centrifuging frequency, but that at the resonant frequency the damping force is a function of the excursion of the tub assembly. The use of this form of damping results in the lowest vibration transmissibility during the spinning cycle.

Referring to FIG. 23, automatic operation of the dampers may be readily provided by use of solenoids. When the solenoids **179***a* and **179***b* are energized by closing the switch **179***d*, the friction members **178***a* are urged against the blades **122**, previously disclosed as mounted on the outer tub, and into contact with the fixed friction members **175** mounted on the frame. The solenoids are de-energized by a centrifugal switch **179***c* mounted to rotate in conformance with the tub rotation.

When the function control dial is moved to the spin-extract position requiring high speed operation of the tub, the switch **179***d* is closed, thus energizing the solenoids **179***a* and **179***b* and actuating the friction dampers to prevent resonant vibration which occurs during the accelerating period. However, as the tub approaches its maximum speed, where damping is no longer required, the centrifugal switch **179***c* opens to break the circuit to the solenoids and release the friction devices. When the function control dial is moved off the spin-extract position, the rotating receptacle decelerates; the centrifugal switch closes but the friction dampers are not activated as the switch **179***d* is now open.

FIG. 35 diagrammatically illustrates an alternate method of spring suspension wherein the outer tub **81** is supported by the spring members **300** and **301**, each of the springs being attached to the tube at **302** and to a member **303** which is part of the frame. Undue oscillation of the assembly may be restrained by means of the depending stud **304** surrounded by a resilient member **305** mounted in the frame portion **306**.

FIG. 36 illustrates another alternate spring suspension method wherein the springs **300** and **301** are fixed to the tub **81** at **307** and to the frame at **308**. The depending stud **304** may again be employed for restraining undue oscillation in the manner illustrated in FIG. 35.

FIG. 37 illustrates a further alternate spring suspension wherein the tub **81** has an upwardly extending neck **310** which is flanged outwardly at **311**. A compression spring **312** engages beneath the flange **311** to thus resiliently support the tub **81**. The lower end of the spring rests on a frame member **313** which, as shown, is perforated at **314** to accommodate the neck **310**. A damping means to prevent undue oscillation of the parts is illustrated in FIG. 38 and comprises an upstanding member **315** faced with friction material **316**. The member **315** has a bent portion or foot **317** having elongated slots **318** and **319** through which slots the large headed screws **320** permit slight movement of foot **317** and its upstanding member **315** carrying the friction pad **316**. Welded or otherwise secured to the flange **311** is a depending arm **321** carrying a roller **322**. The roller engages a cam strip **323** fixed to the member **315**. Due to the formation of the cam strip, as shown, any undue movement of the tub assembly, causing the roller **322** to rise or fall from the position shown, will result in the friction pad **316** being forced against the spring **312**, thus creating a restraining action in proportion to the amount of movement occurring. To prevent the tub assembly **79** from undue oscillation in the fashion of a free pendulum, I employ tension springs indicated at **330**. At their inner ends the springs are attached to the stud **304** and at their outer ends the springs are attached to frame members **331**. I preferably employ at least three of the springs **330** arranged radially about the axis of the stud **304** and equally spaced thereabout.

Ironer Component

In FIG. 2 the cabinet ironer cover **69** is shown in the opening or operating position. The ironer roll **64** itself is of conventional design, being a metal tube covered with a semipermanent padding and a removable, drawstring covering. Referring now to FIGS. 9 and 10, the roll is capable of two degrees of movement, the first a rotation as indicated on the drawing by arrow Y on its concentric axis **181**, and the second a rocking motion towards and away from the stationary ironer shoe **123** on an eccentric axis that is concentric to the fixed tubular cantilever beam **182** which is rigidly held by the roll support casting and gear box **75**. The roll concentric axis **181** is essentially a stub shaft, the inboard section of which is rigidly fastened, as by weld **183**, to two Y-shaped yokes **184** that, in turn, are pivotally mounted on the tubular cantilever beam **182** by the spaced sintered oil-impregnated bearings **185**. The outboard section of the shaft supports a sleeve **186**, to one end of which is keyed or otherwise affixed, as by a pin **186***a*, the rocking gear **187**, and to the other end of which is slidably keyed a series of metal discs **188** that constitute part of the multiple disc clutch **189**. The clutch housing **190** has the ironer roll fixedly mounted thereto by screws **190***a* and its inboard face has an internal gear **191** which meshes with the driver gear **192** which is keyed to the driver shaft **193**. The housing **190** is rotatably mounted on the sleeve **186** on the oil-impregnated bearing **185***a* and within its outboard cavity are housed the friction discs, alternate ones being slidably keyed to it by the integral, axial bosses **194**. The extreme, outboard end of the stub shaft **181** is threaded as at **181***a* to receive the adjusting wing nut **195** that serves as the means for establishing the friction torque of the clutch **189** through the coiled spring **196** and the two pressure caps **197** and **198**. A thrust bearing **199** is inserted next to the inboard face of the rocking gear **187**.

The rocking action is obtained by the meshing of gear **187** (see FIG. 16) with a segment gear **201** that is concentrically and fixedly mounted to the outboard end of the tubular, cantilever beam roll support **182**. The two spaced Y-yokes **184** (FIG. 9) have radial extensions **184a** at the ends of which are mounted rollers **203** that bear on internal bands **204** spot-welded to the inner surface of the ironer roll **64** and serve to stabilize the ironer roll. A stationary bumper **205** (FIG. 10), fixed to the beam **182**, limits the extent of the open position of the ironer roll when engaged by a roller **203**, as illustrated in broken lines. A limit switch **206**, actuated by the cradle stub shaft **181** when the ironer roll is in open position, de-energizes the ironer prime mover **207** by opening the reversing circuit. A groove **208** (FIG. 9) in the inboard end of the ironer roll serves to keep the tightened drawstring of the ironer roll covering clear of the tubular, cantilever beam.

The roll supporting casting and gear box **75**, in one embodiment of my invention, is semi-permanently, rigidly mounted to the reinforced plate **210** that serves as the top of the lower section of the cabinet **62**. The gear box is compact and is mounted as low as possible to permit maximum use of the so-called "closed-end" of the ironer roll. The inboard end of the tubular cantilever beam **182** is firmly held within the gear box **75** by setscrews or other means not shown. Within the gear box **75** (FIG. 7) is the speed reducer spur gear train **212** that drives the shaft **193** through the gear **193***a* at such a speed that the reduction through pinion gear **192** and internal gear **191** results in the desired ironer speed, generally 7.5 r.p.m. The ironer prime mover **207** (FIG. 7) can be a 1/20 horse power, electrically reversible motor that drives the gear box primary shaft **212***a* by means of a V-belt **213**.

Within the two toe-recesses **78** (FIG. 1) are mounted the switches for controlling the two motions of the roll **34**. Switch **76** is a multiple pole, double throw, motor reversing switch. In the normally open position, the electrical connections of this switch are such that the motor will cause the rollshoe sandwich to open, that is, will cause the ironer roll **34** to rock about the supporting beam **182** and move toward the operator. This opening movement away from the ironer shoe **123** is automatically limited by rod **205** and at the end of the movement the opening of the reversing circuit through limit switch **206** within the ironer roll **64** interrupts the motor operation. In the closed position, arrived at by the operator's foot pressure on actuating blade, switch **76** is so connected electrically that the drive shaft **193** within the tubular cantilever beam will rotate clockwise, as seen in FIG. 16, and in turn will rotate the internal gear **191**, the ironer roll **64** and the rocking gear **187** clockwise; gear **187** rides on the stationary fixed segment gear **201** and thus rocks the stub shaft **181** and the supporting cradles **184** clockwise and toward the ironer shoe **123**. All of these clockwise movements will continue until the ironer roll **64** comes into such predetermined ironing pressure contact with the ironer shoe **123** that the previously established friction torque reactions of the multiple disc clutch **189** will be exceeded; at such a point the rocking action ceases, the clutch slips and relative motion is then established between the still rotating clutch housing **190** and the then stationary rocking gear **187**, so that the ironer roll **64** is rotated as required for ironing operation.

Foot switch **77** is a single pole, single throw, normally closed and is used in series with the electrical supply to the ironer prime mover **207**. No matter in which direction the motor **207** is rotating, whether to rotate the ironer roll **64** clockwise or counterclockwise, the direction of rotation cannot be reversed unless this foot switch **77** is actuated to the open circuit position. Taking full advantage of this switching characteristic of reversible, split phase motors, I have been able to achieve a unique and highly desirable ironing action. If the operator actuates foot switch **76** and then releases it to its normal position, the ironer roll **64** will rotate clockwise on both its concentric and its eccentric axes and continue to rotate on the concentric axis after the ironing pressure has been established. If the operator then momentarily actuates foot switch **77**, the main electric supply to the prime mover **207** will be disconnected long enough for the motor rotor speed to drop to that value required for reversing at the instance of foot switch **76** which, under the condition specified immediately above, is in the normal or counterclockwise rotation position; then the ironer roll rotates and rocks backwards, toward the operator, until the limit switch **206** opens the reversing circuit to the motor. This is the type of series of roll movements normally required in the process of ironing.

On the other hand, a pressing action, defined as maintenance of ironing pressure without relative rotational movement between the ironer roll and the ironer shoe, may be achieved with this same set of foot switches merely by altering the operational sequence. If the operator causes the ironer roll **64** to move into pressure contact with the shoe **123** by actuating foot switch **76**, and retains the switch in actuated position, the ironer roll will continue to rotate clockwise in ironing pressure contact with the ironer shoe **123**; as a matter of fact, this ironing action, once started, will continue whether the right foot switch **76** is in the actuated or in the normal position. Now if, while foot switch **76** is held in the actuated position, the foot switch **77** is likewise held in the actuated or "off" position, the clockwise, concentric axis rotation of the roll will cease, because the prime mover **207** has become disconnected and the desired pressing action will have been achieved.

The ironer roll will continue in this "pressing" position as long as both foot switches are held in the actuated position; however, if foot switch **77** is de-actuated first, the ironer roll **64** once more assumes its ironing or clockwise rotary movement; on the other hand, if foot switch **76** is de-actuated first and then the foot switch **77** is de-actuated immediately thereafter, the ironer roll will take on a counterclockwise rotary movement and return to its normally open position.

There are many modifications to the above described ironing means and methods. The reversible, split phase motor can be replaced by a reversible shaded pole motor, or by a reversible shaded pole reluctance motor, as will readily be understood by those skilled in the art, or by two motors as illustrated in FIG. 30, where I have indicated motors **207*f*** and **207*r*** with suitable switches and connections for operating either motor, the motors being arranged to rotate in opposite directions, with the accompanying simplification in the switching circuits. The semi-epicyclic gearing, represented by the four gears within the ironer roll, can be rearranged to such an extent that the ironer roll can be returned to the open position without benefit of a reversible prime mover. However, under such a system, special additional means must be provided for the desired pressing action. Another modification is a simplified version of the friction clutch **189** in which there is but a single friction surface, at the sacrifice of adjustability of the ironing pressure.

FIG. 45 indicates an alternative arrangement of the ironer roll **64** and heating means **124** wherein these elements are pivotally mounted as at **350** permitting them to swing to the dotted position indicated if desired for convenience of the operator.

FIG. 46 indicates another arrangement wherein the ironer roll **64** and heater **124** are mounted on a plate **151** hinged to the cabinet at **152**. With this arrangement, the ironer will be moved to the dotted line position during operation. This position of the ironer provides increased space for the legs and knees when the operator sits before the machine during ironing operations. There is another simplification possible if full advantage is taken of these elements inherent in a combination laundering machine. I have found that about 75% of the ironer prime mover horsepower is required for creating the ironing pressure and only 25% is required for rotating the ironer roll. A combination laundering machine, of the class described herein, necessarily has two sources of pressure—water pressure and air pressure; therefore, by piping either of said pressure sources to the ironer component and using expansible pressure means, the closing of the roll-shoe sandwich may be effected at a savings of some 75% of the ironer prime mover horsepower.

In that embodiment of my invention which comprises, in part, a collapsible laundering receptacle as the fluid extracting means (see FIGS. 57 to 59), there is a compressor for creating the collapsing pressure. The ironer component then becomes, preferably a pivotably mounted ironer shoe whose rocking action is created by a compressed air actuated bellows with the ironer roll capable of rotation only. To conserve space, the now small ironer motor and its speed reducer are mounted internally to the roll itself; the foot operated controls comprise a single pole, single throw push button in the motor circuit and a push valve in the compressed air line.

Electrical Control Circuits and Means

FIG. 29 shows the complete electrical wiring diagram for the preferred semi-automatic embodiment of my invention. There are twenty-three single pole switches involved. Switches No. **1** to No. **12** are all cam operated; switches No. **1** to No **9** are operated by the cams (not shown) mounted on the function control dial shaft **157**; switches Nos. **10**, **11** and **12** are operated by cams (also not shown) mounted on the timer dial shaft **216**. Switch No. **80** is the manually operated push button previously mentioned, located just beside the function control dial **65**, and serves to shunt out the centrifugal starting switch normally associated with electric motors of the type herein described. Switch **80** is actuated by the operator immediately after the function control dial **65** has been so turned that a reverse in the direction of rotation of the tub motor **89** is required to produce the change in the tub operational function. Actually, the actuation of push button **80** serves to brake the motor dynamically and so condition the motor for quick reversal.

The motor braking push button **80** may be made automatic in its operation by incorporating it with the motor reversing switches as a momentary, wiping contactor.

In one embodiment of my invention there are two independent, separately fused 115-volt, 1650 watt supply circuits. In the event of the availability of three wire 220-volt electric supply service, the same wiring diagram prevails as will be readily understood by those skilled in the art. In the event that the drying cycle is operated on the thermal storage principle, the second 115-volt circuit, involving switches No. **9** and No. **12** may be eliminated. As shown in the wiring diagram, this second circuit is used primarily for the booster heating element **129** at the back of the heat exchanger **124**. The wiring diagram for this second circuit includes a motor **111*a*** for the centrifugal blower **111**. This individual drive for the blower (illlustrated in FIG. 31) is alternative to the belt drive **111*b*** shown in FIG. 6.

In the event that a belt drive is used, however, I have found it preferable to employ the damper **135** as previously described at the inlet of the heat exchanger (FIG. 13) and to operate the damper automatically by a cam **135*a*** attached to the function control dial shaft **157** so that the damper **135** is closed during the washing and draining cycles.

Referring again to FIG. 29, the switch No. **1** is normally closed and is opened midway between each of the six positions of the function control dial. The purpose of this switch is to clear the main circuit between actuations of the other cam operated switches.

Swith No. **2** actuates the motorized pump **162** during the draining and the spinning cycles. In the event that the overflow outlet is provided for the tub assembly, along with the proper valving, the washing cycle is added to the functional periods that switch No. **2** is actuated to the "on" position. In the further event that a dehumidifier is used, the drying cycle is added to such actuating periods for switch No. **2**.

Switch No. **3** is actuated to the "on" position during all of the functional cycles except spinning. The ironer motor circuit and the first heat exchanger heating element **127** are energized by switch No. **3**. Thus, the ironer may be operated concurrently with all other laundering functions except during the start of spinning; the reason for the exception, patently not mandatory, is to minimize the line voltage drop when the inner tub is being accelerated to the top spinning speed.

Switches Nos. **4**, **5** and **8** are actuated to the "on" position when the tub motor **89** is to be rotated clockwise (from the output end) for the low-speed operation of the inner tub, that is, during the washing, draining and drying cycles.

Switches Nos. **4**, **6** and **7** are actuated to the "on" position when the motor **89** is to be rotated counterclockwise for the high speed spinning cycle.

Switch No. **9** is actuated to the "on" position during the drying cycle only. In the event, however, that line voltage conditions permit, I have found that the evaporative drying potential of the spinning cycle is greatly enhanced if the induced draft caused by the spinning tub is allowed to be drawn through the heat exchanger previously brought up to operating temperature by having switch No. **9** in the "on" position during the precednig cycles.

Switches Nos. **10**, **11** and **12** are actuated to the "on" position by cams mounted on the shaft **216** driven by the timer **66** (FIG. 6). Switches Nos. **11** and **12** are actuated as long as the timer dial **66** is not in the "off" or zero time position. Switch No. **10**, which controls the motorized pump **162**, is timer-shaft actuated only during the last five minutes of a full revolution of the timer dial **66**; this, fundamentally, is automatic self-cycling and may be used in two ways; first, to permit draining of the tub without rotation of the tub, and second, to permit the operator to fill the tub with the prescribed amount of clothes, water and detergent, to set the function control dial **65** at "wash," to set the timer dial **66** for any required time, and then leave the unit, knowing that for the last minutes of the washing period the washing water will be draining out of the tub; all other non-ironing functions can be made similarly automatically self-cycling.

Switch No. **14** is part of the thermostat **132** and is in series with the first heating element **127** of the heat exchanger **94**. Should conditions warrant, a similar thermostat may be placed in the heater circuit controlled by switch No. **9**.

All switches from No. **2** to No. **12** and No. **80** are normally open.

Switches Nos. **15** to **23** are devoted exclusively to the ironer roll ac tion, as previously described. Switch No. **15**, normally closed, is the left foot switch **77** located in the cabinet, toe recess **78** and is in series with the main, cam operated ironer switch No. **3**, but does not affect the circuit to the first heating element **127**.

Switches Nos. **16** and **18** to **23** constitute the right foot switch **76** located in the cabinet toe recess **78**. Switch No. **16** is single pole, single throw, but switches Nos. **18** and **19**, **20** and **21**, and **22** and **23** are paired as single pole, double throw switches.

Switch No. **17**, in multiple with switch No. **15**, is the limit switch **206** within the ironer roll **64**. When switches Nos. **15**, **17**, **18**, **20** and **22** are in the closed position, all other ironer switches being open, the ironer roll will rotate counterclockwise. At the end of this movement, the automatic opening of switch No. **17** (**206**) interrupts said counterclockwise rotation of the ironer roll **64**. The manual opening of switch No. **15** (**77**) has the same effect. When switches Nos. **16**, **19**, **21** and **23** are closed, the ironer roll **64** will assume a clockwise rotation.

The spin extracting of clothes requires a higher momentary demand on the prime mover than does any other cycle. This high demand occurs during the tub accelerating period; as a precautionary assurance that full voltage will be available for accelerating the masses involved, I provide means for momentarily disconnecting all other major demands on the electric circuit at least during this accelerating period. The momentary disconnect principle applies especially to the heating element **127** and the ironer motor **207**, the circuit to which is opened momentarily by cam-operated switch **3** when the switches **4**, **6** and **7** are initially moved to "on" position. The resulting discontinuity in the supply circuits to the affected components is shown in FIG. 32 where it will be observed that the first heater **127** and the ironer motor are momentarily de-energized as the spin-extracting commences. Similarly, if the second heater **129** is also employed to provide heat for storage, the switch **12** will be removed from the blower circuit to control the heater **129** and will be opened momentarily when switches **4**, **6** and **7** are initially moved to "on" position.

Operation

The operation of the preferred embodiment of my invention is fundamentally different from any and all conventional laundry appliances in that, in the subject instance only, are all of the laundering subfunctions so compacted and so operationally correlated that the total laundering operation can be performed more efficiently and more conveniently than heretofore possible.

In the first place, my machine can be installed even in a small kitchen or bathroom having the necessary plumbing and electrical facilities adjacent to the selected installation point. The top of the cabinet is a convenient continuation of the standard kitchen counter working surfaces; the depth matches that of standard kitchen cabinets; the unit may be fully operated without need for moving it away from the kitchen wall (as, for example, most console type conventional ironers must be moved), and, also, without need of open spaces to either side of the unit.

To prepare my unit for operation, the water-filling connection **146** at the top rear of the cabinet is attached by a flexible hose to the swing, hot-cold water faucet. To the drain connection **147** is attached a flexible, drain hose that may be hooked over the edge of the sink, and the two electric conductors **217** and **217*a*** are plugged into two 115-volt, alternating frequency, separately fused, standard wattage circuits. The machine itself should be leveled by adjusting the four buttons **218** at the bottom corners of the cabinet; no bolting down is necessary since I have provided for a satisfactory vibration isolation system. It is to be understood that the water and drain connections may be permanently made to the supply line and drain, as mentioned above.

To start the laundering operation, turn on the hot water supply at the tap source. Swing back the ironer cover **69**; set the timer dial **66**, set the function control dial **65** to "off"; lock in the friction damper handle **68**; set the thermostat **132** (FIG. 8) to the "high" position; turn the water valve handle **67** to "on" and permit the water to enter the tub until the level is even with the special marking (not shown) on the inner, back face of the receptacle; this will mean about six gallons of water, enough for six pounds of clothes, dry weight. Press the latch button **73** (FIG. 1) to open the filling door **72** and the necessary amount of detergent; close the door and turn the function control dial **65** to "wash" for a minute or so to permit the detergent to go into solution; return the dial **65** to "off" and place approximately six pounds of fabrics in the receptacle; set the dial **65** to "wash" and allow the tumble washing action to proceed for some ten minutes. Turn the dial to "drain" and after all of the free washing solution has been pumped out, and while the receptacle is still rotating, admit rinsing water by turning the valve handle **67**. This first rinse may be hot or cold, as desired. Allow the rinse water to drain out completely, set the dial **65** to "spin" and press the button **80** momentarily; it is optional whether to go directly from "drain" to "spin" or to stop the machine first, remove the fabrics and then place them one by one back in the receptacle after the latter has been brought up to full spinning speed. In either event, after the loaded receptacle has assumed its top speed, turn the damper handle **68** to the "off" position, thus essentially isolating all vibration from the cabinet.

After the spin extraction cycle has operated for some three minutes, admit hot water to the tub by turning the valve handle **67**. In the subject design the spray nozzle **96** causes the inlet water to wet the impinged fabrics continuously as they pass by the jet; this affords not only a superior type of centrifugal rinsing action but in addition raises the temperature of the fabrics, an important advantage both to centrifuging and to subsequent evaporative drying. Turn off the hot spray rinse and allow the fabrics to centrifuge for several additional minutes; it is interesting to note that during this spinning period some 26 c.f.m. of hot moist air will flow out of the tub air outlet **136**, indicating a concurrent evaporative drying, a phenomenon that makes a combination washing and drying machine superior, for the spin-extracting cycle, to conventional single purpose machines.

The next step in the operation of my machine is to turn the function control dial **65** to "dry," press the push button **80** momentarily and relock the friction dampers with the handle **68**. If the spin-extracting cycle has been properly operated, a normal six pound loading of fabrics can reach the fluff-dry condition (i.e. the linen-closet-storing-condition) in approximately thirty-five minutes; this represents an evaporative drying efficiency quite superior to conventional machines. Under less careful handling of the spin-extracting cycle, however, the normal length of the evaporative drying cycle for my machine is thirty-five minutes for ironer-dry and an additional thirty minutes for fluff-dry. If the timer dial **66** has been set initially for such average drying periods, the unit will stop automatically and the fabrics may be removed for ironing or for storing, as the case may be. While I have indicated the operations as above set forth as being accomplished by manual operation of the control elements, the use of the motor operated timer illustrated in FIG. 29 automatically produces the machine operation in the same sequence.

In the event that all of the fabrics within the tub are to be ironed, it is good practice to leave them in the receptacle and remove them one by one as the ironing task progresses.

The ironing method to be followed in the use of my machine is somewhat similar to conventional machines; the fabrics are fed over the top of the ironer roll **64** and into the roll-shoe pressure sandwich, setting the function control dial **65** to "iron" or to any other position except "spin" (see above) and setting the timer dial **66** to the desired limit, is all that is needed to place the ironer component in standard operating condition. There are, however, certain important departures from standard practices; first, the ironing shoe **123** is stationary; second, the shoe temperature is evenly maintained by the heat exchanger mass; third, the ironing pressure is constant regardless of the thickness of fabrics put through the roll-shoe sandwich, due entirely to the slipping friction clutch principle; fourth, the so-called "closed-end" of the roll is more open due to the eccentric mounting of the roll; fifth, the roll **64** is 24" long—the distance between the shoulders of an average shirt, thus facilitating the ironing of shirts; sixth, the foot control of both the rotary and the rocking actions of the roll **64** is prerequisite to the marked improvement in freedom of the operator's hands for smoothing and guiding the fabrics into the roll-shoe sandwich; seventh, the finished ironing may be stored temporarily on the shelf made by the opening of the ironer cover **69**; eighth, the fabrics to be ironed are not only more uniformly and properly dampened but are convenient to the operator sitting before the machine; ninth, the ironer component may be considered definitely safer than conventional types, due to the dual foot control; and, tenth, the structural and functional, compact correlation with the other laundering functions makes the ironing function itself more efficient.

Modifications

The principles and means hereinabove established for a single machine capable of performing all laundering functions are likewise adaptable to machines capable of doing only some of the laundering functions. These modifications of my invention will presently be described and it is to be noted that, as illustrated, many of the component parts may be interchangeable throughout the series of different combinations, thus permitting, incidentally, the following description to be based in a large measure on the previous drawings and designations.

In the structure illustrated in FIGS. 43 and 47, the ironer component has been deleted and a new provision made for locating the various controls and the heat exchanger **124**. The friction damper cam shaft handle **68** and the water inlet valve handle **67** are located in the upper left front face of the cabinet; the function control dial **65**, the timer dial **66** and the motor brake push button **80** are located in the upper right front face of the cabinet. A detailed description of these parts would follow the previous specifications except that the ironer circuit and indications are eliminated and the friction damper control handle **68** operates at 90° to the damper cam shaft **177** previously described.

The cabinet top section **100***a* is removable as a single piece and beneath it are located the various components and auxiliaries previously described. The heat exchanger **124** (see FIG. 47) has not been altered but the ironer shoe has been removed and the insulation covering changed. To eliminate the necessity of special counterbalancing weights, as in FIG. 4, the heat exchanger itself is mounted directly on the outer tub by means of the two supporting brackets **124***b*.

The arguments previously presented and pertaining to the advantages of combining the subfunctions of washing, extracting and evaporative drying in a single machine apply to the subject machine with equal force and intent.

FIG. 48 illustrates a combination dryer and ironer. The present market saturation unbalance in the domestic laundry appliances field (washers 67%, ironers 8% and dryers ½%) is a self-serving argument for the need of a combination dryer and ironer.

Eliminating the washing and extracting means and leaving only the drying and ironing means greatly simplifies the internal construction of this machine. There is but a single rotating receptacle **86***c* supported by a cantilever shaft **87***c* journaled in a needle bearing **87***d* and driven at 49 r.p.m. by 1/7 horsepower, gearhead, shaded pole-reluctance type motor **87***e*. The bearing and motor are supported by a suitable frame **87***f* rigidly mounted to the cabinet.

The 25½" diameter receptacle **86***c* has an imperforate peripheral wall to which six flat, longitudinal baffles (not here shown) are attached. The front end of the tub is open except for the annular lip **86***g* that carries a gasket **86***h* which bears against the inner face of the front of the cabinet. The rear end of the tub is ribbed for structural strength and contains two segmented, screened annuli **86***j* and **86***k*, the outer one **86***k* being for the outlet air and the inner one **86***j* being for the inlet air.

To the front face of the supporting frame **87***f* is fixedly mounted two circular wiping gaskets **87***g* and **87***h* which serve to separate the inlet from the outlet air streams. To this same member are attached the inlet air duct **112***a* from the discharge port of the centrifugal blower and the outlet air duct **136***a* leads to a delinter.

The ironer component **64** and the heat exchanger **124** are the same as described in the specifications herein pertaining to my combination washer, dryer and ironer.

The function control dial **65***a* (FIG. 48*a*), marked off into "off," "iron" and "Dry" selectively operates a single pole switch in the main line for the ironer component (including the ironer motor **207** and the first heating element **127**) and a separate circuit, single pole switch for the drying component (including the gearhead motor **87***e* and the second heating element **129**). The ironing circuit is always energized except when the function control dial **65***a* is at the "off" position. The timer dial **66***a* serves to wind up a timing mechanism capable of tripping a single pole switch in the main line for the gearhead motor **87***e* and the second heating element.

The cabinet for the combination dryer and ironer is the same as for the combination washer, dryer and ironer with the exception that a simple door gasket, not deemed to require illustration, is substituted for the more elaborate bellows type gasket.

As has been previously suggested, the heat exchanger **124** may take several alternative forms such as a thermal accumulator with one or two heating elements or a desiccator with one or two heating elements.

The arguments already made for the enhanced utility obtainable by combining the ironing and the drying cycles in the combination washing, drying and ironing machine, likewise hold true in the instance of a combination dryer and ironer.

FIGS. 50, 39 and 44 illustrate respectively the adaptation of the washing, extracting, drying and ironing means of my combination machines to a separate washer-extractor, a separate dryer and a separate ironer. Previous disclosures and specifications germane to these several means are, in general concept, applicable to the machines illustrated in FIGS. 50, 39 and 44.

FIG. 49 illustrates the adaptation of means and principles already described to a combination washer and ironer. In contradistinction to the washer-dryer-ironer machine, the washer-iron machine has preferably a reduced heat exchanger **124***g* with but a single heating element **127***a* that heats both the ironer shoe and the air used for accelerating the extractive-evaporative process during the spinning cycle. The outer tub, again preferably, has an air duct (not here shown) connecting to the heat exchanger outlet and an air discharge port. No blower is required, neither is a secondary circuit with its customary control means.

Reference was made hereinabove with regard to the use of the hot and cold water mixing valve **146***d* in place of connecting the line **146** to the mixing faucet of the sink, and such structure is illustrated in FIG. 51. In the construction illustrated, a motor **250** has one belt **251** which drives the pulley on the shaft **252** of the blower **253**. A second belt **254** drives through a speed reducing unit **255** to drive a third belt **256** for driving the pulley **257** attached to the shaft **258** of the receptacle contained within the tub **81**. An outlet port in the tub is connected by a suitable conduit **259** to the inlet side of the blower **253**, and an outlet conduit **261** connects the blower to the delivery nozzle through an opening **262** in the rear wall **108** of the tub. Within the conduit **261** an electric heating unit **263** is provided having conductors **264** and **265** connected in the motor circuit or directly to a supply line. It will be noted in this arrangement that the water supply conduit **146***e* from the mixing valve **146***d* is connected to the jet nozzle **96** at the upper part of the rear wall **108** of the tub instead of at the bottom thereof, as illustrated in FIG. 6.

This arrangement is employed in connection with a water weighing device **266** mounted at the bottom of the tub. A plate **267** is supported on the tub on which a platform **268** is mounted to tilt on a pivot **269**. A receptacle **271** is mounted on the right-hand end of the platform **268**, as illustrated in the figure, having connection at the bottom to a conduit **272** which is connected to the drain receptacle **120**. A spring **273** has one end connected to the platform on the side of the pivot adjacent to the receptacle **271**, the other end of which is secured to a stud **274** which extends through a platform **275**. A thumb nut **276**, threaded upon the stud **274**, provides adjustment to the stud to regulate the tension on the spring **273** to thereby control the tilting of the platform **268** as the container **271** fills with water delivered into the tub through the nozzle **96**.

Beneath the left-hand end of the platform **268**, a switch **277** is supported which normally is in "on" position and which breaks a circuit to the solenoid of the valve **146***d* to shut off the admission of water when the depth thereof, as measured by the weight of the water within the receptacle **271**, has reached a proper height. Upon draining the water from the tub, the water will flow freely from the receptacle **271**, the platform will tilt backward, urged by the tension in the spring **273**, to substantially horizontal position, as illustrated in the figure, to thereby again move the switch **277** to "on" position. This movement of the switch to "on" position does not energize the valve **146***d*, the circuit to which has been opened by the switch which controls the admission of water.

The tub **81**, as herein illustrated, is mounted on a pair of cantilever spring supporting elements **278**, the arcuate center portion **279** of which is secured to the tub. A resilient block or spring **280** supports the ends of the cantilever spring **278** on the base of the cabinet, so that the springs **278** function the same as springs **82** hereinabove referred to.

Referring to FIG. 52, a further form of humidifier is illustrated, that wherein a housing **281** has a water spraying device **282** mounted therein for spraying water over baffles **283** which are tilted in a manner to produce a tortuous path of flow for the air from the inlet conduit **284** to the outlet conduit **285** at opposite ends of the housing. A drain conduit **286** is connected to the pump **152** for draining off the sprayed water, the condensate from the air and the lint which has been washed from the air. The conduit **285** is connected to the blower inlet while the conduit **284** is connected to the tub **81**, providing a closed system.

Referring to FIG. 53, a further form of baffle **287** is herein illustrated as being substituted for the baffle **92** on the wall **91** of the receptacle **86**. The baffle is resilient, being made of rubber or similar flexible material and is secured to the inner surface of the wall **91** by suitable means, herein illustrated as by the clamping bands **288**. A spring **289**, herein illustrated as of the leaf type, or which may of course be of any other type of resilient element or material, is mounted within the baffle to resist the collapse thereof under normal use during the washing operation. During the centrifuging of the fabrics, the resilient baffle **287** will collapse an amount conforming to the amount of fabrics which rest thereon and which are subject to the centrifugal force produced during the high speed operation of the receptacle. When the receptacle returns to slow speed operation, the tension in the baffle and the spring **289** will force the baffle to its original position and thereby release the fabrics from the inner surface of the receptacle to which they would otherwise adhere. The fabrics are then free to tumble within the rotor during the slow-speed operation thereof.

In FIG. 54 the modified form of ironer roll and shoe is illustrated when employed on a single purpose ironing machine. In this arrangement the ironer roll **64** is mounted in fixed relation to the cabinet and the shoe **123** is mounted on a pivot **290** so that it may be moved toward and away from the roll **64**. An electric heating element **127** is mounted directly in the shoe and joined by a flexible conduit to the heating circuit. Such an ironer arrangement would be employed in the cabinet illustrated in FIG. 44 hereinabove described.

In FIG. 55 a wiring diagram is illustrated covering the multi-purpose unit as illustrated in FIG. 51, from a 115–230-volt electric circuit. A switch **291** is first energized to energize a solenoid of the valve **146*d*** to admit water to the tub **81**. The water will continue to flow into the tub until the circuit to the switch is broken by the operation of the switch **277**. Simultaneously, the switch **292** is closed for energizing the motor **250**, a similar switch **293** being available for connection to the reverse winding at the time the high speed operation is to be initiated. Switches **294** and **295** are employed for connecting the tandem motors **207*r*** and **207*f*** of the ironer switch of the circuit. A switch **296** is employed for connecting the ironer heating element **127** to the circuit, a thermostat **296*a*** controlling the temperature of the shoe **123** in the normal manner. A switch **297** controls the circuit to the motor of the pump **152**, while a switch **298** controls a circuit to the heating element **129** in which a thermostat **298*a*** is connected in series.

In FIG. 56 a wiring diagram is illustrated which is the same or similar to that of FIG. 55, with the exception that controls are added for the supply of gas heat instead of electric heat. A switch **298*b*** completes a circuit to a high voltage transformer **298*c*** which produces a spark at the points of a spark plug **298*d*** for igniting the gas. A switch **299** completes a circuit to a solenoid coil **299*a*** for operating a gas valve **299*b*** and for momentarily holding the circuit closed. The heat produced by the gas ignited by the spark at the points of the plug **298*d*** operates the thermostat **299*c*** and moves it to closed position and retains the circuit to the coil of the solenoid **299*a*** closed when the switch **299** opens. If the gas is not immediately ignited to heat the thermostat, the movement of the switch **299** to open position permits the valve **299*b*** to close and prevent the escape of gas.

The gas burner which may be employed in place of the heating element **259** is illustrated in FIG. 57 where the burner housing **350** surrounds the conduit **261** and is connected by a flue **351** to atmosphere at the side of the cabinet, from which connection may be made to a chimney. A burner **352** is mounted at the bottom of the housing connected by a conduit **353** to the supply valve **299*b*** which is operated by the solenoid **299*a***. The spark plug **298*d*** is mounted in the side of the housing **350** directly above the burner **352** in position to ignite the gas, the air for combustion being supplied through the passage **354** between the burner and conduit. The heater is connected in the control circuit illustrated in FIG. 56, the operation of which was described above.

In FIG. 58 a further form of a combination laundry unit is illustrated, that where an imperforate, baffled, single speed elastomeric inner receptacle, mounted in a rotatable squirrel cage, is substituted for the baffled, perforated, low and high speed inner receptacle and the imperforate outer tub. The end wills **356** and **357** of a squirrel cage **358** are supported on bearings **359** and **361** mounted on the front and rear walls of a cabinet **355**. Rods **362** join the end walls **356** and **357** to form the cage, with the rods extending inwardly from the periphery of the walls. An elastomeric receptacle **360** fits between the wall of the cage and has inwardly extending peripheral portions which form baffles when supported over the rods **362**, as illustrated in FIG. 59. A band **363** may be provided between the walls **356** and **357** supported on the rods **362** to prevent the receptacle from distorting when loaded with fabrics and water. A door **364** is hinged to the opening in the front wall of the cabinet, having a centrally disposed projecting ball **365** which forms a swivel connection with a cover **366** which seals the opening **367** at the front of the receptacle through which the fabrics are loaded and unloaded. The end extension **368** of the receptacle **360** is bonded to the tapered wall portion **369** of the cage wall **356**. An aperture **371** is provided in the rear wall **357** of the cage on the axis thereof, over which a protective screen **372** is provided. A cylindrical outlet air duct **370** extends to the aperture and is sealed thereto by the sealing element **373**. A bearing **374** is disposed between the collar **375**, which is supported by the bearing **361**, and the air duct **370** to provide rigid support for the driven end of the cage **358**. An inlet air duct **376** is supported on the axis of the outlet air duct **370** when mounted therein to extend to the opening **371** against the screen **372**.

An air delivery conduit **377** communicates with the duct **376** for supplying air to the interior of the receptacle **360** as delivered air descapes through the outlet air duct **370** to atmosphere or to the intake side of the blower, if a closed system is employed. A suitable heater element **378**, which may be of the electric or gas type hereinabove described, is suitably mounted to heat the delivered air. In a square section **379** of the conduit **377** a valve **381** is pivoted, having a lever arm **382** which is operated by a thermal responsive member **383** which may be of the bi-metallic or other known type. When the member **383** is heated, the valve **381** is moved to open position, permitting the air from the blower to be delivered through the conduit **377**, the duct **376**, to the interior of the receptacle **360**. The delivered air, after intermingling with the fabrics within the receptacle, escapes through the duct **370** out through the escape conduit **384** to atmosphere or to the conduit **259** back to the blower if a closed system is employed. A valve **385** is pivoted to the top of the conduit **384** for sealing the end thereof when a vacuum is drawn within the receptacle. Similarly, when the heater **378** is cold, the valve **381** is closed to form a seal when the vacuum is drawn within the receptacle.

The water supply conduit **146e** supplies fluid to the nozzle **96** for delivering water through the duct **376** to the receptacle. A port **386** is connected to the duct **376** and by a suitable conduit **387** to a vacuum pump **388** driven by a motor **389**. The motor also drives through the gear reduction unit **391** for driving a pulley **392** which drives a belt **393** connected to the pulley **394** for rotating the receptacle **360** at a predetermined low speed. The pulley **394** is of V-shape and is secured to the peripheral edge of the cage wall **357**.

In operating the machine as illustrated in FIG. 58, the door **356** is hinged downwardly, moving the cover **366** away from the opening in the receptacle and permitting fabrics to be introduced therein. The door is then closed, forcing the cover **366** to move into sealed relation to the sloping extension **368** of the receptacle. The motor is then operated to rotate the receptacle, and water is introduced therein through the conduit **146e**. The soap, detergent or other cleansing material is added to the receptacle at the time the fabrics are loaded, and after a predetermined time the supply of water is interrupted and the washing operation continues for a predetermined time. Thereafter, the vacuum pump is operated to withdraw the air from within the receptacle to produce a squeeze pressure upon the fabrics, the water from which is drawn off through the vacuum pump. The vacuum pressure may thereafter be relieved and rinse water introduced to produce a rinsing operation upon the fabrics, and such operation may be repeated one or more times. After the last rinse, the vacuum is again relieved and heated air is circulated within the receptacle **360** about the fabrics to produce a drying operation. It is to be understood that in the closed system, the storage of heat during the washing operation, the use of the humidifier **281** and the other features illustrated and described hereinabove may be applied to the machine illustrated in FIG. 58 to obtain the beneficial results provided thereby as from the use recited above.

In FIG. 60 a still further form of the invention is illustrated, that wherein the elastomeric receptacle **360** is mounted within a solid metal receptacle **395**. In this arrangement, a pressure line **396** delivers air, water or other fluid under pressure through the sealing ring **397** to the space between the receptacles **360** and **395** for applying a pressure to the outside of the receptacle. This may occur without the use of the vacuum on the inside of the receptacle **360**, but the combined use of the vacuum on the interior and the pressure on the exterior provides the best results. When vacuum alone is employed on the interior of the receptacle **360**, the squeeze pressure upon the fabrics is in the order of one atmosphere. When fluid pressure is applied to the exterior of the receptacle along with the vacuum on the interior, the pressure on the fabrics is substantially increased. The use of vacuum within the receptacle has the advantage of lowering the boiling point of the contained water in the fabrics and thereby facilitates the extraction of the water therefrom under pressure. As pointed out hereinabove, heat may be used prior to and during the actual extracting process, thus taking full advantage of the favorable changes in the characteristics of the contained water that occurs in the presence of increased temperature. Heated air or water may be employed between the receptacles **360** and **395** to add heat to the fabrics internally of the receptacle **360** to maintain the receptacle and the fabrics at high temperature. When the pressure is obtained by the use of the vacuum within the receptacle **360**, the conduit **386** is so positioned as to withdraw the water from the duct **376** and/or **370** as it is squeezed from the fabrics by the pressure on the receptacle **360**. Otherwise the structure illustrated in FIG. 60 operates in the same manner as that of the structure illustrated in FIG. 58, and it is to be understood that both structures may embody features hereinabove illustrated and described pertaining to other embodiments of the invention.

Referring to FIG. 61, a chart is illustrated showing the success had in reducing the washing and drying time in a laundering unit such as that illustrated in FIGS. 51, 57, 58 and 60, employing a closed air circulating system which embodies the dehumidifying device as illustrated in FIG. 52. From the chart the following will be noted:

	Minutes
Fill and tumble wash	10.00
Drain	.75
Fill and tumble rinse	3.00
Drain	.75
Centrifuge	.75
Threshold rinse and drain	2.75
Centrifuge	1.00
Centrifuge 190° rinse and heat	3.00
Tumble fluff-dry with heat	22.00
Tumble—without heat	1.00
	45.00

This tabulation shows that the washing time was substantially 10 minutes, the rinsing time substantially 10 minutes, and the drying time substantially 25 minutes. It will be noted, however, that certain time intervals overlap, such as the 190° rinse and the circulation of heat, to build up heat in the receptacle and fabrics during the centrifuging operation and prior to the actual tumble drying cycle applied to the fabrics. It was found that the application of heat to the fabrics during the centrifuging operation was of substantial advantage in removing water from the fabrics prior to the evaporative drying which occurs during the tumble drying operation.

Tests were made during the three-minute centrifuging cycle at a receptacle speed of 600 r.p.m. with tap water at 150°, and it was found that six pounds of turkish towels had approximately six pounds of water remaining therein. By boosting the tap water to 190° when repeating the cycle, it was found that the six pounds of turkish towels had approximately four pounds of water remaining therein. The same effect was found to occur when extracting water from fabrics by centrifuging, squeezing, wringing or by other methods upon increasing the temperature of the contained water. It was found that approximately 815 B.t.u. were used in the spin cycle and most of this heat was available during the subsequent drying cycle. During the centrifuging and drying cycles, heated air was passed through the receptacle and fabrics for increasing the temperature of the fabrics, receptacle and tub for producing the evaporation drying of the fabrics. A 5000-watt heating element at 230 volts employed for heating the air produced 5,404 usable B.t.u. After the three-minute extracting period, a period of only twenty-two minutes was required for tumbling the fabrics in the receptacle at a speed of 52 r.p.m. to completely dry the turkish towels. This unusual result was obtained due to the shortage and retention of the heat in the water at the final rinse and centrifuging operation and the application of heated air at the same time. The emission of approximately two pounds of water centrifugally, additionally to the normal expelled amount, contributed substantially to the shortened evaporation drying cycle. There was no loss of heat which occurs when the fabrics are moved from one machine to another or from the cabinet which was sealed and insulated.

Referring to FIG. 62, a schematic arrangement of a washing machine is illustrated which operates on the same cycle as above described while employing the maximum permissible wattage from a 115-volt line. Since the maximum permissible wattage is approximately 1800 watts and the motor requirements is approximately 350 watts, the heater unit therefore must be rated at not more than 1450 watts. The thermal loss of the motor is approximately 9.4 B.t.u. per minute, and the thermal energy generated by the 1450 watt heating element is approximately 82.5 B.t.u. per minute. If the heat produced by the motor and the heating element can be considered usable heat, the total usable energy will then be 91.9 B.t.u. per minute, assuming that a satisfactory system can be set up within an insulated cabinet. As was pointed out above, 815 B.t.u. were required, for the three-minute spin cycle. The 91.9 B.t.u. per minute would therefore, only produce 275.7 B.t.u., requiring an additional 539.3 B.t.u. to be obtained from the boosted tap water. This additional energy for raising the temperature of the tap water from 150° to 190° is obtained from the electrical thermal accumulator exchanger wherein heat is stored during the 17 minute time cycle prior to the spin cycle. There will be 1562 B.t.u. generated and stored, and out of this stored heat, 539.3 B.t.u. is used up in heating the 150° tap water to a temperature of 190° for use in the spin cycle. There is, therefore, left 1022.7 B.t.u. remaining in the stored heat for heating the air during the drying cycle. This leaves approximately 3483 B.t.u. that must be generated for use during the drying cycle.

For a 25 minute drying cycle, 95,000 watt minutes or 3800 watts or 5404 B.t.u. will be required, as pointed out hereinabove. From this is subtracted the calculated radiation losses of 538.33 B.t.u., which leaves a requirement of 4865.59 B.t.u. or 3421.4 watts. From this figure is subtracted the heat stored in the prior cycle to find the B.t.u. which must be present during the drying cycle, which is 4865.59 minus 1022.7 for 3843 B.t.u. or 2702 watts. From this wattage figure is to be subtracted the heater rated wattage of 1450 plus the motor loss of 165 watts or an available total of 1615 watts, leaving a deficit of 1087 watts equal to 1546 B.t.u. which must be supplied within the allotted time. This additional B.t.u. requirement is obtained from the 150° tap water of the home. A heat exchanger is mounted in the air circulating system through which the hot water from the tap is circulated at a predetermined rate to obtain the additional 1546 B.t.u. requirement during the drying cycle. This requires from three to six gallons of water, depending upon the efficiency of the exchanger, and is well within rate of recovery capacity of all home water heaters.

Additional heat is obtained through the use of a condenser exchanger within the air circulating system which embodies a conduit connected to the tub and through a heat exchanger within the air system to the dehumidifier. It was found that as the air within the tub picks up more and more moisture, expansion thereof produces additional pressure to cause a portion of the air to pass from the tub through the exchanger and into the dehumidifier. This is substantially a continuous process so that air approaching saturation is constantly passing through the exchanger from which the water is separated through condensation as heat is transferred from the exchanger to the air from the dehumidifier or breather openings as it is drawn into the main stream of air passing through the blower.

Such a system is illustrated diagrammatically in FIG. 62 wherein an air passageway **410** is connected by a conduit **259** to the blower **253**. The outlet port of the blower is connected by a conduit **261** to the tub **81** in a manner as described hereinabove. The air from the tub passes through a delinting screen **411**, a conduit **412**, to the air passageway **410**. Within the air passageway **410** between the conduits **412** and **259**, the accumulator exchanger **124** of FIG. 15 or 33, alone or in combination with the ironer unit, is located in position to provide the main source of heat for the circulated air. The accumulator exchanger has been described hereinabove as being heated by the 115-volt electric heating unit **127** and in which heat is stored when the blower is not operating, that is to say, prior to the centrifuging cycle to be available for heating the air during the centrifuging and drying cycles. A suitable damper **413** may be provided in the conduit **412** to regulate the flow of air therefrom.

A conduit **414** is connected to the tub **81** and extends into the passageway **410** where it is joined to the heat exchanger unit **415**. The conduit extends downwardly at **416** from the passageway **410** and is joined to the housing **281** of the dehumidifying unit. Cold water is sprayed into the unit from the conduit **282** connected to the valve **417** of the hot and cold water inlets **146*b*, 146*c*,** respectively. The conduit **286** from the dehumidifier is connected to the drain **150** of the system. A heat exchanger **418** is also provided within the air passageway **410** having a conduit **419** from the hot water side of the valve **217** connected thereto and from which a conduit **421** extends to the drain **150**. A heat exchanger unit **422** may be associated with the drain conductors **421** and **286** so that the additional heat in the water passing to the drain conduit **150** may be transferred to the air within the cabinet **423**, which is preferably insulated as by insulating material **424**.

The motor **89** is mounted within the air passageway **410** in the path of flow of air from the conduit **285** which is heated thereby. Suitable breathing apertures **425** are provided near the end of the air passageway **410** adjacent to the motor **89** for the purpose of maintaining a balanced air pressure within the system which changes due to the expansion and the contraction of air at different points in the system. When the pressure of air within the system drops, additional air is drawn in through the breather apertures **425** from the area within the insulated cabinet **423** so that the intake air provided to the system will be heated by the elements within the cabinet. When the pressure within the system rises above that within the cabinet, the breathing apertures **425** are available to permit air to pass outwardly to within the cabinet area where the heat is stored.

It is also within the purview of the invention to provide vanes **426** on the auxiliary motors within the cabinet to have the thermal loss therefrom provide available heat for the cabinet air. Thus, all the available heat in the hot water, in the electric, and hot water exchangers, and in the motors, is retained within the insulating cabinet and is available to raise and maintain the temperature of the tub. The test shows that the high temperature water employed in the washing and rinsing operations is not only important in the washing and rinsing operations but initially heats the tub and fabrics for use in subsequent operations. The use of the 190° rinse water at the time of centrifuging substantially lowers the ratio between the contained water and the weight of the clothes at the end of the cycle. The centrifuging operation is at least 40% more efficient in view of the initial heating of the tub and fabrics and the use of the 190° temperature water. By utilizing all of the available heat, as pointed out hereinabove, during the centrifuging and drying cycles, a degree of efficiency is obtained which can only be produced in the unitary type of machine. In other words, all of the heat provided for the washing and spinning cycles is maintained within the fabrics and the tub and is extremely useful in conjunction with the closed hot air circulating system for producing the drying of the fabrics in a minimum amount of time. As pointed out above, six pounds of turkish towels, which have a great affinity for retaining water, were completely processed in the unit machine from the washing to the drying cycle with only one-quarter of the wattage rating in one-half the rated cycling time of the conventional disparate automatic washer and automatic dryer. It was only through the processing, as pointed out in detail above, that the unitary machine was made commercially acceptable.

It was found that the dehumidifier operates with greater efficiency when capillary means, such as glass fiber, Raschig rings or the like, is provided therein. The capillary means substantially increases the surface of the water available to contact the air as it passes through the dehumidifier to have it operate more efficiently. A damper **420** may be provided in the conduit **414** so that the flow of air from tub may be balanced with that drawn from the conduit **412** having the damper **413** therein.

In FIG. 63, the same system as that shown in FIG. 62 is illustrated, with the exception that the conduit **421** connecting the heat exchanger **418** to the drain passageway **150** in FIG. 62 is eliminated and the tube **421** is connected directly to the dehumidifier. When sufficient heat is extracted from the tap water as it passes through the exchanger **418**, the temperature of the water passing to the dehumidifier is sufficiently lowered relative to the heat of the air passing into the dehumidifier as to operate satisfactorily for lowering the temperature of the air and washing the lint therefrom. Any lint which is collected on the lint screen **411** at the mouth of the outlet **412** from the tub **81** is washed therefrom during the next succeeding washing cycle and is carried to drain so that the lint cannot continue to accumulate upon the screen and interfere with the passage of air from the tub to the air passageway **410**. A time-motor operated control switch **428** controls the operation of the water valve **417**, the blower and pump motors, the motor **89** for driving the receptacle and the predetermined sequence and cycling of the operations, as illustrated in the diagram of FIG. 61.

In FIG. 64, a further form of dynamic balancing device is illustrated, that wherein the receptacle **86** is provided with pairs of diametrically opposed flexible vanes **429**, each pair being connected by a conduit **431**. The vanes and conduit may be made of metal resin compounds, rubber and the like, so long as flexibility is provided in the vane portions. The hollow interior of the vanes is filled with a suitable fluid, such as water, to a predetermined height, providing an air space therein. Upon increasing the speed of the receptacle, any area which is unbalanced due to the accumulation of fabrics thereat will be counterbalanced by the shifting of the fluid in the vanes. The fabrics at the unbalanced area will exert a greater force on the vanes over which they accumulated than is exerted on an opposed vane having a less amount of fabrics thereon. This greater pressure on the vanes will cause the fluid therein to flow through the associated conduit **431** into the opposite vane and thereby shift sufficient weight to maintain the rotor statically balanced even though the fabrics have been unevenly distributed. The collapsing and expanding of the vanes will loosen the fabrics from the wall of the receptacle at the end of the drying cycle, much in the manner as the vane **287** of FIG. 53 above described.

The structure illustrated in the various views should not be considered as separate, disconnected elements since they are intended to be employed in combination with the complete unit machine. The elements have not been illustrated as combined because of the many additional views which would be required. Similarly, the various heat exchangers illustrated in FIG. 62 may be connected in series, in parallel or in any other combination and may include those illustrated as well as those of a form known to be suitable for the purpose stated. It will, therefore, be understood by those skilled in the art that various changes, additions and substitutions may be made in the herein disclosed machine without departing

from the spirit or scope of my invention as set forth in the accompanying claims.

What is claimed is:

1. In a laundering machine, a cabinet having an access opening in the front substantially vertical wall thereof, a tub mounted in said cabinet having an opening in the upper portion of its front face aligned with the opening in the cabinet, the bottom edge of said openings being disposed substantially upon the axis of the tub, a receptacle rotatably mounted within the tub having a narrow front face adjacent to the periphery thereof providing a large opening which extends substantially equal amounts above and below the bottom edge of the opening in the tub, and a door hinged along one edge of the opening in said cabinet.

2. In a laundering machine, a cabinet having an access opening in the front substantially vertical wall thereof, a tub mounted in said cabinet having an opening in the upper portion of its front face aligned with the opening in the cabinet, the bottom edge of said openings being disposed substantially upon the axis of the tub, a receptacle rotatably mounted within the tub having a narrow front face adjacent to the periphery thereof providing a large opening which extends substantially equal amounts above and below the bottom edge of the opening in the tub, a door hinged along one edge of the opening in said cabinet, and a resilient sealing element about the edge of the opening in the front face of the receptacle disposed in engagement with the inner surface of the front face of the tub.

3. In a laundering machine, a cabinet having an access opening in the front substantially vertical wall thereof, a tub mounted in said cabinet having an opening in the upper portion of its front face aligned with the opening in the cabinet, the bottom edge of said openings being disposed substantially upon the axis of the tub, a receptacle rotatably mounted within the tub having a narrow front face adjacent to the periphery thereof providing a large opening which extends substantially equal amounts above and below the bottom edge of the opening in the tub, a door hinged along one edge of the opening in said cabinet, a resilient sealing element about the edge of the opening in the front face of the receptacle disposed in engagement with the inner surface of the front face of the tub, and a resilient gasket sealing the space between the cabinet opening and that of the tub.

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