June 30, 1953 F. W. GRANTHAM 2,643,463

LAUNDRY APPARATUS

Filed Dec. 11, 1948 5 Sheets-Sheet 1

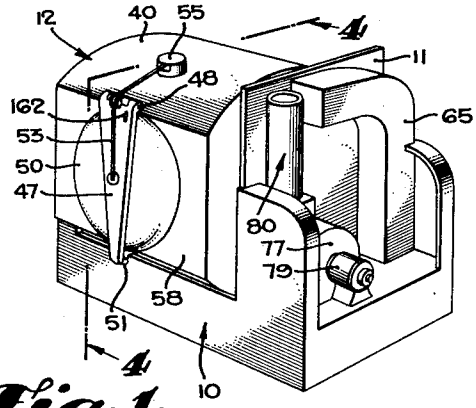

Fig. 1.

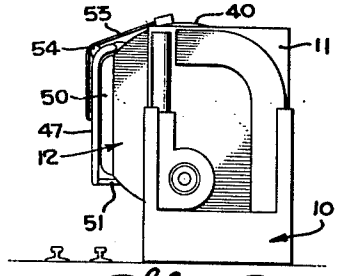

Fig. 2.

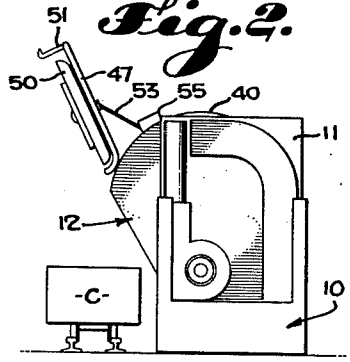

Fig. 3.

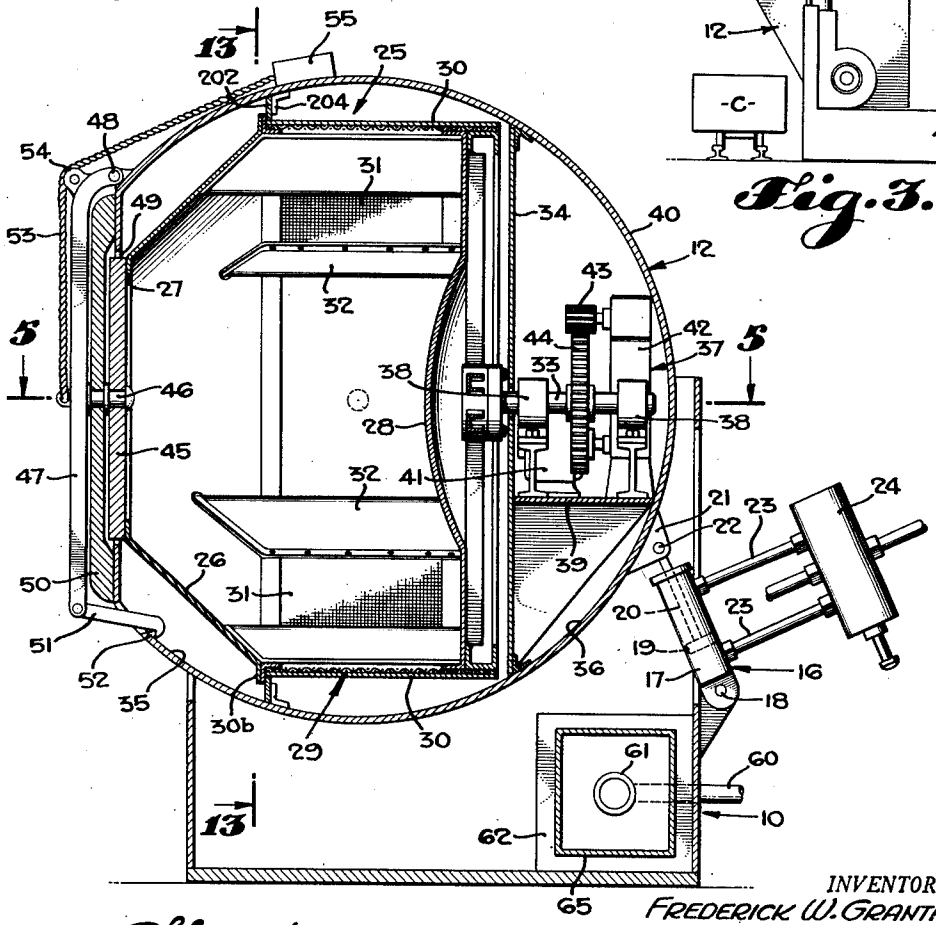

Fig. 4.

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LAUNDRY APPARATUS

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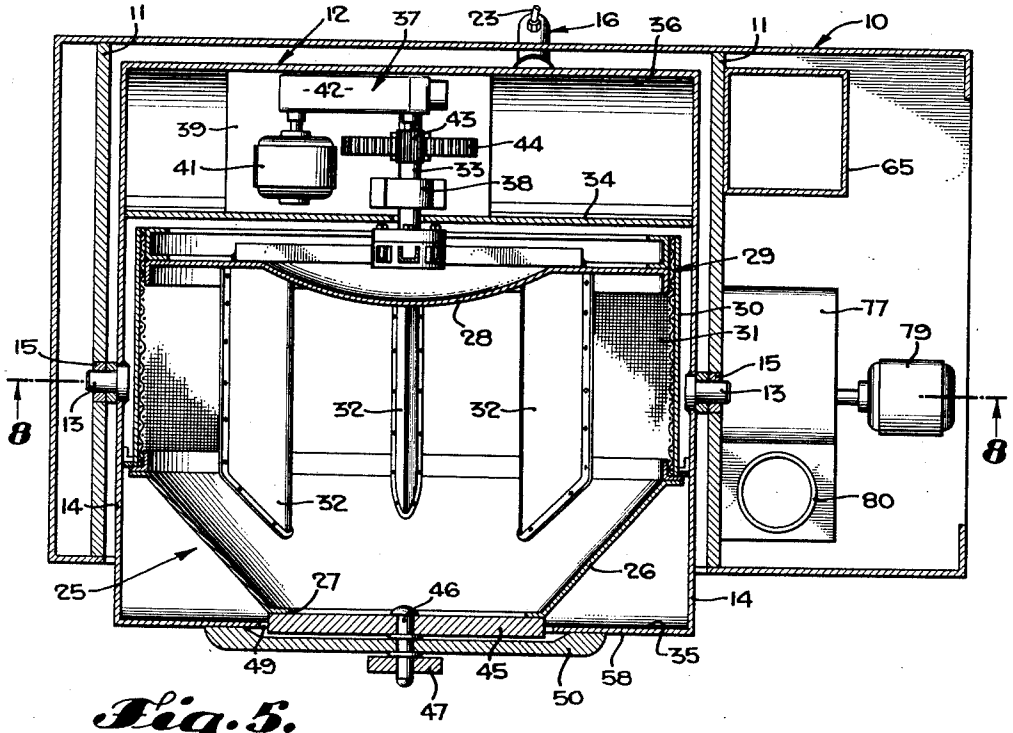

Fig. 5.

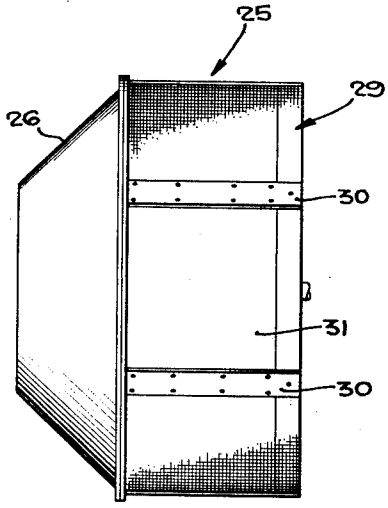

Fig. 6.

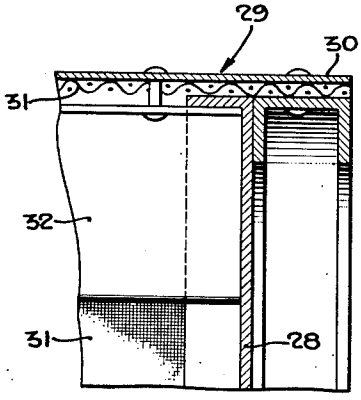

Fig. 7.

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LAUNDRY APPARATUS

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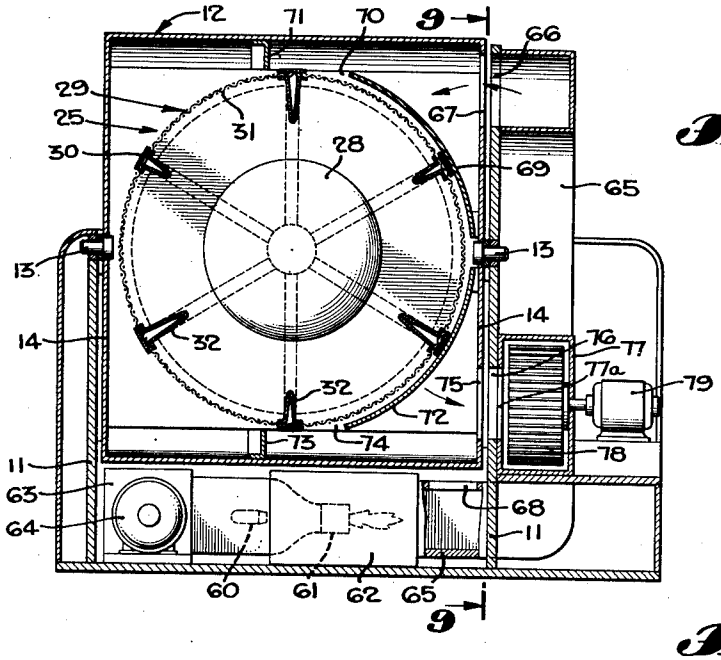


Fig. 8.

Fig. 9.

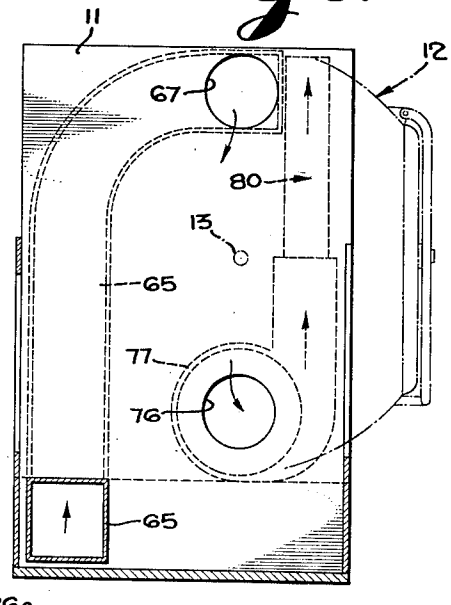


Fig. 11.

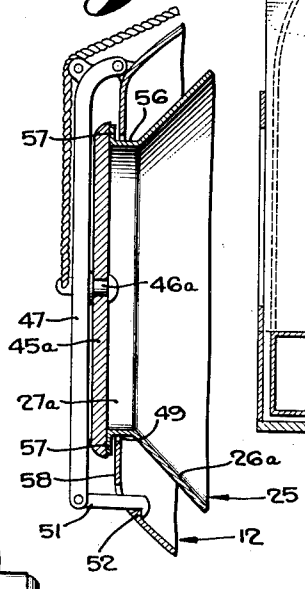
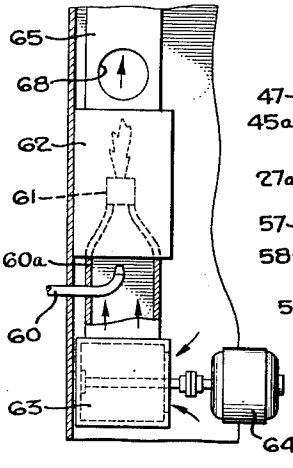


Fig. 10.



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LAUNDRY APPARATUS

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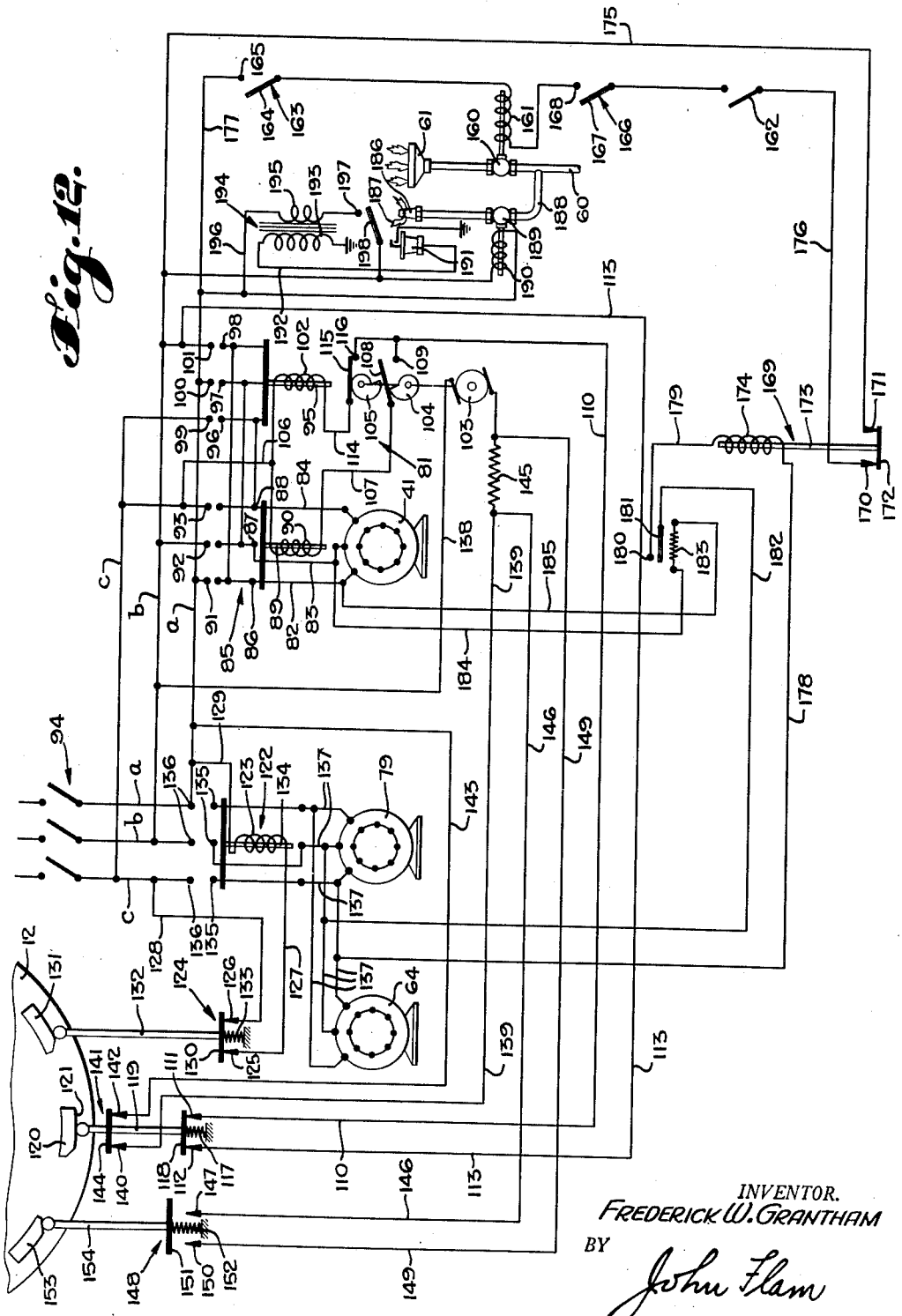
Fig. 12.



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LAUNDRY APPARATUS

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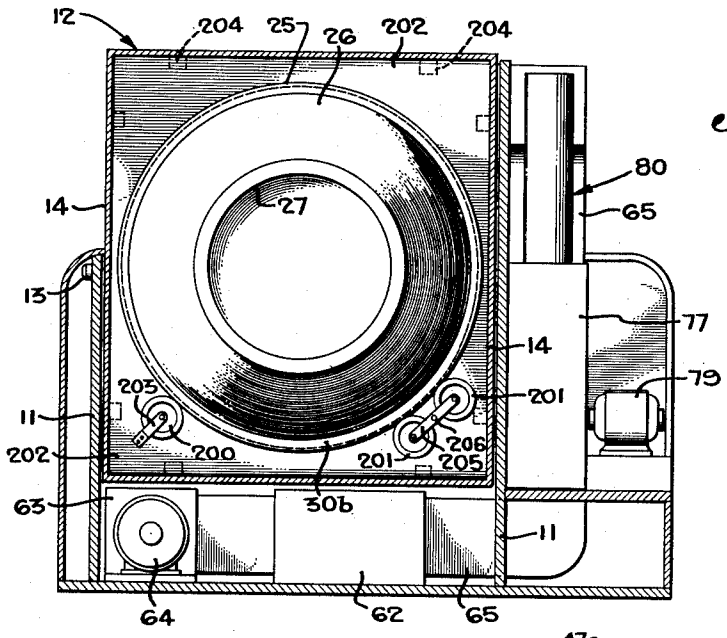

Fig. 13.

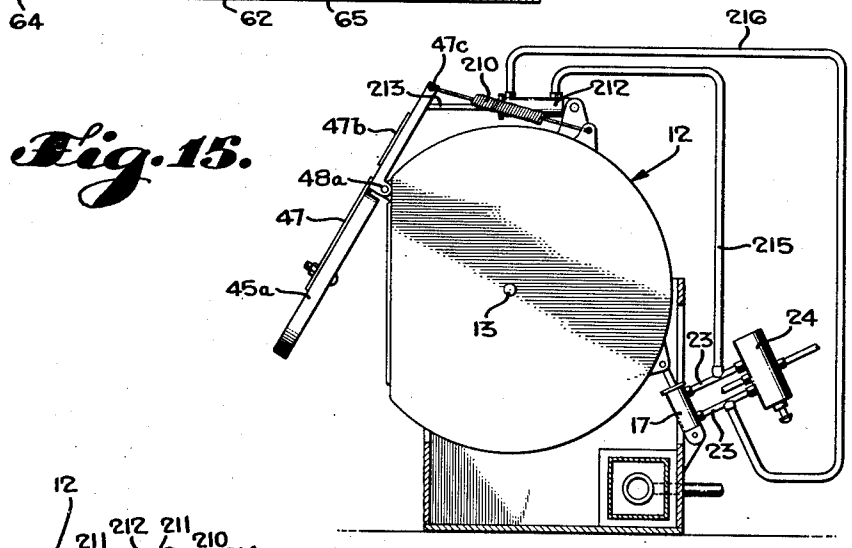

Fig. 15.

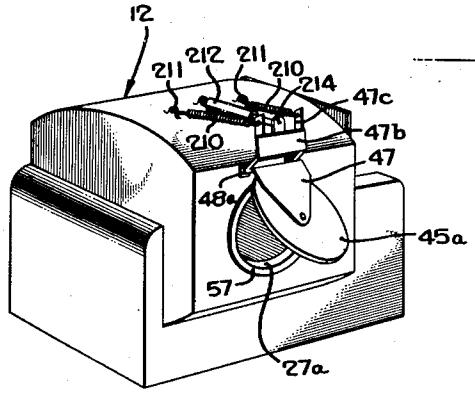

Fig. 14.

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2,643,463

UNITED STATES PATENT OFFICE

2,643,463

LAUNDRY APPARATUS

Frederick W. Grantham, Los Angeles, Calif.

Application December 11, 1948, Serial No. 64,853

17 Claims. (Cl. 34—45)

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The present invention relates to laundry apparatus, and is more particularly directed to laundry apparatus of the tumbler type.

An object of the present invention is to facilitate the unloading of laundry from laundry apparatus of the tumbler type.

Another object of the invention is to continue the tumbling action during unloading of the laundry apparatus in such manner as to insure complete removal of the laundry from the equipment.

Still another object of the invention is to change the tumbling cycle of the tumbler when the apparatus is shifted toward unloading position. The tumbling cycle is preferably reduced in extent under the stated conditions.

A further object of the invention is to provide laundry apparatus which can be tilted to various positions, in order to place the apparatus in locations that are conducive to efficient loading and unloading of the laundry, as well as the performance of the required operations on the laundry in the apparatus.

Yet another object of the invention is to provide laundry apparatus of the tumbler type having a tiltable outer drum or housing, in which the position of the outer drum or housing determines the manner in which the apparatus operates.

A further object of the invention is to provide a laundry dryer of the tumbler type, in which shifting of the dryer toward unloading position automatically discontinues the application of heat to the apparatus.

Another object of the invention is to provide a laundry dryer which assures that heat cannot be applied to the laundry in the dryer until air in adequate quantities is being passed through the dryer.

Yet a further object of the invention is to insure that heat cannot be applied to the laundry in the dryer unless the tumbler is being rotated in alternate directions.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. These forms are shown in the drawings accompanying and forming part of the present specification. They will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

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Figure 1 is a pictorial, perspective view of a laundry drying apparatus;

Fig. 2 is a side elevation of the apparatus shown in Fig. 1, with the outer tiltable drum or housing in position for the performance of the drying operation;

Fig. 3 is a view similar to Fig. 2 of the apparatus in its unloading and loading positions;

Fig. 4 is an enlarged cross-section taken along the line 4—4 on Fig. 1;

Fig. 5 is a section taken along the line 5—5 on Fig. 4;

Fig. 6 is a side elevation, on a reduced scale, of the inner drum or tumbler;

Fig. 7 is an enlarged fragmentary section of part of the inner tumbler;

Fig. 8 is a section on a reduced scale, taken along the line 8—8 on Fig. 5;

Fig. 9 is a section taken along the line 9—9 on Fig. 8;

Fig. 10 is a fragmentary sectional and elevational view illustrating the inlet portion for the heating medium to be passed through the dryer;

Fig. 11 is a fragmentary section illustrating a modified form of closure for the apparatus;

Fig. 12 is a diagrammatic view of the control circuit for the laundry dryer;

Fig. 13 is a section, on a reduced scale, taken along the line 13—13 on Fig. 4;

Fig. 14 is a pictorial, perspective view of the apparatus embodying another form of closure; and

Fig. 15 is a somewhat diagrammatic side elevation of the apparatus shown in Fig. 14, coupled with a control system for automatically operating the closure.

The apparatus is disclosed in the drawings as a laundry dryer. It is to be understood, however, that certain aspects of the invention are applicable to other types of laundry equipment.

The laundry dryer includes a suitable frame or support 10 having vertical standards 11 capable of pivotally supporting the outer drum or housing 12 of the mechanism. Such pivotal support may be provided by opposed coaxial trunnions 13 secured to the opposite side walls 14 of the outer housing and rotatably mounted in bearings 15 within the frame standards. Tilting of the outer drum or housing 12 to several positions, for the purposes to be described hereinafter, may be accomplished by a double acting pneumatic motor 16, including a cylinder 17 whose lower end is mounted on a pivot pin 18 suitably supported in the frame 10 (Fig. 4). A piston 19 is slidable within the cylinder and has a rod 20 secured to it, which is connected to a

bracket 21 at the rear of the outer drum 12 by a suitable pin 22. The intake and discharge of air for both the head end and rod end of the cylinder 17 can take place through suitable air conduits 23 under the control of a suitable manually operated valve 24 of known design.

Normally, the apparatus occupies the position illustrated in Figs. 1, 2 and 4, in which the drying operation takes place on the laundry in the apparatus. Upon entry of air through the lower conduit 23, the piston 19 is moved upwardly to tilt the outer drum or housing 12 to the position illustrated in Fig. 3, in which the laundry may be unloaded from or loaded in an inner drum or tumbler 25.

The inner drum or tumbler 25 is rotatably mounted within the outer drum 12 about an axis which is substantially at right angles to the pivotal axis of the latter. The tumbler 25 may consist of a tapered front wall 26 terminating in a forward opening 27, to permit ingress and egress of laundry into the tumbler, a rear wall 28 extending transversely of its rotational axis, and an intervening perforated cylindrical portion 29 interconnecting the front and rear walls in spaced relation. The cylindrical perforated portion 29 may be constituted by longitudinally extending straps 30 suitably secured to the front and rear walls 26, 28 at spaced intervals around the periphery of the tumbler. A screen or perforated cylinder 31 extends between the front and rear walls and is suitably secured to the latter and to the straps (Fig. 6). In addition, a plurality of radially extending vanes 32 are provided at circumferentially spaced intervals around the inner drum 25, projecting inwardly to a certain extent, so as to impart the tumbling action on the laundry in the drum 25 during its rotation.

The perforated inner drum 25 is provided to allow a heating medium, such as hot gases (including air), to pass through the laundry that is being tumbled in the drum, to effect drying of the latter.

In order to rotate the inner drum 25 alternately in opposite directions, its rear portion is suitably secured to a shaft 33 coaxial with the drum, which extends through a partition 34 extending across the outer housing 12 at right angles to the shaft. This partition divides the outer housing into a tumbler containing portion 35 and a portion 36 housing the drum reverse drive mechanism 37.

The drum shaft 33 is rotatably supported in spaced bearings 38 resting upon a platform 39 extending between the partition 34 and the rear wall 40 of the outer housing. This shaft is rotated by a 3-phase reversible induction motor 41 through suitable reduction gearing. This gearing includes a suitable variable speed transmission 42 driving a pinion 43 meshing with a gear 44 affixed to the drum shaft 33 between the bearing supports. The transmission ratio of the variable speed portion 42 of the gear device can be changed to effect rotation of the inner drum 25 at the desired speed.

In addition to being supported by the shaft 33, the drum 25 is also rotatably supported upon a plurality of rollers 200, 201 adapted to ride upon the drum rim 30b disposed to one side and forwardly of its perforated portion 29. These rollers are located below the drum 25 and on opposite sides of a vertical supporting and baffle plate 202. One of the rollers 200 is rotatably mounted upon a bracket 203 secured to the plate 202, affixed to brackets 204, which are, in turn, attached to the outer housing 12. One or more other rollers 201 are also rotatably supported upon the plate 202. As shown most clearly in Fig. 13, a pair of other rollers are contactable with the drum rim 30b. They are rotatably carried on opposite ends of an arm 205 mounted upon a pin or stub shaft 206 secured to the plate 202. This arrangement permits the arm 205 to pivot on the stub shaft 206, and insures proper contact of at least one of the rollers 201 with the drum.

It is thus apparent that the rear end of the inner drum 25 is supported by the shaft 33, and that the forward portion of the drum is supported upon the spaced rollers 200, 201.

The plate 202 extends across the outer housing 12, snugly engaging its side walls 14 and also its top and bottom. This plate is located in close proximity to the drum rim and acts as a baffle, preventing passage of the hot gases forwardly toward the opening 49 of the housing.

The tumbler opening 27 is closed by a suitable inner door 45 adapted to engage the forward end of the tapered drum wall 26. This door is rotatably mounted on a bearing pin 46 fixed to an arm 47 mounted on a pivot pin 48 suitably supported in the upper portion of the outer housing 12. The outer housing has a forward opening 49 larger than the inner drum opening 27 and coaxial therewith, which is closed by a non-rotatable outer door 50 mounted on the bearing pin 46. The doors are locked in closed position by a suitable latch 51 pivotally mounted on the lower end of the arm 47 and adapted to extend through a housing opening 51a for engagement with a hook 52 extending inwardly from the outer housing 12.

Elevation of the latch 51 releases it from the hook 52 and permits the doors 45, 50 and the supporting arm 47 to be swung upwardly to fully open position, as shown in Fig. 3. Such door opening may be effected by attaching the lower end of a rope or cable 53 to the outer end of the bearing pin 46 and by extending this rope or cable over a pulley 54, mounted on the upper portion of the arm 47, and into a suitable winding device 55 mounted on top of the housing 12. This winding device 55 may be of the type that is spring actuated, always tending to lift the rope 53 and the closure members 45, 50 to fully open position, and to hold them in such position. The closure members can be swung downwardly to closed position manually against the force of the spring winding device, and will be retained in closed position by the latch and hook elements 51, 52.

A modified form of closure device is shown in Fig. 11. Instead of two doors, only a single closure is utilized. The forward end 56 of the drum wall 26a extends through the housing opening 49 and terminates in an outwardly directed flange 57 in advance of the front wall 58 of the housing. This flange is preferably closely adjacent the wall 58 to prevent leakage of any heating medium from the housing 12. The drum opening 27a is closed by a closure member 45a rotatably mounted on a bearing pin 46a fixed to the supporting arm 47.

When the door 45a is in closed position against the flange 57, it rotates with the inner drum 25. The laundry cannot move out through the opening 27a, nor can it become caught between the drum 25 and outer housing 12.

It is to be noted that the mounting of the drum 25 for rotation about an axis at right angles to the tilting axis of the outer housing 12, and the alignment of the closures 45, 45a with the

shaft axis, renders it unnecessary to align the drum 25 with the housing opening 49 for loading and unloading purposes. The drum 25 may be stopped at any position, or it may continue its rotation, and its opening will always be in proper position for loading and unloading when the closure members are opened.

The wet or damp laundry is inserted in the tumbler 25, and is dried while rotating the tumbler alternately in opposite directions by forcing a mixture of hot products of combustion and air through the tumbler. The heat necessary for drying is supplied by gas flowing through a main gas line 60 into a mixing chamber 60*a* (Fig 10), where it admixes with the air necessary for combustion, supplied by a blower 63 driven by a 3-phase electric motor 64. The comingled air and gas are forced through a burner 61 into a combustion chamber 62 to provide the necessary flame and heat at the main burner 61.

The products of combustion pass outwardly from the combustion chamber 62 through an inlet conduit or duct 65 discharging through an opening 66 (Fig. 8) in the frame standard 11 into an inlet opening 67 at the top of the outer housing 12. In order to reduce the temperature of the gases to the desired degree, a secondary air inlet opening 68 is provided in the inlet duct 65 beyond the combustion chamber 62, which will allow secondary air to comingle with the products of combustion.

The hot gases enter the housing inlet 67 and are directed to a location at the upper end of the inner drum or tumbler 25. The gases are confined for travel to this latter point by providing a suitable arcuate shield 69 around and adjacent the drum 25, which extends from a side wall 14 of the outer housing 12 and between its rear portion and the forward portion. The upper end of this shield forms a longitudinally extended opening 70 with a baffle 71 secured to the outer housing and extending lengthwise of the drum 25, so as to enable the hot gases to be directed downwardly through the perforations into the interior of the inner drum. In a similar fashion, a lower arcuate shield 72 is provided around the drum 25, cooperating with a lower extended baffle 73 to form an exhaust opening 74 through which the gases, and moisture evaporated from the wet laundry, can pass through an outlet or discharge opening 75 in the side wall 14 of the outer housing. This outlet opening 75 is normally aligned with an inlet opening 76 in the standard 11, opening into an inlet 77*a* in a blower housing 77 containing a rotor 78 driven by a 3-phase exhaust motor 79. The blower housing 77 has an outlet communicating with a suitable exhaust stack 80 (Fig. 15).

The inlet and outlet openings 67, 75 into the outer housing 12 are in alignment with the corresponding discharge and inlet openings 66, 77*a* in the inlet duct 65 and blower 77, respectively, when the housing 12 is in the drying position, such as shown in Figs. 1, 2 and 4. When the outer housing 12 is tilted to the unloading or loading position illustrated in Fig. 3, these openings are out of alignment, which disrupts communication between the housing 12 and the inlet conduit 65 and exhaust fan 77. Thus, the hot products of combustion are incapable of passing into the dryer housing 12 during its unloading, as well as during its loading. Ordinarily, the completion of the drying cycle results in the shutting off of the combustion air motor 64 and of the gas line 60, as described hereinafter, so as

to discontinue the application of heat to the dryer. But if such application of heat were to continue inadvertently, the laundry in the dryer could not be damaged by subjecting it to an inordinately high temperature.

It is desired to rotate the tumbler 25 alternately in opposite directions during the performance of the drying operation with a reversing cycle of a predetermined amount. It is also desired to continue reverse rotation of the tumbler, but to a substantially smaller extent, for the purpose of facilitating the unloading of the laundry from the tumbler after it has been dried. These operations are made to occur in accordance with the position of the outer housing 12.

As disclosed in Fig. 12, the drum motor 41 is connected to a power source through a reversible switch mechanism 81, so as to obtain alternate operation of the motor, first in one direction and then in the other direction. The motor 41 disclosed in Fig. 12 is a 3-phase one, having its leads 82, 83, 84 running to a suitable switch 85 having three contacts 86, 87, 88. This switch 85 is operated by a solenoid whose plunger 89 carries the contacts, the plunger extending into a solenoid coil 90. When the coil 90 is de-energized, the force of gravity causes the plunger 89 to drop and breaks the engagement of the contacts 86, 87, 88 with companion stationary contacts 91, 92, 93 connected to a 3-phase line *a, b, c* running to a suitable 3-pole switch 94, which, when closed, connects the lines *a, b, c* to a suitable source of power.

The reversing switch 81 also includes a second solenoid having a plunger 95 carrying three contacts 96, 97, 98 adapted to engage companion stationary contacts 99, 100, 101 connected to the 3-phase line. The movable contacts 86, 87, 88 and 96, 97, 98 are interconnected and the fixed contacts 91, 92, 93 and 99, 100, 101 are connected to the power line *a, b, c* in such manner as to effect rotation of the reversible drum motor 41 in one direction when one of the solenoid coils 90 is energized, and in the other direction when the other solenoid coil 102 is energized. Thus, as shown in Fig. 12, the contacts 91, 92, 93 of the left hand switch 85 are connected to lines *a, b, c,* respectively, while the left contact 99 of the right hand switch is connected to line *c,* the middle contact 100 to line *a,* and the right contact 101 to the line *b.* The movable contacts are interconnected so as to join the left, intermediate and right contacts 86, 87, 88 of the left switch 85 with the right, intermediate and left contacts 98, 97, 96, respectively, of the right switch. It is apparent that when the left solenoid 90 is energized to elevate its plunger 89, the drum motor will be operated in one direction, but that de-energizing of this solenoid and energizing of the other solenoid 102 will reverse two of the lines to the induction motor 41, thereby causing its direction of rotation to be reversed.

The energization of the solenoid coils 90, 102 is determined by an induction timer motor 103, which rotates a pair of cams 104, 105 that are out of phase with each other. The circuit through the left relay coil 90 can run through a lead 106 connected to power line *c,* through the coil 90, and then to a lead 107 running to a movable arm 108 of a cam operated switch. This arm 108 is adapted to engage a fixed contact 109 connected by a suitable conductor 110 to 111 of a pair of stationary contacts 111, 112 provided adjacent the outer housing 12. The other station-

ary contact 112 is connected through a suitable conductor 113 to power line *b*.

When the cam operated arm 108 is allowed to engage the stationary contact 109, and when the contacts 111, 112 adjacent the outer housing 12 are bridged, a circuit is completed through the left solenoid coil 90. Similarly, the right solenoid or relay coil 102 is connected to the lead 106, its other end being connected to lead 114 running to another cam operated switch arm 115 adapted to engage a contact 116, which is also connected to the lead 110 running to the limit switch 111, 112.

Opening and closing of the cam operated switches 108, 115 occurs as a result of rotation of the induction timer motor 103. Since the cams 104, 105 are out of phase by about 180 degrees, when one cam 104 shifts its arm 108 to open the switch and the circuit to one of the coils 90, the other cam 105, shortly thereafter, has shifted to a position permitting its arm 115 to close the circuit to the other coil 102. Thus, the coils 90, 102 are alternately energized, which alternately changes the connections to the drum motor 41 and causes its direction of rotation to reverse. It is preferred to have a time interval between opening of one switch and closing of the other switch to enable the drum 25 to come substantially to rest before being rotated in the opposite direction.

The limit switch 111, 112 is normally urged to open position, as by a suitable spring 117, and remains in this open position so long as the outer housing 12 has been tilted fully to its unloading position. In all other positions of the outer housing, namely its drying position, as shown in Figs. 1, 2 and 4, and positions intermediate its drying position and the fully unloading position, the stationary contacts 111, 112 are bridged to allow the timer 103 to alternately complete the circuits to the solenoids 90, 102. Thus, it is apparent that the drum motor 41 continues to reverse so long as the timer motor 103 is operated, and as long as the outer housing 12 has not been tilted to its full unloading position, such as disclosed in Fig. 3.

Operation of the limit switch 111, 112 is effected by connecting its bridge piece 118 to a rod 119 engageable with a cam projection 120 suitably secured on one of the side walls 14 of the outer housing 12. The end of the rod 119 engages an arcuate cam surface 121, which is concentric with the axis of the pivoted housing 12, to hold the limit switch 111, 112 closed during the performance of the drying operation, and during movement of the outer housing 12 toward unloading position. When the housing has been tilted to fully unloading position, the rod 119 no longer engages the arcuate cam surface 121, which allows the spring 117 to shift the bridge piece 118 from engagement with the stationary contacts 111, 112, thereby preventing further reversing rotation of the inner drum 25.

It is also desired to obtain rotation of the combustion and exhaust fan motors 64, 79, but only when the outer housing 12 is in its normal drying position. The passage of current to these motors is under the control of a relay 122, including a coil 123 that may be connected across two of the main power lines *a*, *c*. The circuit through the coil 123, however, is determined by a limit switch 124, including stationary contacts 125, 126, one of which 125 is connected to a lead 127 running to the coil 123, and the other of which 126 is connected to a conductor 128 running to the power line *c*. A lead 129 connects the other end of the coil 123 to the other power line *a*. When a bridge piece 130 engages the stationary contacts 125, 126, the circuit through the coil 123 is completed. However, such engagement will only occur when the outer housing 12 is in the proper position for the performance of the drying operation. When in this position, a cam projection 131 on the housing 12 engages a rod 132 connected to the bridge piece 130, and shifts the latter downwardly against the action of a spring 133 into engagement with the stationary contacts 125, 126. As soon as tilting of the outer housing 12 toward its unloading position commences, the cam 131 permits the spring 133 to shift the bridge piece 130 and plunger 132 upwardly to break the circuit through the coil 123.

When the coil 123 is energized, it elevates a plunger 134, causing three contacts 135 carried by the plunger to engage the stationary contacts 136 connected to the main power lines *a*, *b*, *c*. The movable contacts 135 are connected through suitable leads 137 to the exhaust fan motor 79 and to the combustion air motor 64. Thus, upon shifting of the outer housing 12 to its drying position, the circuit through the solenoid 123 is completed, which elevates the plunger 134 to engage the movable contacts 135 with the stationary contacts 136 and completes the circuits to both the exhaust fan motor 79 and the combustion motor 64, starting them into operation.

When the circuit to the exhaust fan and combustion air motors 79, 64 are completed, a single phase circuit to the timer motor 103 is also completed. Thus, one lead 138 from the timer motor may run to line *b*, while the other line 139 from the single phase timer motor runs to a stationary contact 140 of a limit switch 141 which has a second contact 142 connected to a lead 143 running to power line *a*. The circuit through the timer motor 103 is completed when a bridge piece 144 on rod 119 engages contacts 140, 142. A suitable resistance 145 is connected in series in one of the lines 139, in order to reduce the speed of the timer motor 103 during the performance of the drying operation, thereby increasing the reversing cycle of the drum motor 41. This resistance, however, may be shunted when tilting of the outer housing 12 to its unloading position commences. To accomplish this last-mentioned purpose, a conductor 146 is connected to one end of the resistance 145 and runs to one of the stationary contacts 147 of a limit switch 148 located adjacent the outer housing 12. Similarly, the other end of the resistance is connected, through a conductor 149, to another stationary contact 150 of the limit switch 148. When the bridge piece 151 of the limit switch engages these contacts 147, 150, it is apparent that a shunt has been provided around the resistance 145, causing the timer motor 103 to run faster and reducing the period of energization of the reversing solenoid coils 90, 102. Thus, the reversing cycle is shortened during movement of the outer housing 12 toward its fully unloading position, so as to continue the tumbling action while the laundry is being caused to drop automatically from the inner drum 25 into a suitable car or container C that may operate on tracks T disposed on the floor or ground.

The bridge piece 151 is urged away from the contacts 150, 147 by a spring 152, and is moved

into contact therewith by a cam 153 on the housing 12 shifting a rod 154 downwardly, which rod is secured to the bridge piece 151 of limit switch 148.

When the doors 45, 50 are open, a charge of wet or damp laundry may be placed into the inner drum 25. The doors are then closed and latched, and air caused to enter the rod end of the cylinder 17, in order to tilt the outer housing 12 to a position shown in Figs. 1, 2 and 4, in which the inner drum axis is preferably horizontal. The main switch 94 is then closed, which effects energization of the exhaust fan and combustion air motor coil 123, since the disposition of the outer housing 12 has caused the limit switch 124 to bridge the contacts 125, 126. Such energization closes the exhaust fan and combustion air motor switch 122 and produces their rotation. For that matter, the main switch 94 may remain closed, inasmuch as tilting of the housing 12 to the unloading position illustrated in Fig. 3 will result in opening of the various circuits, and the rendering of the entire system inoperative. The manipulation of the air valve 24 to relocate the housing 12 in its normal drying position automatically effects operation of the various switches, and commences operation of another drying cycle.

With the housing 12 in its normal operating position, the circuit to the timer motor 103 is also completed, since limit switch 141 is closed, and since the outer housing is in the position for the drying operation, limit switch 148 is open and the resistance 145 is effectively in the timer motor circuit. As a result, the timer motor 103 rotates comparatively slowly, to correspondingly rotate the cams 104, 105 connected to it. The limit switch 111, 112 controlling the circuits through the reversing switch mechanism 85 is also closed when the outer housing 12 is in this position. Accordingly, the cams 104, 105 alternately break the circuits to the reversing coils 90, 102, and cause the reversing switches to alternately complete the circuit to the drum motor 41, alternately effecting rotation of the inner tumbler or drum 25 first in one direction and then in the other direction. As an example, the speed of rotation of the timer motor 103 and the disposition of the cams 104, 105 may be such as to cause the drum motor 41 to rotate the drum 25 eight to ten revolutions in one direction, and then eight to ten revolutions in the opposite direction, in order to tumble the laundry disposed within the inner drum 25. During such rotation, the inner door 45 or door 45*a* can rotate upon its bearing supporting pin 46 or 46*a*.

After the laundry has been dried and it is desired to unload it, air is fed into the head end of the cylinder 17, which moves the piston 19 upwardly and tilts the outer housing 12 in its bearings 15. As soon as such tilting commences, the cam 131 is shifted to the right, as shown in Fig. 12, which allows the spring 133 to open the limit switch 124 and the circuit to the solenoid 123, which allows the switch 122 to open and interrupt the circuits to the combustion air and exhaust fan motors 64, 79. This same initial tilting movement of the outer housing 12 also causes the cam 153 to close the limit switch 148, which shunts the timer resistance 145. As a result, the timer motor 103 rotates much faster and changes the cycle of operation of the reversing drum motor 41, effecting its reversal after fewer revolutions, as for example, after one or two revolutions in each direction. Doors 45, 50 can be opened by unlatching the latch 51 and lifting the arm 47. With the doors 45, 50 open, and with the pneumatic motor 16 slowly tilting the outer housing 12 and the inner drum 25 contained therein, the latter is rotated first in one direction and then in the other direction to tumble the laundry and facilitate its disposition through the openings 27, 49 and into the car C.

As indicated, the pneumatic motor tilts the drum relatively slowly. As an example, it may take about fifteen seconds for the drum 25 to be tilted to its fully unloading position. When it has arrived at this position, all, or substantially all, of the laundry has already been discharged from the inner drum 25, whereupon the cam 120 rides off plunger 119 and allows the spring 117 to open limit switches 141 and 111, 112, breaking the circuit to the reversing switch coils 90, 102 and also the circuit to the timer motor 103. All of the mechanism is now at rest, and will remain at rest until another load of wet laundry is placed in the inner drum 25 and the drying operation reinstituted.

Heat is supplied to the dryer only upon the satisfaction of certain operating conditions. The doors 45, 50 must be fully closed, the inlet conduit temperature must not be too high, the outlet stack temperature must be below a predetermined degree, and the reversing motor must be in operation. Otherwise, gas will not flow to the main burner 61.

To accomplish these objectives, the main burner 61 is supplied by a suitable line 60, that has a solenoid operated valve 160 in it. When the coil 161 of the solenoid is energized, the valve 160 is opened; otherwise, it is closed. The solenoid 161 is connected in series with a switch 162 mounted on the door mechanism of the dryer, which may be a mercury switch that is closed only when the doors 45, 50 are latched in closed position. In addition, the inlet conduit 65 may have a switch 163 in series with the coil 161, including a bi-metallic arm 164 that engages the stationary contact 165 of the switch so long as the temperature in the conduit 65 does not exceed a predetermined degree. If the temperature rises above this amount, the bi-metallic element 164 will flex and open the switch 163. Similarly, the exhaust stack 80 is provided with a switch 166 in series with coil 161, including a bi-metallic arm 167 adapted to engage a stationary contact 168, so long as the outlet temperature is below a predetermined value. When this temperature is exceeded, the bi-metallic arm 167 flexes to open the switch 166.

The circuit through the main gas valve solenoid 161 also includes a relay 169, comprising a pair of stationary contacts 170, 171 and a bridge piece 172 connected to a plunger 173 which is actuated upon passage of current through a coil 174. Thus, the circuit through the main valve solenoid 161 runs from one of the main power lines *b* through lead 175 to one of the relay contacts 171, through the bridge piece 172 to the other relay contact 170, and through a lead 176 to the door switch. The door switch 162, inlet duct switch 166, solenoid 161, and exhaust stack switch 163 are all connected in series with one another, and through a lead 177 to one of the other main power lines *a*. When the relay 169 is energized, the circuit to the main valve 160 will be completed. However, this relay 169 is only energized after the combustion air motor 64, exhaust fan motor 79, and reversing drum motor 41 have been placed in operation.

The relay coil 174 is connected to a lead 178 running to one of the lines 137 feeding current to the combustion motor 64. The other end of the relay coil is connected through a suitable lead 179 to a stationary contact 180, which is engageable by a bi-metallic thermostatic arm 181 that is connected by a lead 182 to one of the other lines 137 running to the combustion air motor 64. The engagement of the bi-metallic arm 181 with the stationary contact 180 is dependent upon the operation of the drum reversing motor 41. When the circuit to this motor is completed, a heating element 183, located adjacent the bi-metallic element 181, is energized. This resistance heating element has one end connected through a lead 184 to one of the conductors 83 to the drum motor 41, while the other end of the heating element is connected through a suitable lead 185 to one of the other lines 82 leading to the drum motor. When either of the reversing switch portions are closed, current flows through the resistance heating element 183, heating the bi-metallic switch arm 181 and causing it to engage the stationary contact 180, thereby completing the circuit through the solenoid 174.

Assuming that the doors 45, 50 are closed and the inlet and outlet gas temperatures are below their preset values, the closing of the main switch 94 will close the circuit to the combustion air and exhaust fan motors 64, 79, which will commence rotating. The drum motor will also be set in operation because of the rotation of the timer motor 103, which will also complete the circuit to the heating element 183. This element will heat the bi-metallic arm 181, causing it to close the circuit through the relay coil 174, which will then complete the circuit through the main valve solenoid 161, causing the main valve 160 to open and allowing gas to flow to the main burner 61, where it is ignited by a pilot burner 186 and commences supplying heat to the dryer. The heating element 183 introduces a time delay between the commencement of operation of the combustion air, exhaust, and reversing drum motors 64, 79, 41 and the opening of the main valve 160, insuring that all parts are in proper operation before heat is applied. In the event that the circuit to the combustion air motor 64 is interrupted, the relay 169 will also be de-energized, which will de-energize the main valve coil 161 and cause the valve 160 to close. Thus, assurance is had that the main valve 160 can only be in open position if the combustion air and exhaust fan motors 64, 79 are operating, thereby insuring against excessive heating of the laundry in the dryer. The main gas valve 160 is also controlled by the reversing drum motor 41, since it can only be opened to supply heat to the dryer when the laundry is being tumbled in the drum 25.

A flame may be established at the main burner by a pilot flame 187 at the pilot burner 186, which is supplied with gas through a suitable line 188 having a solenoid operated pilot valve 189 therein. The solenoid coil 190 may be connected across two of the main power lines *a*, *b*, the pilot flame 187 being in existence so long as the main switch 94 is closed. The pilot flame is established by an igniter in the form of a plug 191 having one of its electrodes connected to ground and the other of its electrodes connected through a suitable lead 192 to one end of the secondary 193 of a transformer 194, whose other end is connected to ground. The primary coil 195 of the transformer has one end connected through a suitable lead 196 to one of the main power lines *a*, and its other end connected to a stationary contact 197 adapted to be engaged by a bi-metallic thermostatic switch arm 198, which is connected to another power line *b*. When the pilot flame 187 is in existence, the bi-metallic arm 198 is deflected from the contact 197 to break the circuit through the primary coil 195 of the transformer. Accordingly, a spark does not exist across the ignition plug electrodes. In the event that the pilot flame is extinguished, the bi-metallic element 198 flexes into engagement with the stationary contact 197, completing the primary coil circuit and causing the spark to jump between the electrodes, which again establishes the pilot flame.

In Figs. 14 and 15, a modified arrangement is illustrated for controlling the door closure member 45*a* shown in Fig. 11. This closure arrangement eliminates the need for hand manipulations in opening and closing the door, as well as the use of latch mechanisms. Instead, opening and closing of the door 45*a* is effected automatically in accordance with the position of the outer housing 12.

As in the form of invention illustrated in Fig. 11, the door 45*a* is rotatably mounted upon a supporting arm 47 mounted on a fulcrum pin 48*a* suitably secured to the outer housing 12. The upper extension 47*b* of this supporting arm has spaced projections 47*c*, to which the ends of tension springs 210 are secured. The other ends of these springs are attached to ears or lugs 211 projecting from the housing, so that the springs 210 normally tend to swing the door 45*a* to the partly open position disclosed in Figs. 14 and 15.

In order to shift the door between fully open and fully closed positions, and to hold the door in the latter position, a pneumatic device is provided. This pneumatic device includes an air cylinder 212 having its rearward portion pivotally mounted on the upper part of the housing 12. The cylinder has the usual piston therein (not shown) to which the piston rod 213 is secured. The forward end of the piston rod is pin connected to an upward projection 214 on the supporting arm 47, disposed between the outer extensions 47*c*.

An air line 215 is connected between the air conduit 23, running to the rod end of the housing cylinder 17, and the head end of the door cylinder 212. A second air conduit 216 is connected to the line 23 running to the head end of the cylinder 17 and to the rod end of the door cylinder 212 (see Fig. 15). When the manually operated valve 24 is shifted, so as to cause air to enter the rod end of the housing cylinder 17 and tilt the housing 12 to its normal drying position, such as shown in Figs. 1 and 2, air is also fed into the head end of the door cylinder 212, shifting its piston and piston rod 213 forwardly, and swinging the door 45*a* to closed position against the flange 57. So long as the air pressure is maintained in the door cylinder 212, the door 45*a* is held in closed position, without the need for any other elements, such as the latch 51, 52 shown in Fig. 11.

When the manually operated valve 24 is shifted in the opposite direction to feed air into the head end of the housing cylinder 17, the latter effects tilting of the housing 12 toward its unloading and loading position shown in Fig. 3. When air enters the conduit 23 leading to the

head end of the housing cylinder, it also enters the conduit 216 leading to the rod end of the door cylinder 212, the other air conduit 215 from the door cylinder, of course, being exhausted. Accordingly, the piston and piston rod 213 move rearwardly, or to the right, as seen in Fig. 15, swinging the door to its fully open position. In Fig. 15, the door is disclosed in only a partly open position, and it is to be understood that when the piston is shifted in the cylinder 213 to its fullest extent toward the right, the door is elevated completely free from the opening 27a.

By virtue of the arrangement shown in Figs. 14 and 15, movement of the manually operated valve 24 effects automatic tilting of the outer housing 12 between its drying position, on the one hand, and the unloading and loading positions, on the other hand, as well as shifting of the door 45a between open and closed positions. Opening of the door 45a automatically disconnects the circuit to the solenoid 161, and insures prompt shutting off of the gas supply flowing through the conduit 60. Similarly, as has been described above, the initiation of the tilting movement of the housing 12 to unloading position disrupts the circuits to the blower and exhaust fan motors 64, 79. It is evident that the operation of the entire apparatus is under the control of the manually operated valve 24, which is the only part that need be manipulated by the operator.

When no air under pressure is present in either of the lines 215, 216 leading to the door cylinder 212 and they are open to exhaust, the springs 210 swing the door 45a to the partially open position shown in Figs. 14 and 15. Thus, assurance is had that the drum 25 is vented during non-use of the apparatus, insuring against the entrapment of any gases and vapors therewithin.

The inventor claims:

1. In laundry apparatus: a support; an outer housing tiltably mounted on said support; an inner drum mounted in said housing for rotation about an axis disposed substantially at right angles to the tilting axis of said housing; said drum and housing having openings substantially aligned with each other and with the drum axis; and closure means mounted on said housing and adapted to close both of said openings; said closure means including a first cover member for the drum and rotatable with the drum, and a second cover member for the housing.

2. In laundry apparatus: an outer housing; an inner drum rotatably mounted in said housing; reversible drive means for rotating said drum alternately in opposite directions by a predetermined angular amount; means for reducing the angular movement of said drum in each direction; and means for automatically effecting said reduction when laundry is to be unloaded from said drum.

3. In laundry apparatus: a support; an outer housing tiltably mounted on said support; means for tilting said housing; an inner drum rotatably mounted in said housing about an axis substantially at right angles to the tilting axis of said housing; reversible drive means carried by said housing for rotating said drum alternately in opposite directions; and means carried by the housing operable in response to the tilting of said housing for adjusting the extent of angular motion of said drum in each direction.

4. In laundry apparatus: a support; an outer housing tiltably mounted on said support; means for tilting said housing; an inner drum rotatably mounted in said housing about an axis substantially at right angles to the tilting axis of said housing; said housing and drum having openings substantially aligned with each other and with the drum axis; closure means for at least one of said openings; reversible drive means carried by said housing for rotating said drum alternately in opposite directions by a predetermined angular extent when said housing is in one position; and means for reducing angular movement of said drum in each direction, operated when said housing begins to tilt to unload laundry from said drum.

5. In laundry apparatus: a support; an outer housing tiltably mounted on said support; means for tilting said housing; an inner drum rotatably mounted in said housing about an axis substantially at right angles to the tilting axis of said housing; said housing and drum having openings substantially aligned with each other and with the drum axis; closure means for at least one of said openings; reversible drive means carried by said housing for rotating said drum alternately in opposite directions by a predetermined angular extent when said housing is in one position; and means carried by said housing and operating in response to the tilting of said housing for reducing the angular motion of said drum in each direction when said housing begins to tilt to unload laundry from said drum.

6. In laundry apparatus: a support; an outer housing tiltably mounted on said support; means for tilting said housing; an inner drum rotatably mounted in said housing about an axis substantially at right angles to the tilting axis of said housing; said housing and drum having openings substantially aligned with each other and with drum axis; closure means for at least one of said openings; reversible drive means, including a reversible electric motor, carried by said housing for rotating said drum alternately in opposite directions; timing means controlling the application of current to said motor to effect its reversal at periodic intervals; and means for adjusting the operation of said timing means for changing the intervals at which the direction of rotation of said motor is reversed.

7. In laundry apparatus: a support; an outer housing tiltably mounted on said support; means for tilting said housing; an inner drum rotatably mounted in said housing about an axis substantially at right angles to the tilting axis of said housing; said housing and drum having openings substantially aligned with each other and with the drum axis; closure means for at least one of said openings; reversible drive means, including a reversible electric motor, carried by said housing for rotating said drum alternately in opposite directions; timing means controlling the application of current to said motor to effect its reversal at periodic intervals when said housing is in one position; and means for adjusting the operation of said timing means for reducing the intervals at which the direction of rotation of said motor is reversed, operated when said housing begins to tilt to unload laundry from said drum.

8. In drying apparatus: a support; an outer housing tiltably mounted in said support; means for tilting said housing; an inner perforate drum rotatably mounted in said housing about an axis

substantially at right angles to the tilting axis of said housing; said housing and drum having openings substantially aligned with each other and with the drum axis; closure means for at least one of said openings; reversible drive means including a reversible electric motor carried by said housing for rotating said drum alternately in opposite directions; electrical timing means controlling the application of current to said motor to effect its reversal at periodic intervals; means comprising an electric motor for circulating a heating medium through said drum; and means having a member carried by said housing and cooperating control means operated by said member to effect operation of said circulating motor and of said timing means at a relatively slow rate when said housing is in its normal drying position, said control means being operated by said member to discontinue operation of said circulating motor and to effect operation of said timing means at a faster rate when said housing is tilting from its normal drying position, said control means also stopping said timing means to discontinue rotation of the reversible motor when said housing is tilted to its unloading position.

9. In laundry apparatus: an outer housing; means for tilting the housing about an axis; a rotary perforated drum in the housing, the drum axis being transverse to the housing axis; means for rotating the drum; said drum having a tubular projection extending through an opening in the housing; a cover for the projection; and a pivotal support for the cover.

10. In laundry apparatus: a tiltable outer housing; means for tilting said housing about an axis; a drum in said housing and rotatable about an axis transverse to the tilting axis; said drum having a hollow extension projecting through an opening in the housing; an arm pivoted on the housing; and a cover rotatably mounted on the arm and cooperating with the edge of said extension for closing the drum.

11. In laundry apparatus: a tiltable outer housing; means for tilting said housing about an axis; a drum in said housing and rotatable about an axis transverse to the tilting axis; said drum and housing having aligned openings; a cover for at least one of the openings; an arm pivoted to the housing for supporting said cover; spring means urging the arm to cover-opening position, and operating on that side of the arm remote from the cover; and power means for moving the arm to cover-closing position.

12. In laundry apparatus: a tiltable housing; a rotary drum in the housing; means for tilting the housing to an unloading position; an electric motor for driving the drum; a circuit controller for said motor; and means carried by the housing for operating the circuit controller to maintain the motor energized except when the housing is in fully tilted position.

13. In laundry apparatus: a tiltable housing; a rotary drum in the housing; said housing having an opening; a door for the opening; spring means for urging the door toward opening position; means for angularly moving the housing from a tilted position; means for moving the door toward closed position; and a common control for said angularly moving means and the door closing means.

14. In laundry apparatus: a tiltable housing; a rotary drum in the housing; said housing having an opening; a door for the opening; spring means for urging the door toward opening position; fluid pressure means for moving the door toward closed position; fluid pressure means for angularly moving the housing from a tilted position; and a common valve means for controlling both said fluid pressure means.

15. In laundry apparatus: a rotary drum; a reversible electric motor for driving the drum; a circuit controller for cyclically reversing said motor; an auxiliary motor for operating the circuit controller; and means for adjusting the speed of said auxiliary motor.

16. In laundry apparatus: a rotary drum; means for tilting the drum to assume a charging and discharging position; a reversible electric motor for driving the drum; a circuit controller for cyclically reversing said motor; an auxiliary motor for operating the circuit controller; and means operated by the movement of the drum toward fully tilted position for increasing the speed of said auxiliary motor.

17. In laundry apparatus: a rotary drum; means for tilting the drum to assume a charging and discharging position; a reversible electric motor for driving the drum; a circuit controller for cyclically reversing said motor; an auxiliary motor for operating the circuit controller; means operated by the movement of the drum toward fully tilted position for increasing the speed of said auxiliary motor; and means operated by the movement of the drum to fully tilted position for deenergizing the reversible motor.

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