

[54] CONDENSER APPARATUS

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55/230, 261/90

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[58] Field of Search 34/72-78, 130,
34/131, 133; 68/18 C; 55/230; 261/90

[56] References Cited

UNITED STATES PATENTS

3,022,581 2/1962 Smith 34/75
3,121,000 2/1964 Hubbard 34/75

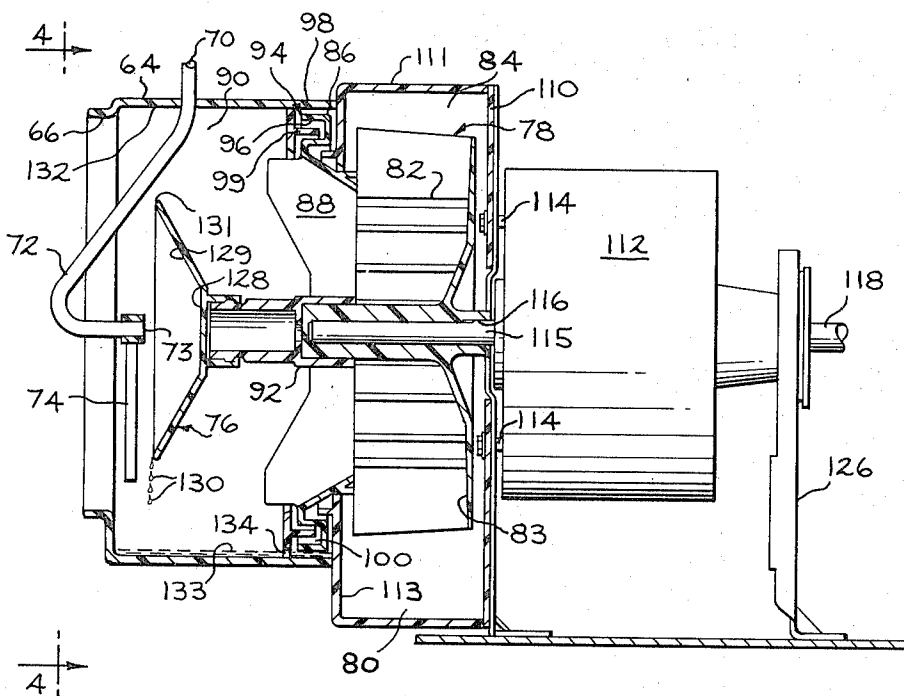
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air including a housing for the condenser apparatus, which housing has both a cooling liquid inlet and an air inlet at one end. Within the housing is a rotatable disc downstream from the liquid inlet so that when the disc is rotated and liquid is directed against the disc a cooling liquid droplet cloud is produced. At the opposite end of the condenser housing from the inlet is an air outlet and a concentrically positioned rotatable blower. Located between the blower and the rotatable disc is a rotatable water wheel for collecting entrained liquid droplets before they pass into the blower. Circumferentially around the rotatable water wheel is a liquid pump that removes liquid from the condenser apparatus. A single electric motor is utilized for rotatably driving all of the rotating elements. The condenser apparatus is utilized particularly in an automatic clothes dryer wherein hot moisture-laden air that has been passed over the fabrics to be dried is introduced into the condenser apparatus which reduces the temperature of the air to condense moisture therefrom and then recirculates the air again through the clothes dryer.

[57] ABSTRACT

Condenser apparatus for removing moisture from the

8 Claims, 4 Drawing Figures



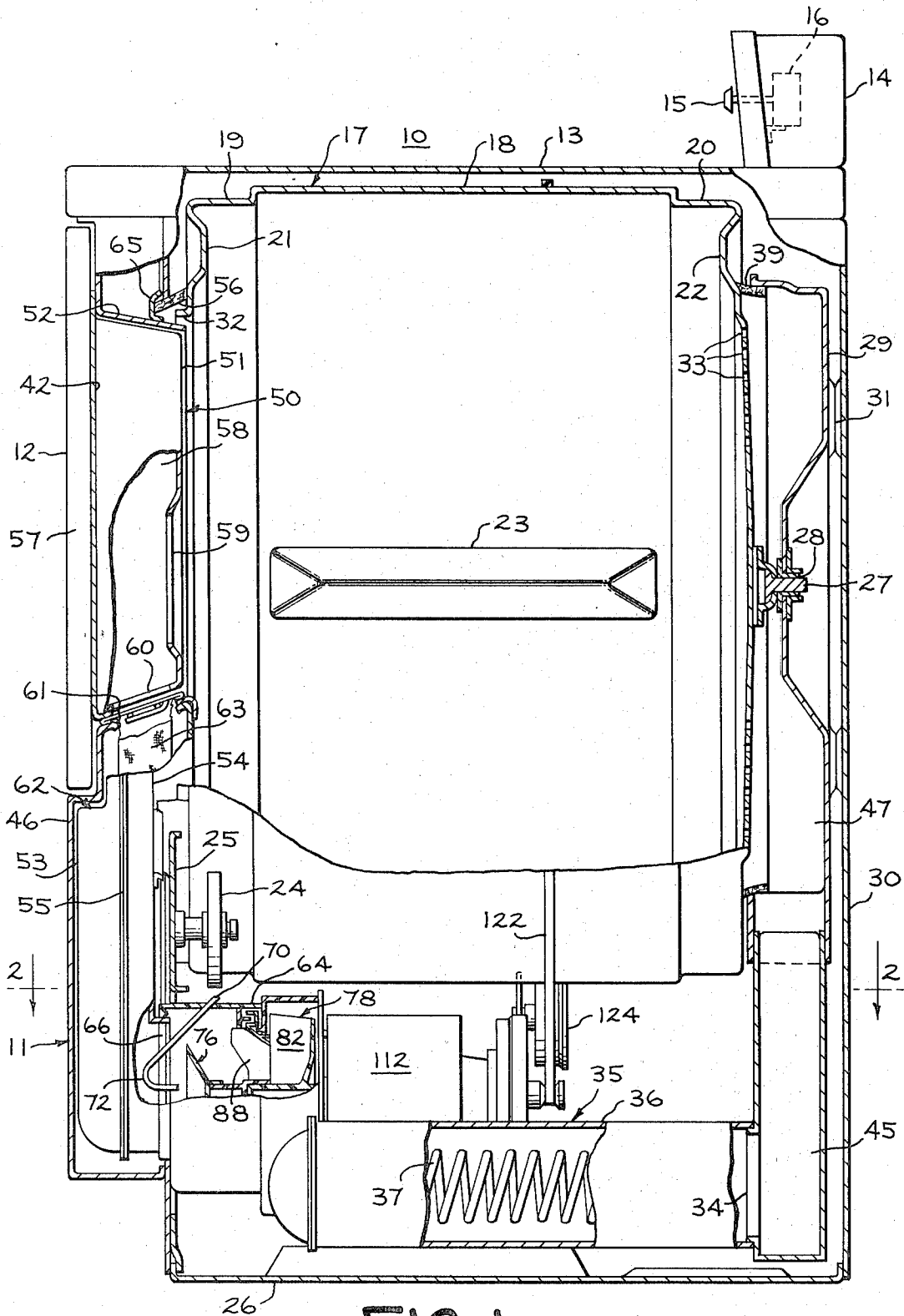
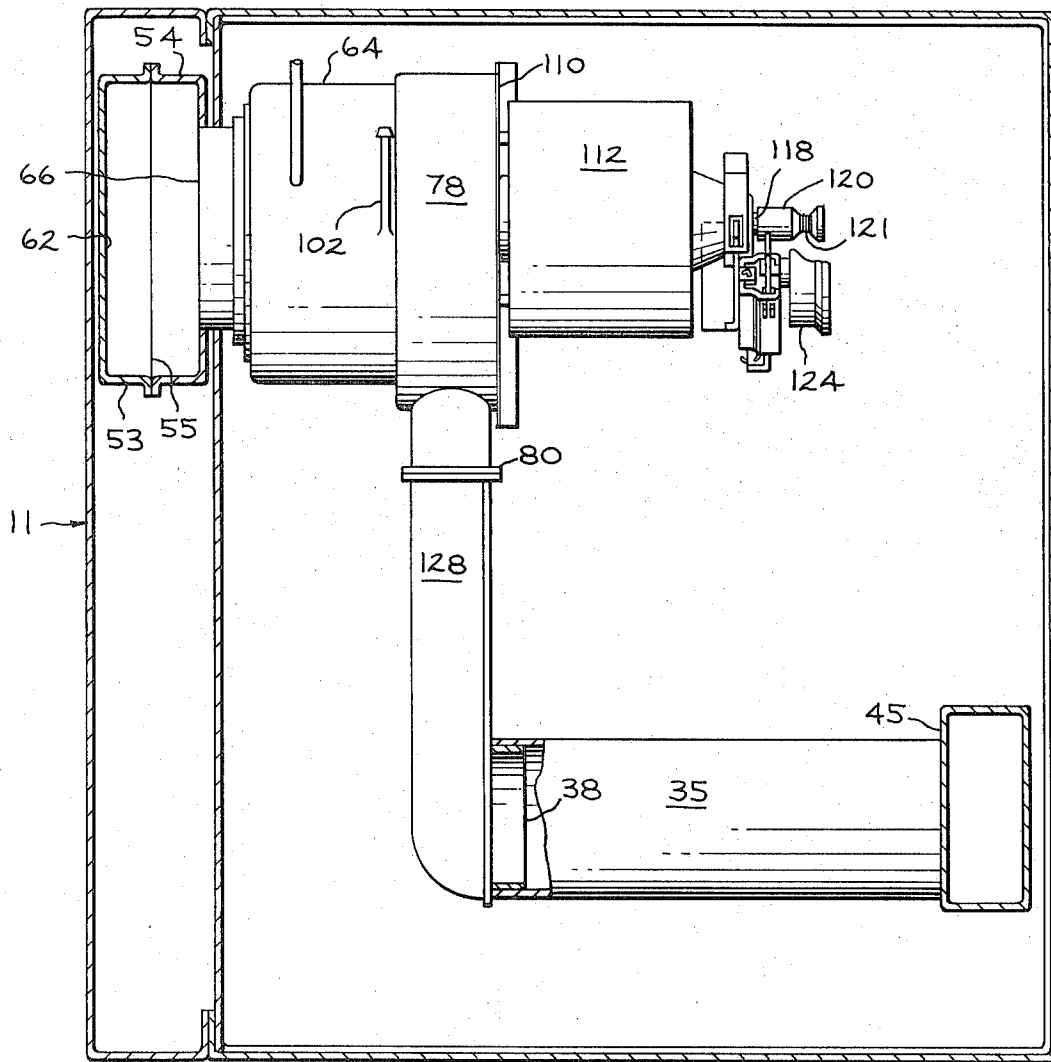


FIG. 1



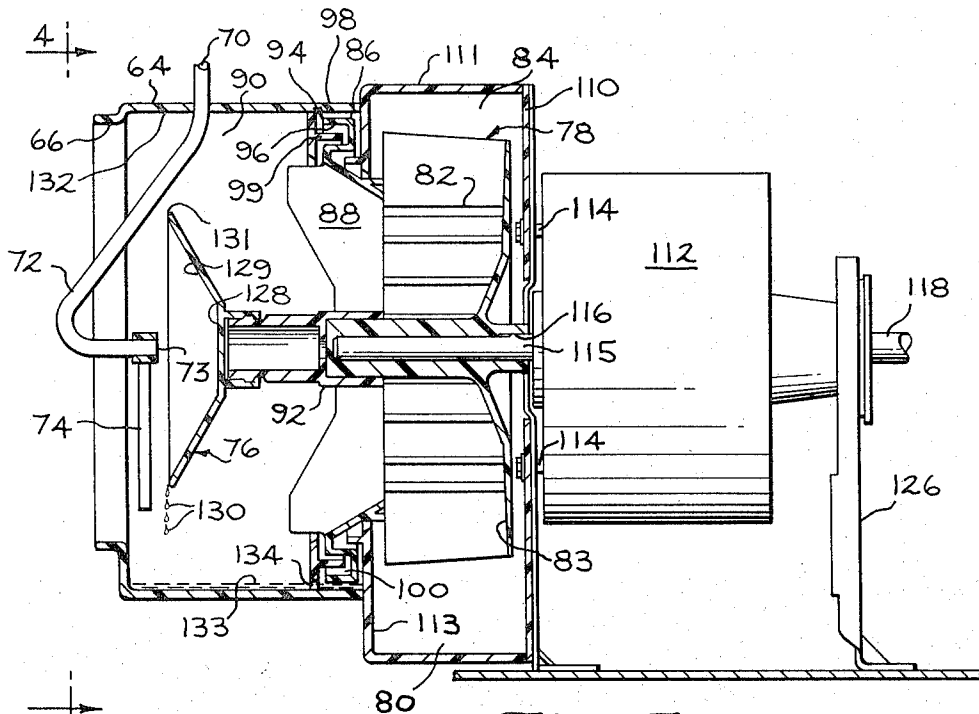


FIG. 3

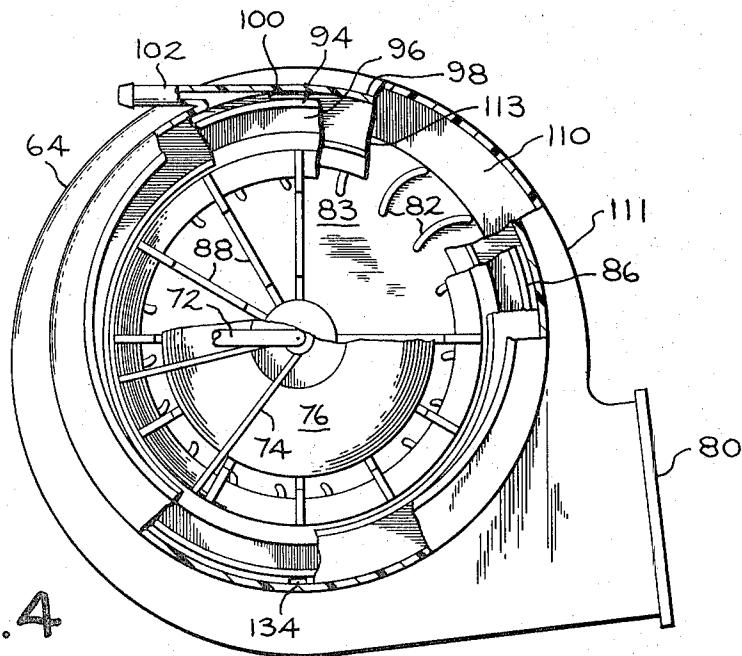


FIG. 4

CONDENSER APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention:

This invention relates to condenser apparatus, and more particularly to condenser apparatus for utilization in an automatic clothes dryer so that warm moisture-laden air from the clothes dryer is cooled and moisture removed therefrom.

2. Description of the Prior Art:

In automatic clothes dryers it is common to vent the warm moisture-laden exhaust air or vapor outside the machine and preferably even outside the house or building while air is constantly being introduced into the clothes dryer, heated and passed over the fabrics to be dried. It is not, however, always possible and, in fact, it may not be desirable to provide such a venting system for automatic clothes dryers in apartments or other high rise housing establishments. In drying fabrics in a clothes dryer it is highly desirable to be able to heat the air, pass the heated air over the fabrics to be dried and withdraw moisture therefrom, remove the hot moisture-laden air from the fabrics and introduce it into an apparatus that lowers the temperature of the moisture-laden air thereby condensing out moisture from the air, then recirculate the air through the clothes dryer.

Condensing apparatus has been utilized in laundry machines, both combination clothes washers and dryers and automatic clothes washers, for many years. One such condensing apparatus is shown in U.S. Pat. No. 2,451,692 wherein moist air is passed through a water spray from a nozzle that is also used to effect movement of the air and free water from the spray is removed by a stationary screen. Another type of condensing apparatus is disclosed in U.S. Pat. No. 2,785,557 wherein only a controlled portion of the moist air is passed through a dehumidifier. U.S. Pat. No. 2,921,384 shows apparatus that uses an impeller to circulate air that also has the cooling water discharged directly against the impeller, however, there is no free water collection means provided. U.S. Pat. No. 3,121,000 utilizes a condensing arrangement that is a coherent film of water on a channel wall to avoid entrainment of water droplets.

Condenser apparatus for automatic clothes dryers must be efficient in operation, low in manufacturing cost, and economical to operate in order to make it desirable. Moreover, it should be compact and of a size such that it can be easily installed in present standard size clothes dryers.

By my invention, there is provided an improved condenser apparatus particularly for use in automatic clothes dryers that accomplishes the abovementioned desirable characteristics not found in condenser apparatus heretofore.

SUMMARY OF THE INVENTION

In accordance with this invention, there is provided a condenser apparatus for removing moisture from the air and particularly a condenser apparatus that is utilized in connection with an automatic clothes dryer and includes a housing for the condenser apparatus, which housing has both a cooling liquid inlet and an air inlet at one end, and air outlet at the opposite end of the housing, and a condensing chamber therebetween. Downstream from the liquid inlet is a rotatable disc po-

sitioned within the condenser housing. The liquid introduced through the liquid inlet is directed against the disc which is rotated and the centrifugal force acting on the liquid causes the liquid to be radially thrown from the periphery of the disc in the form of droplets and in a plane normal to the axis of rotation of the disc. The droplets are intercepted by the condenser housing and deflected and form a cooling liquid droplet cloud in the condensing chamber. Near the air outlet of the condenser apparatus there is positioned a rotatable blower for inducing an air flow through the condenser apparatus from the air inlet to the air outlet passing through the liquid droplet cloud. Located between the blower and the disc, also positioned within the condenser housing, is a liquid droplet collecting means for collecting entrained liquid droplets before they can pass into the blower. A liquid pump that removes both the introduced cooling liquid and the moisture condensed from the air from the condenser apparatus to a drain external of the condenser apparatus is also provided. There is also a means for rotatably driving all of the rotating elements including the pump.

It is an object of this invention to provide an improved condenser apparatus.

It is another object of this invention to provide an improved condenser apparatus for use in an automatic clothes dryer.

It is also an object of this invention to provide a condenser apparatus which is simple in construction, efficient in operation, and compact in size to enable its incorporation into standard existing automatic clothes dryers.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of an automatic clothes dryer suitable for incorporation of the condenser apparatus of the present invention, the view being partly broken away and partly in section to illustrate details.

FIG. 2 is a view taken along the lines 2-2 of FIG. 1 showing the condenser apparatus installed in the automatic clothes dryer.

FIG. 3 is a side elevational, cross-sectional view of the condenser apparatus.

FIG. 4 is a front elevational view of the condenser apparatus shown in FIG. 3 taken along lines 4-4 and partially broken away to illustrate details.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and initially to FIG. 1 thereof, there is illustrated a domestic automatic clothes dryer 10 including an appearance and protective outer cabinet 11 having a door or closure 12 to provide access into the interior of the cabinet for loading and unloading fabrics. Provided on the top 13 of cabinet 11 is a control panel 14 which may, in a conventional way, include a suitable manual control 15 connected to a control assembly 16 mounted in the panel 14. By manual setting of control 15, the machine may be caused to start and automatically proceed through a cycle operation.

Within cabinet 11, there is provided a clothes tumbling container or drum 17 mounted for rotation on a substantially horizontal axis. Drum 17 is substantially cylindrical in shape, having a central cylindrical wall portion 18, and outer cylindrical wall portions 19 and

20, located respectively adjacent an annular front wall 21 and a circular rear wall 22 of the drum. Wall portions 18, 19 and 20 are imperforate over their entire area. On the interior surface of wall portion 18 there is a plurality of clothes tumbling ribs 23 so that clothes are lifted up when the drum rotates, and then permitted to tumble back down to the bottom of the drum. The front of the drum 17 may be rotatably supported within outer cabinet 11 by suitable slide members or idler wheels, one of the latter of which is indicated by the numeral 24. These wheels are rotatably secured to the top of the support member 25 which extends up from the base 26 of the machine. The wheels 24 are disposed beneath the drum, in contact with portion 19, so as to support the portion 19 on each side to provide a stable support.

The rear end of drum 17 receives its support by means of a stub shaft 27 extending from the center of wall 22. Shaft 27 is secured within a bearing 28 mounted in a baffle-like structure 29 which, in turn, is rigidly secured to the back wall 30 of the cabinet 11 by any suitable means such as screws at a number of points 31. With the arrangement shown, the drum may rotate on a horizontal axis, with slides or rollers 24 providing the front support and stub shaft 27 within bearing 28 providing the rear support.

In order to provide for the flow of drying air through the clothes drum, it is provided with a central aperture 32 in the front wall 21 and a plurality of perforations 33 in the rear wall 22. Perforations 33 in the present case are formed to extend around the rear wall in an annulus. The air provided to the drum is heated as by an electrical resistance heating element 37, the element being the form shown in the drawings, which issues from the outlet 34 of the heating unit 35. Heating unit 35 includes a heater housing 36 and an electrical resistance heating element 37. In the conventional way, air is drawn into the heating unit 35 through an inlet opening 38 (FIG. 2) and is warmed as it passes over and through the electrical resistance heating element 37 and then out the heater outlet 34.

The outlet end 34 of the heating unit communicates with an upwardly extending duct 45, which enters a generally circular heat diffuser chamber 47 formed between the member 29 and the rear wall 22 of drum 17. A flexible circumferential seal 39 is interposed between member 29 and rear wall 22 of the drum to provide a rear drum airseal and is secured to member 29 and contacts the rear wall of the rotating drum. The heated air flows from the chamber 47 through the perforations 33 into the interior of the drum 17.

The front opening 32 of the drum is substantially closed by means of a stationary bulkhead generally indicated by the numeral 50. Bulkhead 50 is made up of a number of adjacent members including the inner surface 51 of the access door 12, a stationary frame 52 formed as a flange on front wall 46 of the cabinet and a front door liner 42.

An exhaust duct is formed by joining together cavity member 54 and cavity member 53 at an annular flange 55. It will be noted that a suitable clearance is provided between the inner edge of aperture 32 and the edge of frame 52 so that there is no rubbing between the drum and the frame during rotation of the drum. In order to prevent substantial air leakage through the aperture 32, a suitable front drum ring seal 56 is secured to the

flange 65 in sealing relationship with the exterior surface of the drum wall 21.

Central aperture 32, in addition to serving as part of the air flow passage to the drum, also serves as a means whereby clothes or other fabrics may be loaded into and unloaded from the drum. Door 12 is mounted on cabinet 11 so that when the door is opened fabrics may be inserted into and removed from the drum through the door frame 52. It will be noted that the door includes an outer, flat imperforate section 57 and an inwardly extending hollow section 58, mounted on the flat outer section. Between the outer section 57 and hollow section 58 is a door liner 42. Hollow section 58 extends into the door frame 52 when the door is closed, and the door surface 51 which comprises part of the combination bulkhead 50 is actually the inner wall of the hollow section.

The air outlet from the drum is provided by a perforated opening 59 formed in the inner wall 51 of the hollow door section 58. The bottom wall section of door 12 and the adjacent wall of door frame 52 are provided with aligned openings 60 and 61, opening 61 providing an entrance to a duct 62 formed by joining together cavity member 54 and cavity member 53. A lint trap 63 may be positioned in the duct 62 within opening 61 and supported by the door frame 52. Duct 62 leads downwardly and communicates with condenser housing 64. It is within the condenser housing that the hot moisture-laden air is cooled which causes moisture to be removed from the air prior to reintroducing the air into the heating unit 35 and then recirculated through the clothes dryer.

With reference to FIGS. 1, 3 and 4 in particular, the operation and construction of the condenser apparatus will now be explained. The condenser apparatus includes a housing 64 which is cylindrical or drum shaped and has an air inlet 66 located at the front of the condenser unit which is also near the front of the clothes dryer. Hot moisture-laden air from the drum is introduced into the condenser unit through the air inlet 66 by a transition duct 62 (FIG. 1) between the drum and the air inlet. Also located at the same end of the condenser housing 64 is a liquid inlet means 70 which may conveniently be a hose a tubular conduit 72 supported by structure 74 secured in a suitable fashion to the condenser housing. The structure 74 secures and positions the tubular conduit 72 substantially on the longitudinal axis of the condenser housing 64 with the end 73 of the conduit 72 directed into the condenser apparatus. The liquid introduced into the condenser apparatus by means of the tubular conduit 72 is in the form of a stream and is furnished from a source external of the clothes dryer such as a household faucet. Also within the condenser housing 64 and spaced axially from the liquid inlet means 70 is one or more concentrically positioned rotatable discs 76. There is shown in the drawings one disc, however, more than one disc may be used by providing a means of distributing the incoming liquid to the other discs. At the opposite end of the condenser housing 64 from the liquid inlet means 70 is a blower 78 for inducing air to flow from the air inlet 66 to an air outlet 80. The blower 78 not only induces air flow through the condenser apparatus but causes the air to flow through the entire clothes dryer so that only a single blower is needed. The blower in this embodiment consists of a rotatable blower wheel having a plurality of blades 82 secured as by molding to circular

plate 83 and a confining air space 84 surrounding the blower wheel for developing sufficient air pressure within the blower to induce the abovementioned air flow through the entire clothes dryer including the condenser unit. Positioned within the condenser housing 64 and located between the rotatable disc 76 and the blower 78 is a water droplet collecting means 86 which in the present preferred embodiment described is in the form of a rotatable water wheel having a plurality of spaced blades 88 which extend radially outward from the axis of rotation of the wheel. The axial depth of blades 88 is such that they extend from the blower wheel 78 into the condensing chamber 90. The blades 88 are integrally formed with a hub 92 and are spaced so that air flowing through the condenser apparatus may flow through the spaces between the radial blades 88 and into the blower. Surrounding the water droplet collecting means 86 is a pump 94 which consists of a rotatable U-shaped inner wall 96 and a stationary outer pump wall 98 which cooperate with each other to provide a pump cavity 100 therebetween. The outer pump wall 98 may be integrally formed with the condenser housing. Also forming one part of the pump 94 is a circumferential wall member 99 that is stationary and secured to the inside of the condenser housing and inwardly depending therefrom. Rotation of the inner pump wall 96 forces the liquid to be accelerated circumferentially by rotational force and discharged through the pump discharge outlet 102. The discharge outlet 102 is connected by suitable means to a drain outside of the clothes dryer.

At the rear of the condenser housing 64 is a rear wall 110 which forms part of the condenser housing. The rear wall 110 together with cylindrical wall section 111 of housing 64 and inwardly directed circular flange 113 form blower chamber 84. Secured to the rear wall 110 on the opposite side from the blower chamber 84 is an electric motor 112 which may be suitably attached to the rear wall as by bolts 114. The electric motor has a rotatable shaft extending through an aperture 116 in the rear wall 110 close to the central longitudinal axis of the condenser apparatus. Secured to this motor shaft 115, which extends into the condenser housing, are the four rotatable elements of the condenser apparatus, namely, the blower 78, the water droplet collecting means or water wheel 86, inner wall 96 of the pump 94 and the disc 76. The single motor 112 rotatably drives all four of these condenser apparatus elements.

The motor shaft 115 also extends rearwardly of the motor in the opposite direction from the condenser apparatus and is utilized to rotate drum 17. In order to effect this rotation, motor 112 is provided with a shaft portion 118 having a small pulley 120 secured to the end thereof. Around the pulley 120 and seated in groove 121 and entirely around the cylindrical wall section 18 of drum 17 is a movable belt 122. The relative circumference of the pulley groove 121 and the wall section 18 of the drum 17 causes the drum to be driven by the motor at a speed suitable to effect tumbling of fabrics to be dried in the drum. In order to effect proper tensioning of the belt 122, a suitable idler assembly 124 is secured to the same support 126 which supports one end of the motor.

The air exiting the condenser apparatus through air outlet 80 passes via duct 128 into the heating unit 35 for heating the air and recirculating it into the clothes dryer drum 17.

The operation of the condenser and dryer apparatus is as follows: Hot moisture-laden air that has been passed through the clothes dryer drum and picked up moisture from the fabrics tumbled therein is introduced into the condenser unit through the air inlet opening 66 while a stream of cooling liquid is being introduced into the condenser unit through tubular conduit 72. When the condenser apparatus is operating the electric motor provides for simultaneous rotation of the blower 78, droplet collecting water wheel 86, inner wall 96 of pump 94 and disc 76. As disc 76 is being rotated the stream of liquid being introduced directed against the rapidly rotating disc. The liquid striking the rotating surface 128 is acted upon by centrifugal force causing the liquid to spread into a film and travel up the inclined inner wall surface 129 of the disc 76 to the periphery 131 thereof and from there thrown outwardly in the form of liquid droplets 130. The generally radial flight of the liquid droplets 130 is interrupted by the inner surface 132 of the condenser housing 64 whereupon the liquid droplets are deflected back toward the center of the condenser chamber 90, this in effect produces a curtain or cloud of liquid droplets within the condensing chamber 90 while the incoming hot moisture-laden air from the dryer drum flows through this resultant liquid droplet cloud. The hot moisture-laden air in contact with the cooler liquid droplets causes the air temperature to be lowered and the moisture condensed therefrom. Because the air flowing through the condenser chamber 90 may entrain liquid droplets the water droplet collecting means 86 is positioned upstream of the blower 78 between the disc 76 and the blower 78 so that entrained liquid droplets are essentially collected by the rotating blades 88 and deposited in an underlying liquid bath 133 which is in communication with the pump 94 through an opening 134. It will be understood that simultaneously with the introduction of cooling liquid into the condenser apparatus through the tubular conduit 72 that liquid will also be removed from the condenser apparatus by the pump 94 at a rate such that only a small amount of liquid is in the liquid bath 133 at a given time during operation of the condenser apparatus. The now cooled air reaches the blower 78 which applies air pressure to induce the air flow and force the air out of the condenser apparatus through air outlet 80 for introduction into the heating unit 35 and again recirculates through the clothes dryer.

The foregoing is a description of the preferred embodiment of the invention and variations may be made thereto without departing from the spirit of the invention, as defined in the appended claims.

What is claimed is:

1. Condenser apparatus for removing moisture from air comprising:
 - a. a housing,
 - b. liquid inlet means at one end of said housing,
 - c. air inlet means at said one end of the housing,
 - d. air outlet means at the end of the housing opposite the air inlet means,
 - e. a rotatable disc positioned within the housing and downstream from said liquid inlet means,
 - f. a rotatable blower for inducing air flow from the air inlet means to the air outlet means,
 - g. means for collecting liquid droplets positioned within the housing and located between the disc and blower,

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h. means for removing liquid from the condenser apparatus, and

i. means for rotatably driving the disc and blower.

2. The condenser dryer apparatus of claim 1 wherein the means for rotatably driving the disc and blower is a motor and is in axial alignment with the disc and rotatable blower and the motor shaft directly drives the disc and blower.

3. The condenser apparatus of claim 1 wherein the rotatable blower is positioned within the housing at the opposite end of the housing from the liquid inlet means.

4. The condenser apparatus of claim 1 wherein the means for removing liquid from the condenser apparatus is a pump driven by the means for rotatably driving the disc and blower.

5. In an automatic clothes dryer machine having a cabinet, a drum mounted for rotation within the cabinet to tumble clothes to be dried, means for passing air through the drum and heating means to heat the air, a condenser apparatus, including:

a. a housing,

b. liquid inlet means at one end of said housing,

c. air inlet means at said one end of the housing,

d. air outlet means at the end of the housing opposite the air inlet means,

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e. a rotatable disc positioned within the housing and downstream from said liquid inlet means,

f. a rotatable blower for inducing air flow from the air inlet means to the air outlet means,

g. means for collecting liquid droplets positioned within the housing and located between the disc and blower,

h. means for removing liquid from the condenser apparatus, and

i. means for rotatably driving the disc and blower.

6. In the automatic clothes dryer machine of claim 5 wherein the means for removing liquid from the condenser apparatus is a pump also driven by the means for rotatably driving the disc and blower.

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7. In the clothes dryer machine of claim 5 wherein the means for rotatably driving the disc and blower is a motor and is in axial alignment with the disc and rotatable blower and the motor shaft directly drives the disc and blower.

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8. In the clothes dryer machine of claim 5 wherein the rotatable blower is positioned within the housing at the opposite end of the housing from the liquid inlet means.

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