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Gould

[11] **3,805,404**

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[54] **WATER COOLED CONDENSER DRYER FOR LAUNDRY CENTER**

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[52] **U.S. Cl.** **34/75,** 34/77, 34/133, 68/20

[51] **Int. Cl.** **F26b 21/06**

[58] **Field of Search** 34/72–78, 131–133; 68/20

[56] **References Cited**

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2,785,557	3/1957	Stilwell, Jr.	34/77
2,843,943	7/1958	Geldhof et al.	68/20
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3,584,393	6/1971	Menk	34/88

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1,028,699	5/1953	France	34/77

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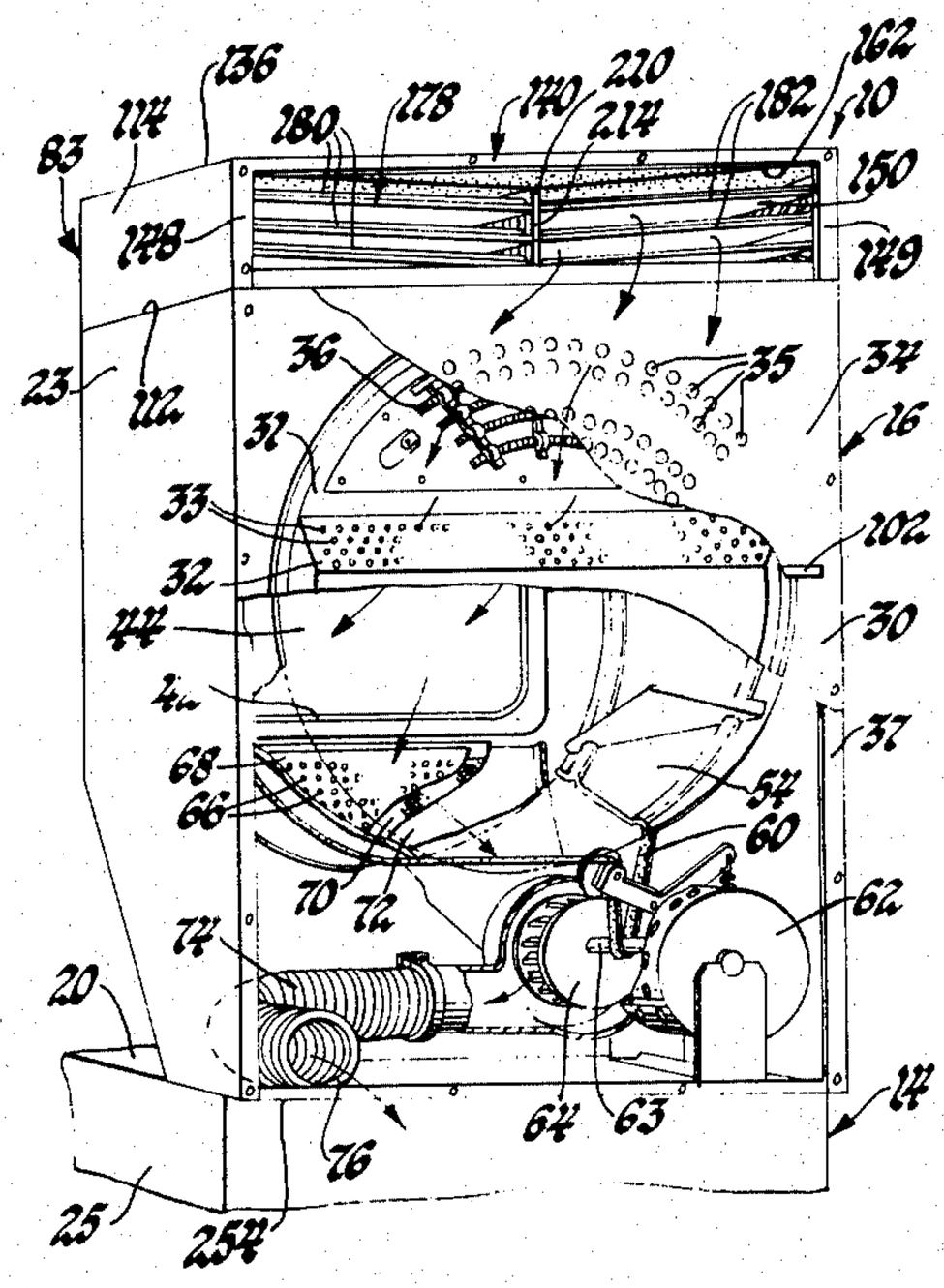
[57] **ABSTRACT**

A recirculating water-cooled low profile condensing unit for a vertically stacked combination clothes washer and non-vented dryer wherein a plurality of condenser plates, located in a plenum chamber above the dryer top wall, are arranged in a vertically spaced shallow V-shaped configuration. A serpentine cooling water series passageway is connected via valve means to the cold water inlet tube of the washer and contacts the plates in heat exchange relation such that the volume of water required for condensing is reduced to a minimum without increasing the drying time interval required for a vented dryer. A longitudinally extending center baffle partition is aligned with the apex of the plates so as to divide the spaces between the plates into a plurality of parallel side-by-side spent air inlet and condensed air outlet air flow passages to maximize the condensing plate surface contacted by the recirculating drying air. Condensate flows from the plates to an underlying conforming shallow V-shaped drain pan for discharge into the washer located beneath the dryer.

4 Claims, 7 Drawing Figures



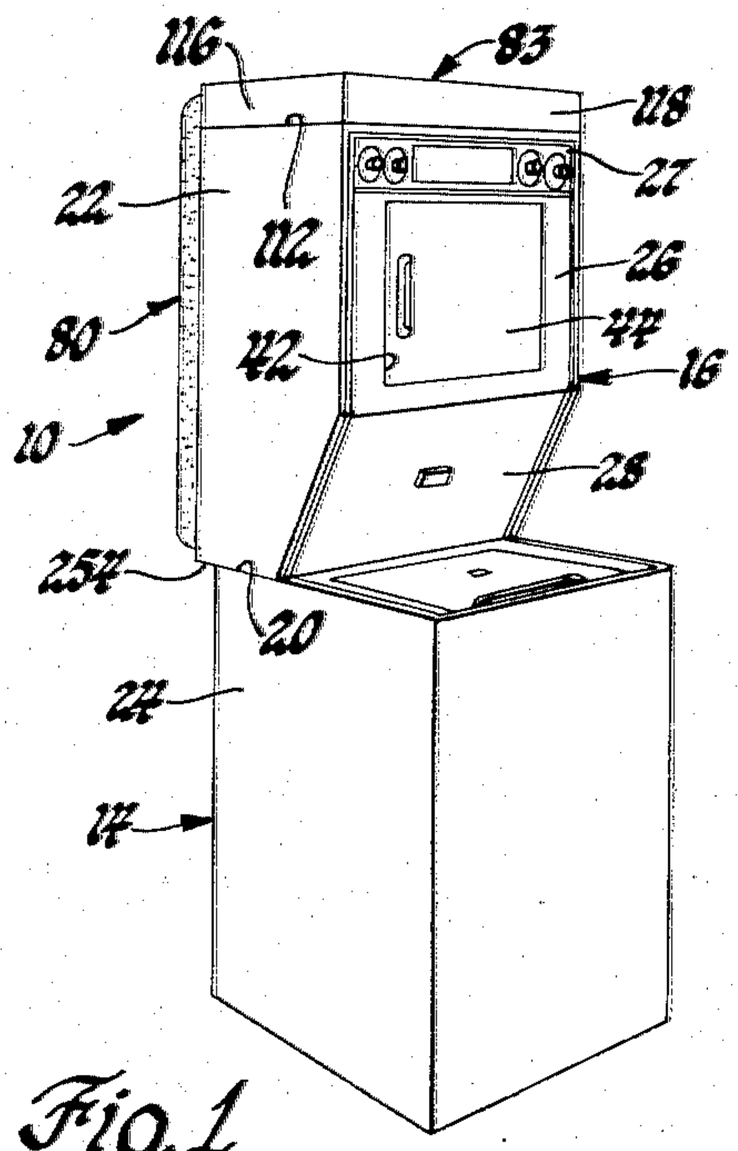


Fig. 1

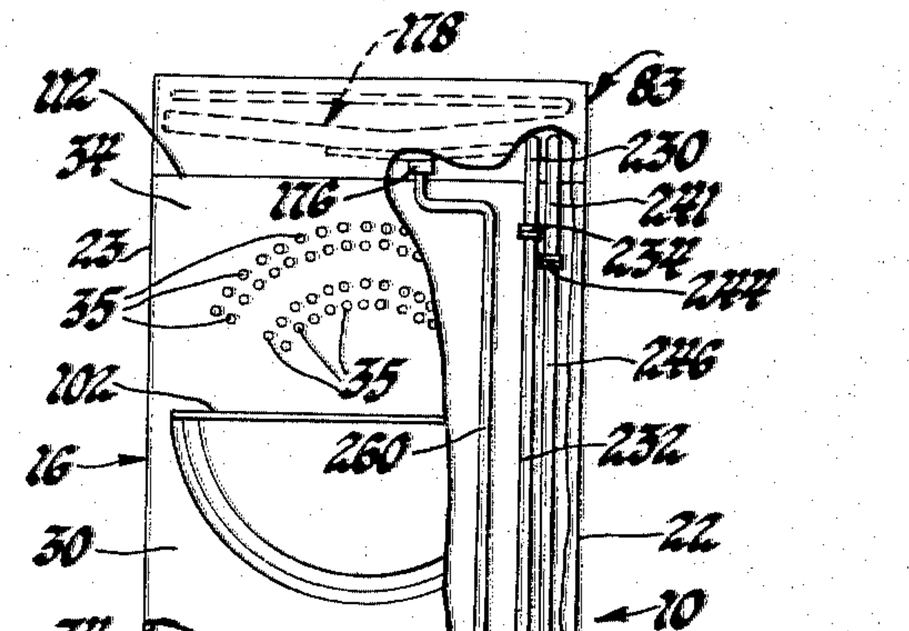


Fig. 2

Fig. 3

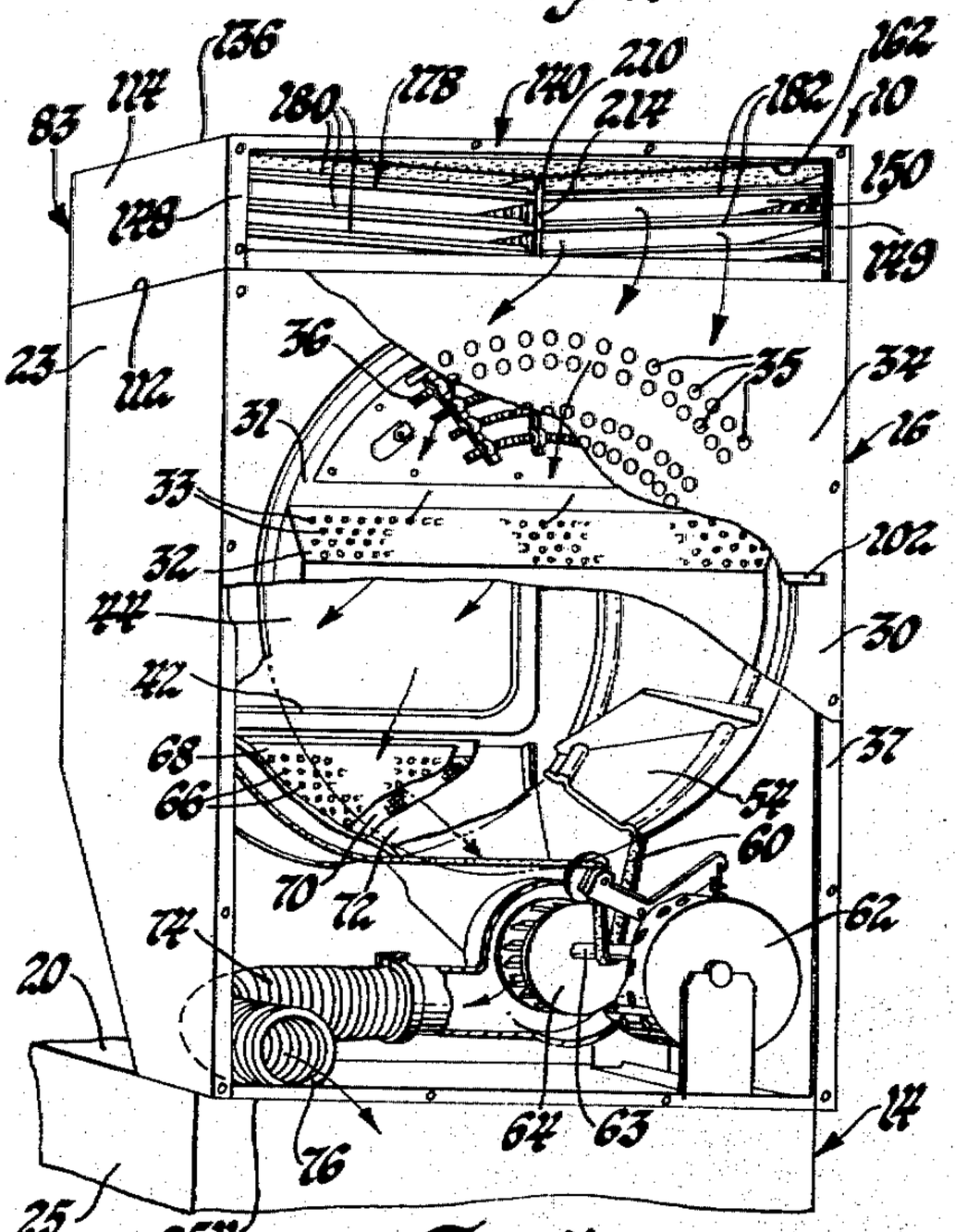


Fig. 4

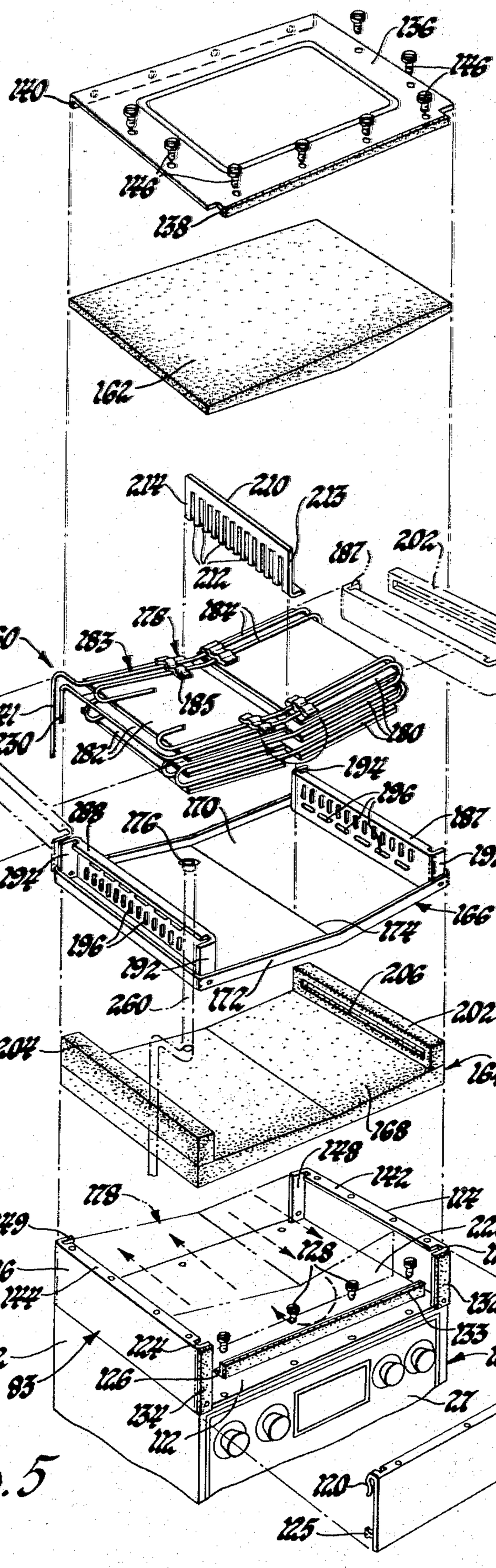


Fig. 5

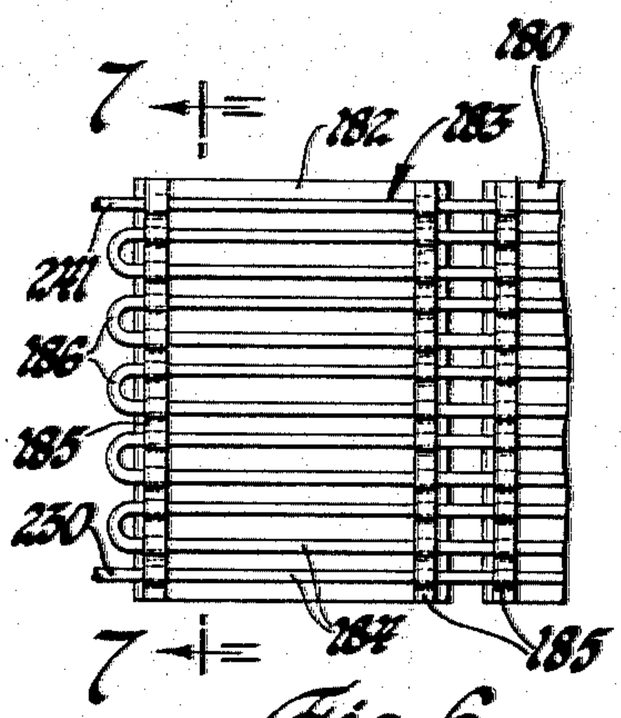


Fig. 6

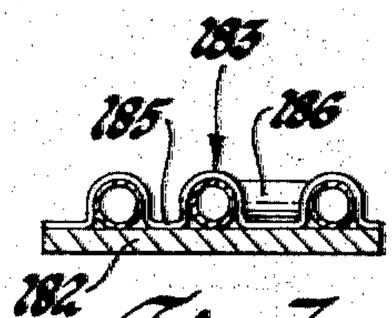


Fig. 7

WATER COOLED CONDENSER DRYER FOR LAUNDRY CENTER

This invention relates to a vertically stacked combination clothes washer and clothes dryer, and more particularly, to a recirculating water cooled condenser for the combination washer and nonvented dryer for removing moisture from the drying air without increasing the drying time interval.

As discussed in U.S. Pat. No. 3,545,235 issued Dec. 8, 1970 to M.A. Menk, and assigned to the same assignee as the instant application, the vertically stacked combination clothes washer and vented clothes dryer incorporates a mounting arrangement for a laundry center wherein the clothes dryer is stacked on top of the clothes washer so as to provide an appliance that has a minimal overall vertical height such that the superimposed dryer is convenient for loading and operating and also for locating the appliance in low ceiling environments such as alcoves or closets.

It is an object of this invention to provide a vertically stacked combination clothes washer and nonvented clothes dryer incorporating a recirculating air condensing arrangement of the water cooled type for removing moisture from the drying air without materially increasing the overall size of the unit while minimizing the volume of condensing water required.

Another object of this invention is a provision of a combination of a washer-dryer appliance such that the dryer is in a stacked-on cabinet with the dryer top wall having a low profile water-cooled condenser formed of a plurality of super-imposed vertically spaced plates in a plenum chamber, each having a chevron or shallow V-shaped configuration in cross section cooled by a single cooling water passageway in the form of a serpentine coil associated with the plates. A longitudinal center partition or air baffle, aligned with the crests of the plate V's divides the spaces therebetween into a network of side-by-side inlet and outler parallel air passageways which communicate via a duct housing on the back wall of the dryer for recirculation of drying air therebetween. The condenser plates are sloped to the center drain trough allowing the water of condensation to pass downwardly on either side of the baffle to a subjacent drain pan having a complementary shallow V-shaped cross section for passage via the cooling water drain tube to the drain facilities of the washer below.

In the Drawings:

FIG. **1** is a perspective view of the combination washer-dryer incorporating the water-cooled condenser of the present invention;

FIG. **2** is a rear view, partly in elevation and partly in section, with parts cut away to show the water circulating system of the condenser;

FIG. **3** is a perspective view of the duct housing for mounting on the rear wall of the dryer;

FIG. **4** is a perspective view of the dryer portion of the appliance with parts cut away to show the air recirculating system between the condenser and the dryer;

FIG. **5** is an exploded perspective view of the water cooled condenser components;

FIG. **6** is an enlarged fragmentary plane view of the condenser in flat assembly;

FIG. **7** is a section of the condenser taken on line **7—7** of FIG. **6.**

In accordance with this invention and with reference to FIGS. **1, 2, 3** and **4,** a vertically stacked combination washer-dryer or domestic laundry center **10** is illustrated. The appliance is comprised of a clothes washer or article washing machine **14** and a clothes dryer or article drying machine **16** located directly above the washing machine **14.** Details of the clothes washer **14** form no part of the instant invention. For a description of one type of washing machine suitable for use with the dryer, reference may be had to the above-referenced U.S. Pat. No. 3,545,235, the disclosure of which is incorporated by reference herein.

The clothes dryer **16,** located immediately above the clothes washer **14,** has its cabinet portion mounted on the top wall **20** of the washing machine cabinet. The dryer cabinet includes vertical side walls **22** and **23** located in the same vertical plane as the side walls **24** and **25,** respectively, of the washing machine cabinet. The dryer cabinet also has a front wall formed of a substantially vertical upper portion **26** including a control panel **27** and a slanted or non-vertical lower portion **28.** The dryer cabinet portion also has a rear panel **30** (FIG. **4**) having an indented portion **31** and an inwardly canted portion **32** with perforations **33** therethrough. Mounted on the rear panel **30** behind the indented portion **31** is a heater support panel **34** carrying a plurality of electric heaters **36** located within a heater cavity formed by the heater panel **34** and the indented portion **31** of the rear panel **30.** The panel **34** is also provided with four rows of openings **35** near its upper edge and behind the heater so that air may be drawn across the heaters and heated before entering the drum or clothes treatment enclosure as disclosed in U.S. Pat. No. 3,584,393, the disclosure of which is incorporated by reference herein. The rear panel **30** with the indented portion **31** and the heater panel **34** are assembled together as a unit and mounted on rear flanges **37** of the side walls of the dryer cabinet.

Mounted behind the vertical portion of the front wall **26** of the dryer cabinet includes a dryer access opening **42,** while a dryer door **44** is pivotally mounted on a vertical axis to form a closure for the dryer access opening **42.** Located within the dryer cabinet is a rotating drum **54** which is cylindrical and perforate, the details of which are disclosed in the U.S. Pat. No. 3,545,235.

A belt **60** encircles the drum **54** and is driven by a prime mover including a motor **62** and a power shaft **63.** The power shaft **63** directly drives a blower **54** and the belt **60.** As the blower **54** is driven, air is impelled through an air flow duct system, indicated by the solid line arrows in FIG. **4,** as follows. Air is drawn through the opening **35** in the heater panel **34,** downwardly past the heaters **36,** where it is heated, then through the perforations **33** of the indented portion **32** and diagonally through the dryer drum enclosure **54.** The air is drawn through the perforations **66,** located in the lower part of the stationary front portion **68,** and passes through the lint filter **70** positioned behind these last-named perforations **66,** and the passageway **72** to the blower **64** and is then exhausted from the dryer cabinet by way of a flexible conduit **74** which is adapted for connection by means of a collar **76** (FIG. **2**) to a rear exhaust opening in the rear panel **30.**

A back ducting panel, shown generally at **80** in FIG. **3,** is preferably formed in a one-piece integral molded manner from suitable plastic material such as A.B.S. plastic, provides a rectangular pan-shaped duct panel

member having a surrounding turned-out flat flange **81** covered with a felt strip **82** for air-tight sealed abutment to the outer periphery of the rear panel **30,** heater panel **34** and the open end of the top mounted condenser plenum housing **83** (FIG. **4**) by suitable threaded fasteners positioned in holes **84.** The ducting panel **80** provides an upwardly diverging vertically elongated spent drying air expansion duct **86** and a generally box-shaped condensed air venting cavity **88** separated by a vertical partition **89** having a diverging wall portion **90** and a vertical wall portion **91.** The expansion duct **86** includes a lower cover panel **92** having an upper cover panel **94** inwardly off-set by notched portion **96.** The lower border of upper cover panel **94** includes lower seal means in the form of a flat felt strip **98** which is flush with felt seal portion **99** located on the edge of recessed transverse partition **100.** The felt seals **98** and **99** are adapted to abutt in a sealed manner with the turned edge of outwardly directed transverse flange **102** formed along the bottom edge of the heater support panel **34.** The off-set wall **94** is defined at its upper extremity by transverse upper seal means formed by sealing strip **103** defining the lower edge of a rectangular spent air duct outlet **104.** The lower end of casing **86** has an opening **105** fitted with a collar **106** which mates in a sealed manner with collar **76** in rear panel **34.** It will be noted that in the preferred form the depth of duct housing **80** is about 2.0 inches so as not to add materially to the overall depth of the dryer cabinet.

The venting cavity **88** and the duct outlet **104** are separated by partition **91** having a flanged felt seal strip **110** coplanar with panel duct flat flange **82** for sealed contact with the baffle to be described.

The low profile condenser housing **83** shown in FIG. **5** is located on and coextensive with the dryer cabinet top wall **112** and enclosed on three sides by means of rectangular flanged side panels **114** and **116** and a removal clip-on front panel **118.** The front panel **118** has an upper integral reverse bent clip flange **120** operative to be received in notched portions **122** and **124** of side panels **114** and **116,** respectively, together with lower push-in clips **125.** An L-shaped angle member **126** is suitably secured to the top wall **112** as by threaded fasteners **128** while the outward faces of the angle **126** and front flanges of the side panels **114, 116** and L-shaped angle **126** are provided with sealing material **132, 133** and **134** such as felt strips, for example. A top condenser chamber cover plate **136,** having downwardly extending front and rear flanges **138, 140** is affixed to the top flanges **142** and **144** of the side panels such as by threaded fasteners **146.** Rear flanges **148** and **149** are provided on the side panels **114, 116** respectively, for abuttingly receiving in a sealed manner with coplanar flange **140** the upper portion of housing peripheral flange **82** to complete a condenser planeum cavity **150** coextensive with the top wall **112** of the dryer and having a low profile vertical height of about 5.50 inches so as not to add materially to the overall height of the washer-dryer cabinet.

A plate-type condenser assembly, generally indicated at **160** in FIG. **5,** fabricated for vertical spaced location in the plenum cavity **150** by support means in the form of upper and lower polystyrene expanded or cast foam insulation pieces **162** and **164.** The lower cast insulation piece **164** is provided between the top wall **112** of the dryer cabinet and condensate drain pan **166** and has a shallow V-shaped upper surface **168** for receiving the conforming shallow V-shaped bottom wall **170** of the pan **166.** The drain pan has a peripheral upstanding flange **172** for retaining condensate water for flow to its center longitudinal fold-line or apex **174** while a drain receptacle **176** is located adjacent the aft portion of the drain pan **166** adjacent to the apex **174** for receiving the condensate water. In the disclosed form of the invention condenser means in the form of assembly **178** comprising two side-by-side tiers of paired plates **180** and **182** arranged in stacked symmetrical fashion with each pair of plates having a shallow V-shape cross-section supported in vertically spaced conforming relation to the adjacent pair of plates.

As seen in FIG. **5,** cooling water flow passage means contacting the paired tiers of plates are shown in the form of a single coil **183** consisting of a continuous tube or pipe having a plurality of parallel, generally straight portions **184** interconnected by return bend portions **186** to provide series flow of cooling water through the water supply tubing. The cooling coil **183** is secured to the plates **180, 182** preferably formed of aluminum sheet material, in any suitable manner, such as by welded straps shown at **185** to provide a good heat conductive bond between the plates and the tube. The plates **180, 182** and coil **183** are folded upon themselves in S-shaped fashion to provide the paired tiers shown.

Identical condenser support means, in the form of coil support header cap plates **187** and **188,** are secured by their end flanges **192** and **194** adjacent either side flanges **172** of the drain pan **170** and are provided with suitable slotted openings **196** for receiving the return bend portions **186** of the coil **183** therethrough. Although in the disclosed form of the invention the coil **183** and rectangular plates are shown as being separately fabricated members, it is understood that the condenser plate could be made in the form of roll bonded sheets in integral form by means in which a continuous plate with expanded passageways could be fabricated and return folded in a similar S-shape manner.

In the preferred form of the invention each pair of shallow V-shaped condenser plates **180** and **182** are sloped inwardly at a drain angle of about 1 inch in 10.5 inches while the vertical spacing between banks of plates is about one inch and the spacing between the topmost and bottommost pair of plates and the insulation pieces **162** and **164,** respectively, is about three-eighth inch to provide four tiered parallel air flow passages. The dimension of each of the paired rectangular plates **180** and **182** is of the order of 9.5 inches by 12.00 inches. A pair of side insulation pieces **202** and **204** are shown in FIG. **5** having an inwardly facing groove **206** for encasing the return bend portion **186** of the cooling coils **183.**

In order to divide the sandwich or tiered plate condenser into side-by-side air entrance and air return passes a longitudinally extending divider baffle, indicated **210** in FIG. **5,** is provided which in the disclosed form is provided with a plurality of vertically extending equally spaced slots **212,** thus allowing the baffle **210** to be positioned between the pair of tiered plates **180** and **182** with the coil straight pipe sections **184** being received in the slots **212.** As viewed in FIG. **4,** the rear facing edge **214** of the baffle **210** is located flush with the outer faces of the condenser housing flanges **140, 148** and **149** such that the sealing strip **110** of duct

housing **80** abutts the baffle edge **214** in an air sealing manner upon mounting of the ducting panel **80.** In this way spent moist drying air exits ducting panel outlet **104** and is drawn into the condenser plenum chamber **150** for movement through the tiered parallel laminar flow passages defined between the right hand tier of plates **180** (as viewed in FIG. **5**).

The spent air passes into the forward plenum chamber crossover duct **220** defined by the forward edge **213** of the baffle plate **210** and the front removable panel **118,** which in the form shown is about 7.3 inches, such that the drying air is redirected through an angle of 180°, indicated by the dashed arrows in FIG. **5.** Thus, the spent drying air is drawn by blower **64** through separate laminar flow parallel passages between the condenser plates **180** where it is allowed to mix in crossover duct **220** before entering the flow passages between plates **182.** The decrease in velocity and increase in turbulence of the air in plenum chamber duct **220** allows the settling out of lint into the crossover duct **220** which lint can be periodically collected by the housewife by removal of the front panel **118.**

As best seen in FIGS. **2** and **6** the condenser plate coolant inlet tubing **230** mates with a cold water inlet tube **232** via connection **234.** The lower end of tube **232** is connected to a solenoid controlled valve **236** which valve is in turn connected to one branch **238** of a Y connection **240** having its stem portion connected to the cold water inlet tube **242,** adjacent hot water inlet tube **243,** for the washing machine **14** of the combined appliance. The coolant water exits the plate condenser coil **183** by outlet pipe **241,** connected by flare connector **244** to coolant drain pipe **246** which is in turn connected to one branch **248** of a second Y connector **250** which has its stem portion connected to a flexible condensate drain tube **252.** The flexible drain tube **252** exits from the rear overhang **254** of the dryer cabinet and is attached by suitable means such as straps **256** to the washer drain tube **258** for discharge to any convenient drainage or sewage system. As seen in FIG. **2** the condensate water drain receptacle **176** is connected to a condensate drain pipe **260** which is connected to the other branch **262** of a second Y connection **250** for drainage into tube **252.**

While the embodiment of the present invention herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

I claim:

1. In combination a stack-on laundry appliance comprising a lower washer cabinet including a top wall, said washer cabinet adapted to be associated with a source of water supply and a drain, an article drying cabinet mounted directly on the top wall of said washer cabinet, said article drying cabinet comprising a box-like structure enclosing a rotatable tumbling drum including a front panel having a front access opening and a rear wall having a portion thereof provided with air inlet means, an exhaust air outlet opening in the rear wall, means for recirculating heated air through said tumbling drum including a drying air blower having an inlet and an outlet, means connecting said blower inlet to the interior of said tumbling drum, means connecting said blower outlet to said exhaust air outlet, an apertured heater support plate mounted on said dryer rear wall rearwardly thereof and cooperating with the heater cavity portion of said rear wall to form a heater cavity, heater means supported adjacent said rear wall air inlet means whereby condensed air may be heated prior to being drawn into said drum through said inlet means wherein the improvement comprises, a condenser plenum housing located coextensive with the top wall of said dryer cabinet having an open rear end wall, two side-by-side tiers of water cooled vertically spaced condenser plates in said condenser housing, each pair of opposed plates symmetrically positioned in shallow V-shaped configuration in cross-section, means for recirculating cooling water from said washing machine source of water supply in heat exchange relation with said condenser plates for return to said washer drain, a vertical positioned longitudinally extending divider baffle located between said tiered plates dividing said open rear end wall of said condenser housing into a spent air-intake side and a condensed air-discharge side, said tiered condenser plates providing a plurality of laminar flow parallel air flow passages therebetween, said plates spaced a defined distance from said condenser plenum housing front end wall providing a cross-over mixing air flow space at the closed portion thereof, duct means on the rear wall of said dryer cabinet, said duct means providing a first duct section conducting the dryer spent air from the blower outlet to the air-intake side of said condenser plenum, said duct means providing a second duct section conducting the condensed air from the air-discharge side of said condenser plenum housing to said rear wall inlet means so as to be drawn therethrough for reheating and return to said drum.

2. In combination a stack-on laundry appliance comprising a lower washer cabinet including a top wall, said washer cabinet adapted to be associated with a source of water supply and a drain, an article drying cabinet mounted directly on the top wall of said washer cabinet, said article drying cabinet comprising a box-like structure enclosing a rotatable tumbling drum including a front panel having a front access opening and a rear wall having a portion thereof perforated and offset inwardly to form a heater cavity portion, an exhaust air outlet opening in the rear wall adjacent the dryer bottom wall, means for recirculating heated air through said tumbling drum including a drying air blower having an inlet and an outlet, means connecting said blower inlet to the interior of said tumbling drum, means connecting said blower outlet to said exhaust air outlet, an apertured heater support plate mounted on said dryer rear wall rearwardly thereof and cooperating with the heater cavity portion of said rear wall to form a heater cavity, heater means supported by said heater support panel within said heater cavity whereby air may be drawn into said drum through said apertures past said heater means wherein the improvement comprises, a condenser plenum housing located coextensive with the top wall of said dryer cabinet having an open rear end wall, two side-by-side tiers of water cooled vertically spaced condenser plates in said condenser housing, each pair of opposed plates symmetrically positioned in shallow V-shaped configuration in cross-section, a single-pass water conducting passageway comprising a tubing bent in the form of a serpentine coil provided with a plurality of looped ends extending between said plates and a plurality of straight portions contacting said plates, means for circulating cooling water from said washing machine source of water supply through said tubing for return to said washer drain, a vertical positioned longitudinally ex-

tending divider baffle located between said tiered plates dividing said open rear end wall of said condenser housing into a spent air-intake side and a condensed air-discharge side, a condensate drain pan folded about a longitudinal fold line providing a shallow V-shaped bottom wall in cross section conforming with said plates and positioned subjacent thereto, a drain receptacle located substantially at the apex of said fold line for receiving condensate water from said plates, said plates spaced a defined distance from said condenser plenum housing front end wall providing a cross-over turbulent air flow space at the closed portion thereof, and a pan-shaped back panel duct housing coextensive with the backwall of said dryer cabinet providing side-by-side inlet and outlet openings separated by a vertical partition, said vertical partition having its outer edge in sealed abutment with the rear edge of said baffle plate whereby said duct inlet and outlet openings are in communication, respectively with said spent air-intake and said condensed air-discharge of said plenum housing, said duct housing having a first vertically oriented duct section enclosed by a closure panel conducting the dryer spent air from the blower outlet to the air-intake side of said condenser plenum, said closure panel having a portion thereof overlying said heater panel apertures rearwardly off-set from the plane of said vertical partition rear sealing edge, said back panel duct housing providing a second open duct conducting the condensed air from the air-discharge side of said condenser plenum housing for drawing through the perforated heater plate for reheating and return to said drum.

3. In combination a stack-on laundry appliance comprising a lower washer cabinet including a top wall, said washer cabinet adapted to be associated with a source of water supply and a drain, an article drying cabinet mounted directly on the top wall of said washer cabinet, said article drying cabinet comprising a box-like structure enclosing a rotatable tumbling drum including a front panel having a front access opening and a rear wall having a portion thereof perforated and offset inwardly to form a heater cavity portion, an exhaust air outlet opening in the rear wall, means for recirculating heated air through said tumbling drum including a drying air blower having an inlet and an outlet, means connecting said blower inlet to the interior of said tumbling drum, means connecting said blower outlet to said exhaust air outlet, an apertured heater support panel mounted on said dryer rear wall rearwardly thereof and cooperating with the heater cavity portion of said rear wall to form a heater cavity, heater means supported by said heater support panel within said heater cavity whereby air may be drawn into said drum through said apertures past said heater means wherein the improvement comprises, a condenser plenum housing located coextensive with the top wall of said dryer cabinet having an open rear end wall, two side-by-side tiers of water cooled vertically spaced condenser plates in said condenser housing, each pair of opposed plates symmetrically positioned in shallow V-shaped configuration in cross-section, serpentine cooling water flow passage means contacting said plates, a vertical positioned longitudinally extending divider baffle located between said tiered plates dividing said open rear end wall of said condenser housing into side-by-side spent air-intake and condensed air-discharge openings, said condenser plates spaced a defined distance from said condenser plenum housing front end wall providing a cross-over air flow space at the closed front end portion of said plenum, and a pan-shaped ducting panel having a surrounding flat flange sealed to the periphery of said dryer cabinet rear wall, said ducting panel having a substantially vertical partition dividing said duct panel into an open cavity portion and a closed duct portion enclosed by a closure panel, said duct portion having an upper air outlet in coextensive sealed relation with said plenum spent air-intake and a lower spent air-inlet in communication with said blower outlet, said closed duct portion having an upper cover portion in spaced overlying relation with a portion of said heater panel apertures whereby said cavity portion is in communication with said heater panel apertures such that condensed air from said plenum housing air-discharge is drawn through said heater panel apertures for reheating and return to said drum.

4. In a clothes dryer having an article drying cabinet, said article drying cabinet comprising a box-like structure enclosing a rotatable tumbling drum including a front panel having a front access opening and a rear wall having a portion thereof perforated and offset inwardly to form a heater cavity portion, an exhaust air outlet opening in the rear wall, means for recirculating heated air through said tumbling drum including a drying air blower having an inlet and an outlet, means connecting said blower inlet to the interior of said tumbling drum, means connecting said blower outlet to said exhaust air outlet, an apertured heater support panel mounted on said dryer rear wall rearwardly thereof and cooperating with the heater cavity portion of said rear wall to form a heater cavity, heater means supported by said heater support panel within said heater cavity whereby air may be drawn into said drum through said apertures past said heater means wherein the improvement comprises, a condenser plenum housing located coextensive with the top wall of said dryer cabinet having an open rear end wall, two side-by-side tiers of water cooled vertically spaced condenser plates in said condenser housing, each pair of opposed plates symmetrically positioned in shallow V-shaped configuration in cross-section, serpentine cooling water flow passage means contacting said plates, a vertical positioned longitudinally extending divider baffle located between said tiered plates dividing said open rear end wall of said condenser housing into side-by-side spent air-intake and condensed air-discharge openings, said condenser plates spaced a defined distance from said condenser plenum housing front end wall providing a cross-over mixing air flow space at the closed front end portion of said plenum, and a pan-shaped ducting panel having a surrounding flat flange sealed to the periphery of said dryer cabinet rear wall, said ducting panel having a substantially vertical partition dividing said duct panel into an open cavity portion and a closed duct portion enclosed by a closure panel, said duct portion having an upper air outlet in coextensive sealed relation with said plenum spent air-intake and a lower spent air-inlet in communication with said blower outlet, said closed duct portion having an upper cover portion in spaced overlying relation with a portion of said heater panel apertures whereby said cavity portion is in communication with said heater panel apertures such that condensed air from said plenum housing air-discharge is drawn through said heater panel apertures for reheating and return to said drum.

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