March 29, 1966 J. W. JACOBS 3,242,584

DOMESTIC CLOTHES DRYING APPLIANCE

Filed April 29, 1963 2 Sheets-Sheet 1

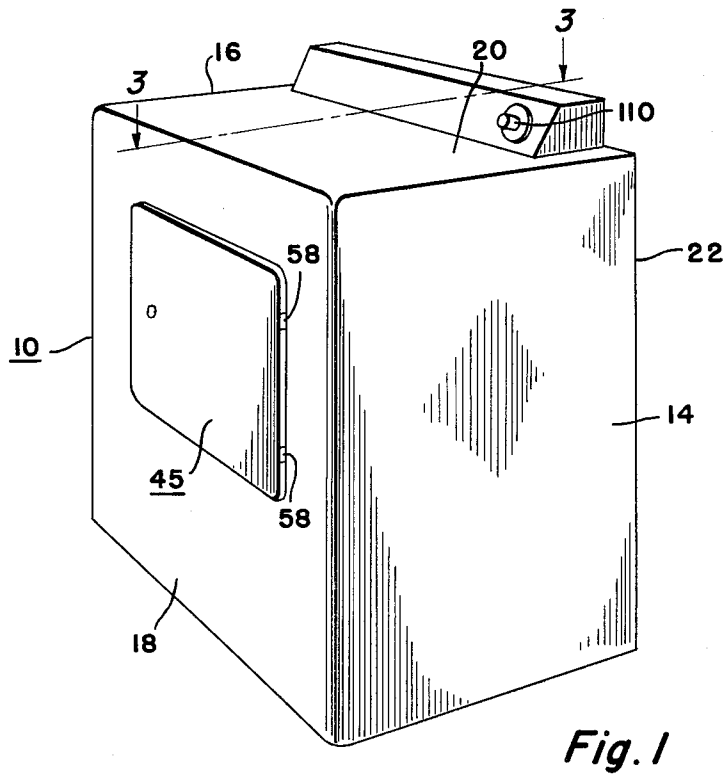

Fig. 1

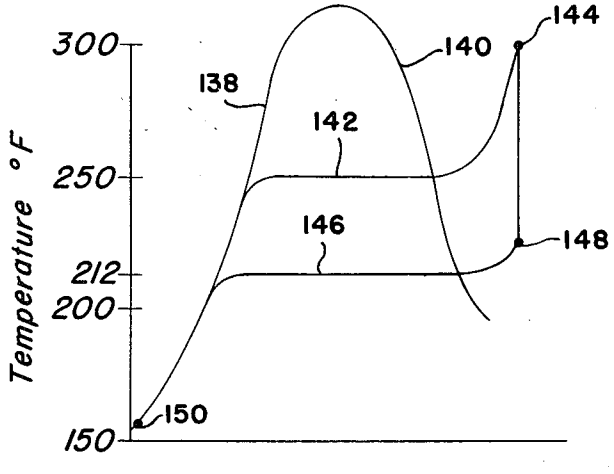

Fig. 2

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DOMESTIC CLOTHES DRYING APPLIANCE

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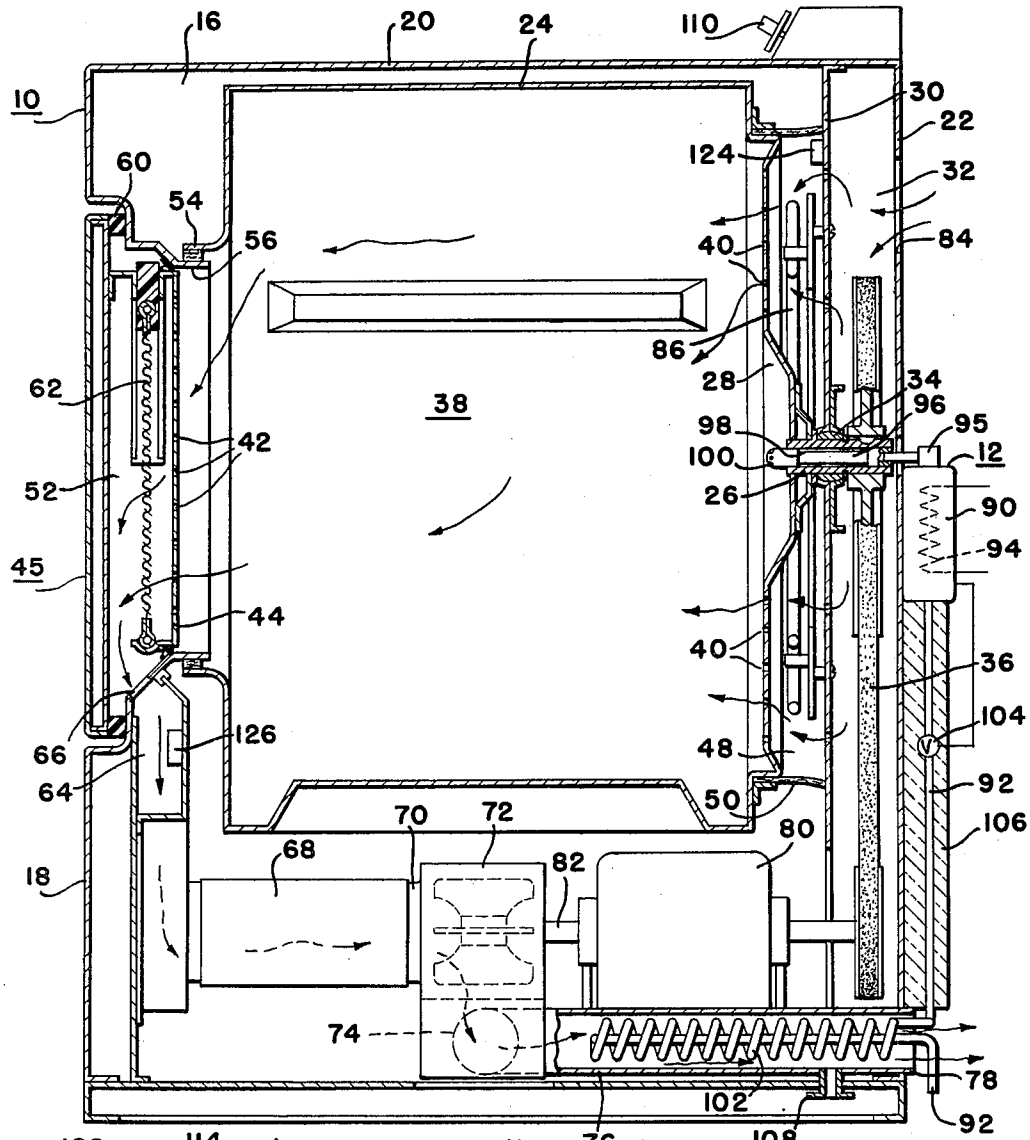

Fig. 3

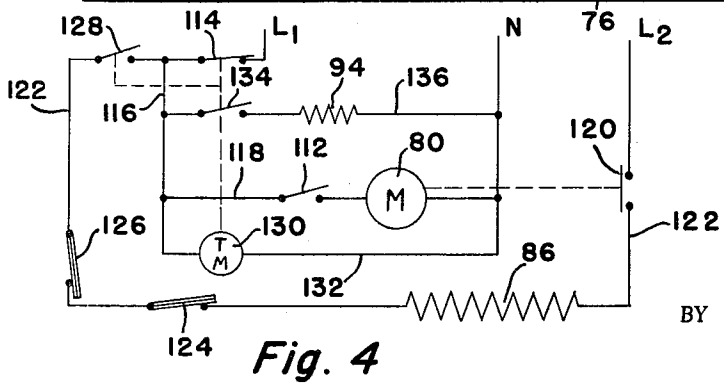

Fig. 4

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3,242,584

DOMESTIC CLOTHES DRYING APPLIANCE

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7 Claims. (Cl. 34—37)

This invention relates to a domestic appliance and more particularly to a domestic clothes dryer.

In many conventional clothes dryer arrangements heated air is circulated through wet fabric tumbled by a rotatable drum or fabric enclosure for removing moisture therefrom. In such arrangements the time necessary to dry fabric is generally dependent upon the amount of heat supplied to the air being circulated through the tumbling fabric. Where the source of heat for heating the air is generated from a residential source of power, such as electricity, the amount of heat available for fabric drying is limited by the capacity of the power supply. In many areas the source of power limits the heat output to unduly lengthen the period of time required to dry the fabric present in the tumbling drum.

An object of the present invention, therefore, is to provide an improved method for drying fabric including the use of a source of vaporized drying fluid as the primary means for drying clothes in a tumbling drum type clothes dryer in order to reduce the time required to dry the fabric therein.

A further object of the present invention is to provide an improved method for drying fabric including conditioning a fluid stream passing therethrough by adding a superheated drying fluid as the primary drying agent and adding heated air from a suitable source as a secondary drying agent.

A further object of the invention is to improve a domestic dryer having a rotatable drum for tumbling clothes by the provision of means for evenly distributing a vaporized drying fluid through the clothes tumbled by the drum for vaporizing the water contained therein; and to provide such a dryer having means for condensing such vaporized water and removing it from the dryer.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a view in perspective of a clothes dryer including the present invention;

FIGURE 2 is a temperature-entropy chart showing various phases of the operation of the invention;

FIGURE 3 is a sectional view taken substantially along the line 3—3 of FIGURE 1; and

FIGURE 4 is a schematic wiring diagram for controlling the operation of the invention.

Referring now to the drawings, in FIGURES 1 and 3 a clothes dryer is shown generally at **10** including a superheated source of drying fluid generally designated at **12**. The dryer **10** includes side walls **14**, **16**, a front wall **18**, a top **20** and a rear wall **22**. A generally cylindrical tumbling drum **24** is rotatably supported within the chamber formed by the walls **14**, **16**, **18**, **22** and top **20** by means of a shaft **26** having one end thereof secured to a perforated rear wall **28** of the drum **24** and having the opposite end thereof directed through a perforated bulkhead **30** spaced forwardly of the rear wall **22** to form a rear machinery compartment, or space, **32**. A universal bearing arrangement **34** supported by the bulkhead **30** rotatably supports the shaft **26** and the drum **24**. The machinery compartment **32** separates a pulley

system **36** from the drying chamber or interior **38** of the tumbling drum **24**.

The drum **24** includes inlet ports or apertures **40** in the rear wall thereof and outflow ports or apertures **42** in the inside wall **44** of a door arrangement **45**. The inlet ports **40** communicate with an annular plenum or inlet chamber **48** defined by the perforated rear wall **28**, the perforated bulkhead **30** and an annular seal **50** of felt or other suitable material carried by the rear wall **28** of the drum in sliding sealing engagement with the interior surface of the bulkhead **30**. The outlet ports or apertures **42** communicate with a duct **52** formed in the door **45** adjacent the outlet ports **42** in the inside wall **44** thereof. The drum **24** has an outwardly directed flange portion **54** overlying an inwardly directed flange portion **56** on the front wall **18** for providing an access opening interiorly of the drum **24** through which clothes can be inserted therein to the tumbling drum interior **38**. The door **45** is axially aligned with the opening formed by the flange **54** and is supported by a hinge **58** on the front wall **18** to open and close the access opening into the tumbling drum **24**. The door **45** has an annular seal **60** thereon for sealing an opening in the front wall **18** when closed and further serves as a support for a filter unit **62** located between outlet ports **42** and duct **52** for collecting lint.

A duct **64** disposed below the door **45** communicates with the door duct **52** through an opening **66** in the bottom of the door and is also located in fluid flow relationship with a passageway or conduit **68** leading to the inlet **70** of a blower **72** having the outlet opening **74** thereof connected to a discharge duct **76** for communicating the blower **72** through an opening **78** in the rear wall **22** of the dryer.

A single motor or prime mover **80** drives the blower **72** through a shaft **82** while simultaneously rotating the tumbling drum **24** through the pulley system **36**. By virture of the above-described ducts and passageways, air is drawn from an opening **84** in rear wall **22** across an air heater **86** supported by bulkhead **30** within chamber **48** for warming the air before it enters the drum interior **38** through the inlet ports **40** in the rear wall of the drum. Air then is drawn through the drum interior **38**, the outlet ports or apertures **42** across filter **62**, through the door duct **52** from whence it passes through the front duct **64**, conduit **68**, inlet **70** of the blower **72** and hence through the blower outlet **74**, duct **76** and opening **78** to atmosphere.

Referring now more particularly to the source of drying fluid **12**, a flash boiler **90** supported without the machinery compartment **32** has a fluid inlet conduit **92** directed thereto communicating with a suitable source of fluid such as a household water system for directing water into boiler **90** where a heater element **94** electrically connected to a source of power heats the water and converts it to steam which is pressurized by a control valve **95** and discharged through a tube **96** directed through rear wall **22**, rear bulkhead **30**, and rear wall **28** of the drum **24** through a central opening **98** directed axially through the drive shaft **26**. The tube **96** extends into the drying chamber or interior **38** at a point substantially centrally located therein and has a nozzle **100** connected to the outlet thereof for evenly distributing steam through clothes agitated by the drum **24**. The provision of a source of drying fluid such as that discussed above provides means for boiling off moisture carried by the clothes and, in accordance with certain principles of the present invention, serves as the primary heat source for drying the clothes in the dryer **10**.

In accordance with other features of the present invention the inlet line **92** has a portion **102** thereof coiled

in heat transfer relationship with the air discharge duct **76** whereby warm air passing therethrough will preheat the fluid passing into the boiler **90** under the control of a liquid level controlled inlet valve arrangement **104** in line **92**. A layer **106** of suitable heat insulation material surrounds the line **92** between portion **102** and the boiler **90** to prevent dissipation of the preheating effect of duct **76**. The coiled portion **102** also serves as a condenser surface for removing moisture from the fluid stream passing through duct **76** with the moisture so removed draining from the duct **76** through a fitting **108**.

The operation of the features of this invention will be best understood by referring to the entrophy diagram of FIGURE 2 and the schematic wiring diagram of FIGURE 4 wherein similar elements carry the same numerals used in conjunction with the dryer structure illustrated in FIGURES 1 and 3. A drying cycle is initiated by placing a load of wet clothes within the tumbling drum **24** through the access opening thereto and a timer dial **110** is then turned to close a switch **112**. The motor or prime mover **80** is thus energized by way of L1, a normally closed first timer switch **114** and conductors **116**, **118** to N. Once the motor is energized, it will drive the drum **24** to tumble the clothes therein and concurrently actuate a centrifugal switch **120** in a conductor **122** connected across L1, L2. The conductor **122** serially connects the air heater element **86**, a safety switch **124** disposed above heater **86** in the inlet chamber **48** and a cycling thermostat **126** disposed in the front duct **64**. The safety switch serves to eliminate dangerous high temperatures within the drying chamber **38** of the drum while the cycling thermostat **126** operates to cycle the heater **86** in maintaining a predetermined desired temperature within the tumbling drum **24**. As a further assurance against overheating, the centrifugal switch **120** actuated by energization of the motor **80** is opened whenever the motor is de-energized to prevent the heater **86** from dangerously increasing the temperature in the inlet chamber **48** in cases when air is not being circulated by the blower **72** therethrough. With the above-described components the heater **84** is energized from L1 through conductor **122**, a normally open second timer switch **128**, cycling thermostat **126**, safety switch **124**, centrifugal switch **120** to L2.

Concurrently with energization of the motor **80** a timer motor **130** is energized by way of L1, timer switch **114**, conductor **116** and a conductor **132** to line N to close the second timer switch **128** and a third timer switch **134** for concurrently energizing the air heater **86** and the boiler heater **94** a predetermined period of time after switch **112** is closed. More particularly, the boiler heater **94** is energized by way of L1, timer switch **114**, conductor **116**, and a conductor **136** to line N.

Initially, when the boiler **90** is cold the liquid level control inlet valve **104** in the inlet line **92** meters a predetermined charge of water into the boiler **90** to be converted to steam by the heater **94** during the drying cycle. Following energization of the air heater **86** and the boiler heater **94**, the operation of the improved drying system proceeds through an initial phase in which the steam generated by the boiler **90** is pressurized under the control of valve **95** to a predetermined temperature and pressure, for example, approximately 30 p.s.i.a. and 300° F. During this time the blower **72** circulates warm air through the drying chamber **38**.

Once the steam reaches the predetermined desired temperature and pressure the control valve **95** will open during a steam phase of operation to direct the steam through tube **96** and nozzle **100** into the drying chamber **38** to be evenly distributed through the clothes being tumbled therein. Referring now to FIGURE 2, one representative set of operating conditions is illustrated for improving the removal of moisture from such tumbling clothes. The diagram includes a liquid curve **138**, a saturation curve **140** and a first pressure curve **142** having a point **144** thereon corresponding to the condition of the steam leaving the nozzle **100** at a superheated state. The steam attains a superheated state since it is at 300° F. in the boiler and as it passes through the nozzle **100** it immediately expands to substantially atmospheric pressure where the 300° F. temperature of the steam constitutes a superheated state. This quickly raises the temperature of the moisture in the clothes tumbling therethrough so that the moisture will boil off and turn to steam. The superheated steam and the moisture driven from the clothes thereby is drawn from the drying chamber **38** by the blower **72** through the outlet ports **42** in the drum at which point the condition of the steam follows a pressure curve **146** having a point **148** thereon in the superheated range at substantially the same entropy as the steam that entered the drum but at a reduced pressure and temperature. The steam is then drawn through the interchanged defined by the coiled portion **102** of the water inlet line **92** and the discharge duct **76** at which time the steam is condensed to water at point **150** in FIGURE 2 and drained through fitting **108**. The superheated steam is continually generated by the boiler **90** for a predetermined period of time under the control of timer motor **130** until a substantial portion of the moisture has been driven from the clothes in the dryer chamber **38** with the time required to remove such moisture being substantially reduced by using superheated steam to vaporize the moisture from the clothes. Following this second, or steam, phase of the dryer operation, the timer motor **130** opens the timer switch **134** to de-energize the boiler heater **94** and thus terminate the passage of steam interiorly of the drum **24**. The blower **72** continues to circulate air across the energized heater **86** during a third or secondary phase of the drying operation during which time any remaining moisture is removed from the clothes by warm air passing therethrough. Once the clothes are completely dried by the hot air passing thereover during the third phase, the timer motor **130** will open the timer switch **128** and switch **112** to de-energize the air heater **86** and the motor **80** to thereby complete the drying cycle.

By virtue of the above-described arrangement, it has been found that the use of a drying fluid such as steam to supplement the drying effect of an electric heater or the like substantially reduces the time required to process a load of damp fabric and in accordance with certain of the principles of the present invention uses such a supplemental heat source in an improved method that basically comprises adding superheated drying fluid such as steam to a circulating air stream and also adding heat thereto; passing the air stream across damp fabric until a substantial portion of the water therein has been converted to steam and removed from the clothes and then terminating the addition of steam and continuing to pass a stream of hot air through the clothes for a predetermined period of time following the steam treatment to assure that the clothes will be essentially completely dry.

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

What is claimed is as follows:

1. In a domestic clothes drying device the combination of a rotatable drum for tumbling damp fabric, means for producing superheated steam, means for passing a predetermined amount of said superheated steam interiorly of said drum for vaporizing the liquid contained in the fabric tumbled by said drum, means for circulating air through said drum for extracting steam and vaporized liquid therefrom, and means for heating the air circulating through said drum for providing a final drying cycle supplementing that produced by said superheated steam.

2. In a domestic drying device the combination of a rotatable drum for tumbling damp fabric, a superheated steam generating device including a discharge tube directed interiorly of said rotatable drum and having the

outlet opening thereof located centrally of the interior of said drum for distributing superheated steam evenly through the tumbling fabric, means for maintaining a discharge of superheated steam interiorly of said drum for a predetermined period of time required to raise the temperature of the liquid contained in the fabric sufficiently to substantially convert it to a vaporized state, means for withdrawing the steam and the vaporized liquid from the interior of said drum, and means for passing air at a predetermined temperature through said drum for subjecting the fabric to a final drying cycle until essentially dry.

3. In a domestic clothes drying device the combination of a rotatable drum for tumbling damp fabric, motor means actuatable to drive said rotatable drum, a primary source of heat for drying the liquid containing tumbling fabric including superheated steam generating means having a discharge conduit located interiorly of said drum with the outlet thereof centrally disposed within the drum for evenly distributing superheated steam across the tumbling fabric for converting the liquid contained therein to a vapor state, a secondary source of heat operable concurrently with the first source of heat, means operatively associated with said motor means for circulating air in heat transfer contact with said secondary source of heat and through said tumbling fabric, means for maintaining the discharge of superheated steam from said primary heat source interiorly of said drum for a predetermined period of time required to convert the liquid in the tumbling fabric to a vapor state, said means for circulating air through said drum to continually remove steam and vaporized liquid therefrom for said predetermined period of time, said secondary heat source continuing to operate following termination of steam discharge into said drum until the tumbling fabric is essentially dry.

4. In a domestic clothes drying device the combination of a rotatable drum for tumbling damp fabric, means for generating superheated steam, means for passing a predetermined amount of said superheated steam interiorly of said drum for vaporizing the liquid contained in the fabric tumbled by said drum, means including a discharge conduit for circulating air through said drum for extracting steam and vaporized liquid therefrom, said superheated steam generating means including a liquid inlet line having a portion thereof located in heat transfer relationship with said discharge conduit for preheating liquid into said generating means and for condensing liquid from the vapor passing through said discharge conduit, and means for draining the liquid condensed in said discharge conduit therefrom.

5. A method for drying damp fabric by conditioning air passing therethrough comprising the steps of adding a predetermined quantity of superheated steam to said air at substantially atmospheric pressure, heating said air independently of said superheated steam, removing said superheated steam from said air, and continuing to heat the air stream passing through the fabric until it is essentially dry.

6. A method for drying liquid containing articles comprising the steps of tumbling liquid containing articles, generating superheated steam, contacting the tumbling articles with the steam at substantially atmospheric pressure for a predetermined period of time to vaporize the liquid in the tumbling articles, and circulating air through said tumbling articles to remove the steam and vaporized liquid therefrom.

7. A method for drying damp fabric comprising the steps of tumbling the damp fabric, generating a predetermined quantity of superheated steam, heating a stream of air, concurrently passing the steam and heated air through the fabric at substantially atmospheric pressure for vaporizing the liquid therein and removing it therefrom, terminating the generation of steam, and continuing to pass the heated air stream through the fabric until it is essentially dry.

References Cited by the Examiner

UNITED STATES PATENTS

2,019,011	10/1935	Johnson.	
2,189,915	2/1940	Mellor et al.	34—27 X
2,198,412	4/1940	McDonald.	
2,297,314	9/1942	Offen	34—37 X
2,376,612	5/1945	Muench et al.	34—37 X
2,397,091	3/1946	Davis.	
2,731,732	1/1956	Harris et al.	34—37 X

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