July 10, 1962 B. L. BRUCKEN 3,043,015

DOMESTIC APPLIANCE

Filed March 27, 1958 3 Sheets-Sheet 1

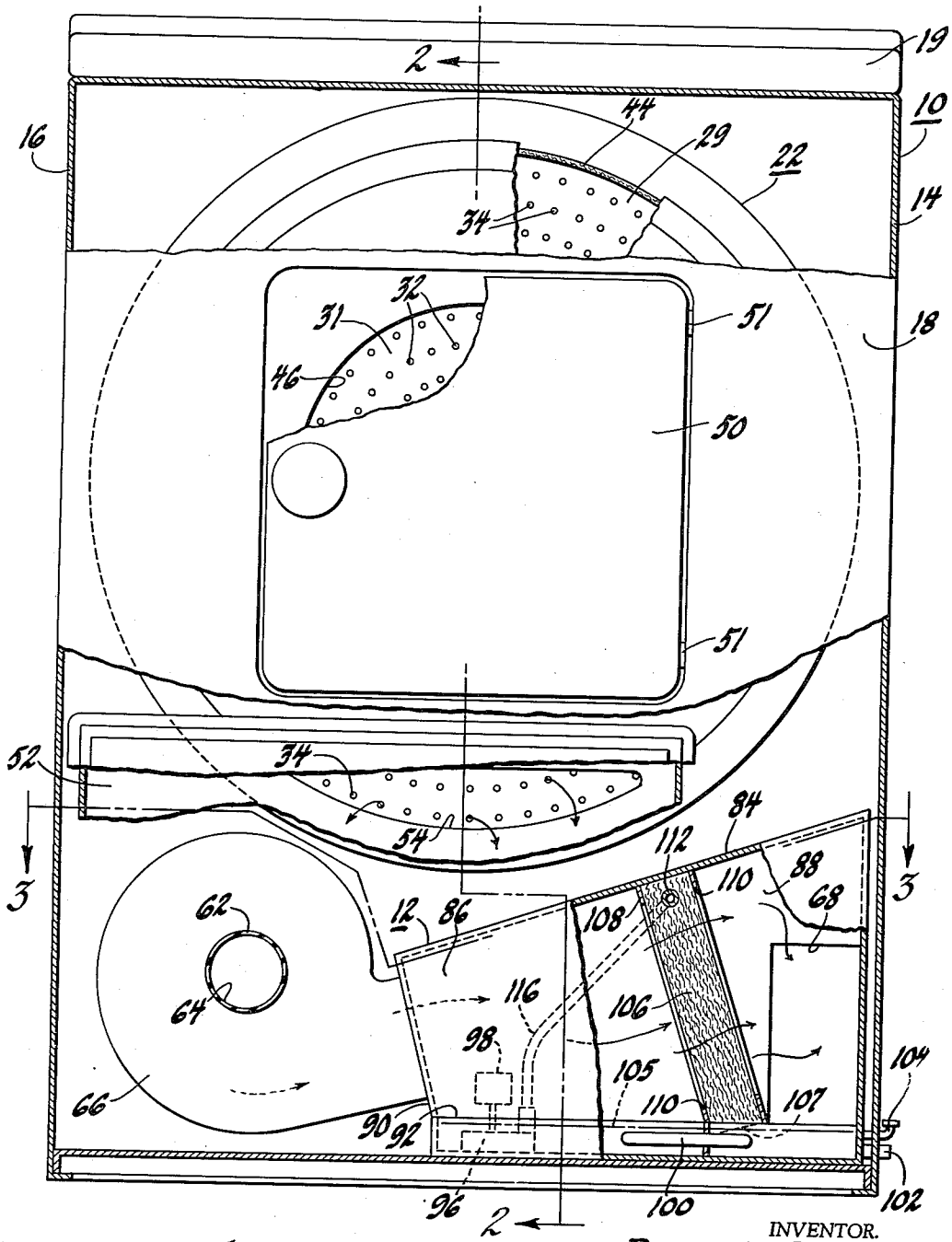

Fig. 1

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DOMESTIC APPLIANCE

Filed March 27, 1958 3 Sheets-Sheet 2

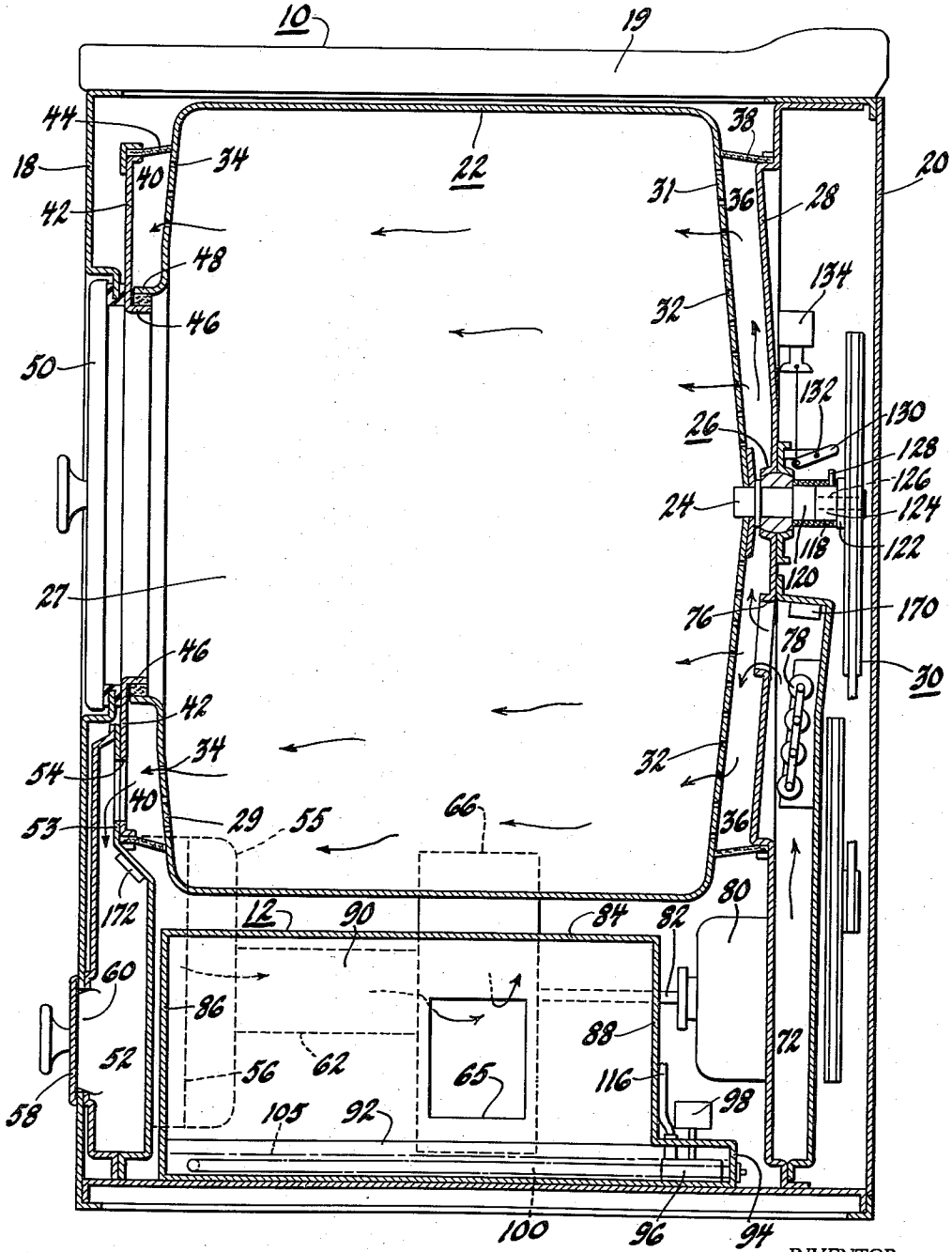

Fig. 2

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DOMESTIC APPLIANCE

Filed March 27, 1958 3 Sheets-Sheet 3

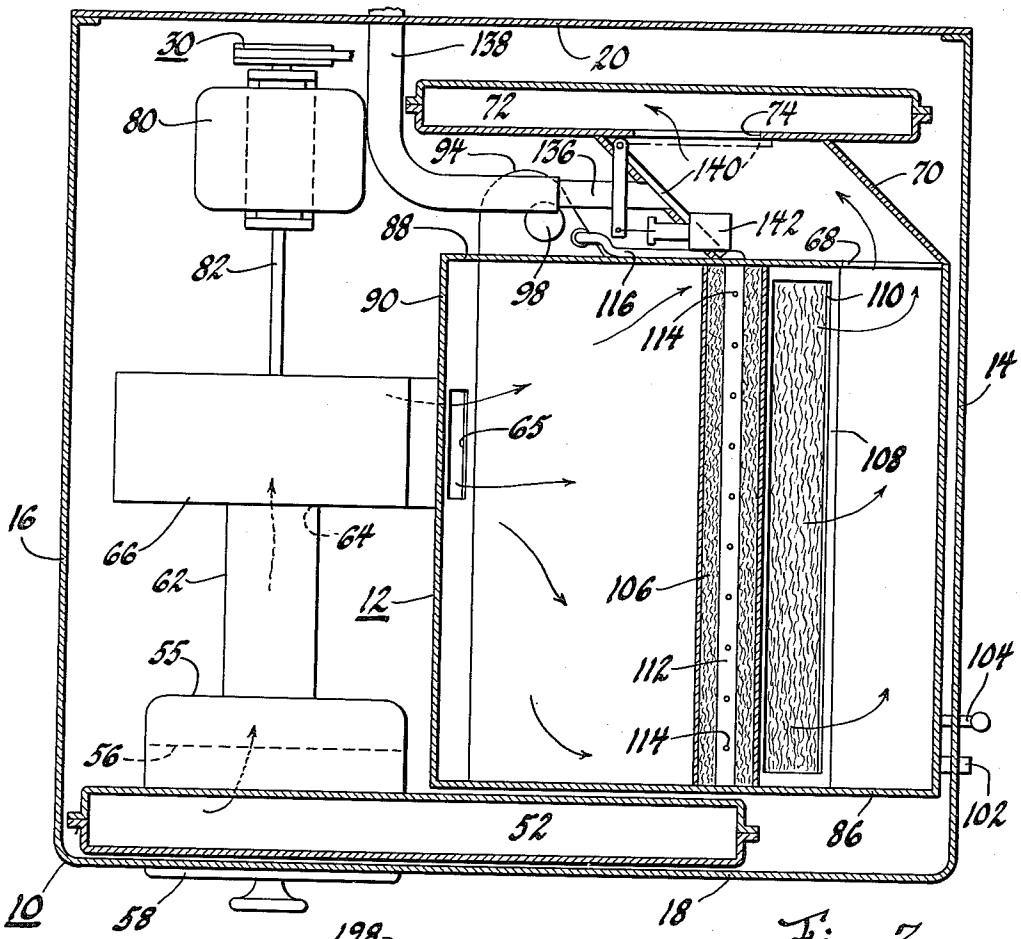

Fig. 3

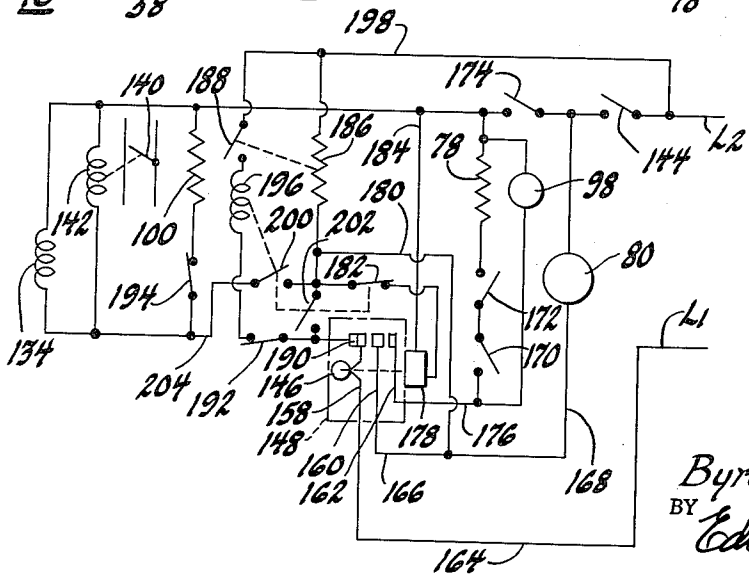

Fig. 4

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3,043,015

DOMESTIC APPLIANCE

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5 Claims. (Cl. 34—80)

This invention relates to a domestic appliance and more particularly to an improvement in adsorbent clothes dryers.

In conventional clothes dryers it is the procedure to flow an amount of heated air through a chamber full of clothing that is being tumbled therein. In this manner the length of time necessary to dry the clothing is dependent generally upon the amount of heat which is supplied to the air being circulated through the clothes drying chamber. Where the heat utilized in such a clothes drying process is generated from a normal residential source of power, such as electricity, the amount of heat input available for the clothes drying is limited by the capacity of the power supply. It has been proposed to supplement the heat available for a clothes drying operation from a conventional power supply with heat given up by an adsorbent process. The heat evolved in such an adsorbent process is denoted as a heat of condensation and a heat of wetting. A more complete explanation of the adsorbent clothes drying concepts are set forth in copending application Ser. No. 689,570, filed October 11, 1957, wherein a solid adsorbent or desiccant is disposed in the flow path of the drier air.

In the operation of a clothes dryer using a solid adsorbent to remove the moisture from the air being recirculated through the dryer, certain disadvantages appear. For one thing, a reasonably large amount of solid adsorbent must be used to adsorb the quantity of moisture found normally in a dryer load of damp clothes. This creates space problems within the dryer cabinet. Furthermore, since the solid adsorbent intercepts or filters substantially all of the air being recirculated through the dryer, dryer use over an extended period will cause a build-up of very small lint particles on the surface of the solid adsorbent. Such lint build-up impedes air flow and fosters a generally lessening efficiency of the adsorbing process, in particular, and the dryer operation in general.

Servicing problems, too, are created with the use of solid adsorbents which are necessarily bulky. For this reason dryer cabinet design must provide for replacing the solid adsorbent, and thus add to manufacturing costs.

Accordingly, it is an object of this invention to use a liquid adsorbent or hygroscopic material which has a higher moisture adsorbing capacity than have the solid adsorbents.

It is also an object of this invention to provide a liquid adsorbent distribution system wherein a spray of adsorbent fluid is interposed in the dryer air stream.

A more specific object of this invention is the provision of a filter interposed in the dryer air stream and over which liquid adsorbent is pumped in a manner to minimize lint build-up which could reduce the dryer air flow.

Additional advantages are achieved by this invention in an adsorbent dryer provided with means to facilitate draining of a liquid adsorbent from the dryer, whereby lint build-up may be cleaned from the adsorbent.

It is also an object of this invention to provide a clothes drying system which will impart a fabric conditioning to the clothes being dried.

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 front elevational view, with parts broken away, of a clothes dryer provided with this invention;

FIGURE 2 is a sectional view taken generally along the line 2—2 of FIGURE 1;

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

FIGURE 4 is a schematic wiring diagram setting forth one manner in which this invention may be placed in operation.

In accordance with this invention, and with reference to FIGS. 1 and 2, a clothes dryer shown generally at **10** is provided with a liquid adsorbing arrangement shown generally at **12**. The dryer **10** is comprised of side walls **14**, **16**, a front wall **18**, a top wall **19** and a rear wall **20**. Within the chamber formed between walls **14**, **16**, **18** and **20** a tumbling drum **22** is rotatably mounted on a shaft **24** which is supported in a universal bearing arrangement **26**. A bulkhead **28** extends parallel to the rear wall **20** from the top wall **19** of the dryer downwardly. The bulkhead **28** supports the drum shaft carrying bearing arrangement **26** and serves also to isolate the area in which the pulley system **30** resides from the drying chamber or interior **27** of the tumbling drum **22**. The drum **22** is formed with inlet ports or apertures **32** in a rear wall thereof and outflow ports or apertures **34** in the drum front wall **29**. In this regard, an annular chamber **36** is defined by the perforated rear wall **31** of the drum, the imperforate bulkhead **28** and an annular seal **38** of felt or other suitable material carried by the bulkhead **28** and in sliding engagement with drum rear wall **31**. A second annular chamber **40** is formed adjacent the outflow ports **34** in the drum front wall **29** and is defined by a front bulkhead **42** and an annular seal **44** carried thereby. The front bulkhead **42** is inwardly flanged at **46** into underlying concentric relationship with an overlying flanged neck portion **48** of the tumbling drum, thereby forming a clothes loading access to the tumbling drum interior **27**. Axially aligned with the openings formed by flanges **46** and **48**, is an access door **50** hingedly mounted at **51** on the front wall **18** of the dryer. Disposed below the access door **50**, a front duct **52** is arranged in consecutive air flow relationship with the front annular chamber **40** by means of an opening or cutout **54** through juxtaposed front duct wall **53** and bulkhead **42**. Immediately behind the front duct **52** and in air flow relationship thereto is a lint disposal housing **55**. Within the housing **55**, and disposed to intercept substantially all of the air flowing through the duct **52** is a lint collector or disposer **56**. Preferably, the collector **56** includes a lint burning arrangement as taught in copending application S.N. 635,635 filed January 23, 1957, but may be merely a screen for trapping the lint. To facilitate an occasional cleaning of the lint collecting and/or burning arrangement **56**, an access panel **58** is arranged to overlie and snap-fasten to an opening **60** in the front duct **52** and dryer wall **18** through which access may be gained to the lint disposal arrangement **56**. In this construction, a vacuum cleaner may be used to remove lint from a collecting screen or ash from a lint burner. Connected to the lint disposal housing **55**, a passageway or conduit **62** leads to an inlet **64** of blower **66** from which point the blower discharges air through an opening **65** into the adsorbent chamber **12**, to be described more fully hereinafter. The air is subsequently discharged from this chamber through an outlet opening **68** into a regeneration air exhaust chamber or damper housing **70** which selectively connects either to atmosphere through a conduit **138** or to a rear duct **72** through

an opening 74. The rear duct 72 extends upwardly along the rear bulkhead 28 and terminates adjacent an opening 76 leading to the rear annular chamber 36. Within the rear duct 72 a primary heater 78 is arranged to intercept and heat the air being circulated to the tumbling drum 22.

A single motor or prime mover 80 may be utilized to drive the blower 66 through a shaft 82 while simultaneously rotating the tumbling drum 22 through the pulley system 30. It is, therefore, evident that a recirculating or closed air flow path has been provided whereby air impelled by the blower 66 proceeds through an adsorbent chamber 12 to a rear duct 72. Air then progresses upwardly in duct 72 past primary heater 78 where it may be warmed preparatory to entering the rear annular chamber 36 and subsequently tumbling drum 22 through drum ports 32. As the heated air circulates in a normal drying cycle, the drum 22 is rotated and the clothing placed therein tumbled in the stream of heated air. Air is drawn from the interior 27 of drum 22 into the front annular chamber 40 through ports 34 from which point the air proceeds downwardly in front duct 52, through the lint disposal housing 55, returning again to blower 66 to complete the closed recirculating air system.

Reference may now be had to FIGS. 1 and 3 for a more complete description of the adsorbent chamber 12. The chamber 12 is formed with a sloping top wall 84 which is so configured to fit within the available space beneath the outer periphery of the tumbling drum 22. The chamber 12 is further defined by a front wall 86, a rear wall 88 and a blower inlet wall 90. The bottom portion of chamber 12 is formed into a liquid containing sump 92 which has an enclosed extension or pump housing 94 projecting from chamber rear wall 88. It should be noted that the extended portion 94 is at the lowermost point of the sump 92 since a pump 96 resides therein and is driven by a small, fractional horsepower motor 98 to circulate fluid within the chamber 12. Carried also within the sump 92 is an adsorbent regenerative heater 100, the function of which will be more fully understood hereinafter. Suffice it to say at this point that the heater 100 serves to "boil-off" the moisture which the liquid desiccant in sump 92 has adsorbed during the clothes drying process.

The sump 92 may also be provided with a drain tube 102 and a supply tube 104 for servicing the liquid adsorbent, either of which tubes may carry a valve for convenience. Disposed within the chamber 12 and completely filling the area between the liquid adsorbent in sump 92 and the chamber walls 84, 86 and 88 is a filter 106 of aluminum or other suitable material. The filter material 106 may be carried in a frame 108 which is provided with an opening 110 on either side of the filter material 106. In a top portion of the filter frame 108 a spray header or sprinkler 112 extends the width of chamber 12 from wall 88 to wall 86 and is provided with a plurality of spray nozzles 114 arranged along the top of the header to effect a complete liquid adsorbent covering for the filter material 106. In this relationship the pump 96 is adapted to supply header 112 with adsorbent fluid by way of a conduit 116.

To place the liquid adsorbent distribution system in condition for operation, an adsorbent fluid is supplied to the bottom of chamber 12 or sump 92 through inlet 104 until a liquid level 105 is reached which sufficiently covers the bottom 107 of the filter material 106 and regenerative heater 100. This, then, assures that all air passing through chamber 12 must necessarily pass through the filter 106. Suitable liquid adsorbents may be found in the glycol or glycerol group such as glycerine and ethylene glycol. With the motor 98 energized, the pump 96 will function to circulate the adsorbent fluid by way of conduit 116 to the spray header 112, thereby distributing the adsorbent evenly and continuously over the surface of the filter material 106. The fluid will then flow by gravity over the filter fibers until it returns again to sump 92. The pump 96 is circulated continuously during the clothes drying period. In this regard, while the heated air is picking up moisture released from the damp clothes tumbling in its path, the adsorbent fluid is being sprayed over the filter 106 in a manner to intercept all of the moisture-laden air being circulated and to thereby adsorb moisture from the air.

After the clothes are dried, it is generally desirable to remove the moisture adsorbed by the desiccant. For this purpose a regenerative heater 100 is disposed within the sump 92 and submerged in the adsorbing fluid. Although the arrangement here described contemplates a regenerating of the adsorbent at the conclusion of each drying cycle, it should be noted that regeneration of the adsorbent is dictated solely by the moisture adsorbing capacity of the desiccant. Therefore, it should be apparent that an arrangement could easily be devised whereby the adsorbent fluid is regenerated only when it has adsorbed its full moisture capacity.

During the regeneration process it is desirable to cease rotating the tumbling drum 22 and to exhaust to the atmosphere any moisture which is being heated or boil off the adsorbent liquid in sump 92. To further the first of these aims, a conventional spring clutch 118 is adapted partly to overlie a drive portion 120 of drum support shaft 24 and partly to overlie a shaft stub portion 122 which is integral with pulley hub 124. In this respect it should be noted that the shaft stub 122 is drilled to receive a reduced diameter extension 126 of drum support shaft 24 to retain the shafts 24 and 122 is concentric, relatively rotatable relationship. One terminus or boss 128 of the spring clutch projects radially upwardly into the path of an arm 130 pivotally mounted at 132 to move in response to the action of solenoid 134. With the solenoid 134 energized, arm 130 is pivoted into blocking engagement with spring clutch boss 128 thereby relaxing the tension of the spring convolutions 118 to allow the pulley system to rotate freely without driving the tumbling drum 22, i.e., the pulley shaft portion 122 merely idles on drum shaft extension 126.

To effect the exhaust of the moisture-laden air during regeneration of the adsorbent, the passageway or damper housing 70, extending between the adsorbent chamber 12 and rear duct 72, mounts an air outlet stub connection 136 which projects through the wall of passageway 70. Extending from the stub 136 to any point outside the dryer 10 is a conduit 138 which is preferably flexible. It should be noted that conduit 138 may be considerably smaller than the conventional 3" and 4" dryer vents, as outlined more fully in the aforementioned copending application. Disposed within the passageway 70, a damper 140 is adapted to overlie and seal outlet stub 136 during normal dryer operation. However, throughout a regeneration cycle, a solenoid 142 is energized to pivot damper 140 into air sealing engagement with rear duct outlet 74. Thus, with motor 80 driving blower 66, moisture "boiled" from the adsorbent in sump 92 is carried through conduit 138 to the outside atmosphere. Air flow during regeneration is necessarily reduced in accordance with the size of outlet stub 136 which has been found to produce satisfactory air flow when approximately 1" to 1½" in diameter. In addition, sufficient leakage is found to occur along the sliding engagement between drum 22 and seals 38 and 34 to provide make-up air for the amount exhausted to atmosphere during regeneration.

In operation the features of this invention will best be understood with reference to the schematic wiring diagram of FIG. 4 wherein similar elements carry the same numerals used in conjunction with the dryer construction. A drying cycle is initiated by placing a load of damp clothing within the tumbling drum 22 by way of access opening 50. The system includes a safety door switch 144 which prevents operation of the dryer until door 50 is closed. Timer dial (not shown) is

then turned to cause a cam **146** within a conventional timer **148** to bias switch blade **158** downwardly into engagement with switch blades **160** and **162**. In this manner the drying cycle is initiated. The motor or prime mover **80** is energized by way of L_1, line **164**, contact blade **158**, contact blade **160**, line **166**, line **168**, the motor **80**, and the door switch **144** to L_2. The main heater circuit includes a safety switch **170**, disposed above the primary heater **78** in rear duct **72** and a cycling thermostat **172** disposed in front duct **52**. The safety switch **170** serves to eliminate dangerous high temperatures within the heater chamber, while the thermostat **172** operates to cycle the heater **78** in maintaining a selected drying temperature within the tumbling drum **22**. As a further assurance against undue temperature rise within the dryer, a motor interlock switch **174** actuated centrifugally by the rotation of motor **80** is closed whenever the motor is in operation. With the components just described in circuit and the dryer dial set as aforesaid, the main heater **78** will be energized from L_1 through line **164**, timer blade **158**, timer blade **160**, timer blade **162**, line **176**, heater control switches **170** and **172**, safety switches **144** and **174** to the other side of the line L_2. The pump motor **98** is similarly energized but bypasses the heater control switches **170** and **172**. In this same operation, the timer motor **178** is energized from L_1, line **164**, timer blade **158**, timer blade **160**, line **166**, line **180**, switch **182**, the timer motor and line **184**, switches **144** and **174**, to L_2. This timer induced relationship of the pump motor **98**, heater **78** and motor **80** maintains throughout the time interval selected on the timer **148**.

Immediately upon energization of motor **80**, a thermal relay **186** is energized to close a switch **188** in the regeneration circuit. At the conclusion of the drying cycle, timer cam **146** will cause timer blade **158** to disengage timer blades **160** and **162** and permit engagement with regeneration circuit contact **190**. The regeneration circuit includes a normally closed thermostat **192** which operates to terminate the regeneration process. A second thermostat **194** may be included within the adsorbent sump **92** to insure against explosion hazards or excessive overheating of the liquid adsorbent. In this regard the thermostat **194** will act to open the circuit leading to the regenerative heater **100**.

With the clothes drying cycle completed and the dryer contacts disposed to place timer blade **158** in engagement with contact **190**, a solenoid **196** is thus energized by way of L_1, line **164**, timer blade **158**, timer contact **190**, regenerative thermostat **192**, thermal relay actuated. regenerative circuit arming switch **188**, line **198** to L_2. This energization of solenoid **196** will reverse the positions of switches **200**, **202** and **182** from those shown in FIG. 4. Thus, the timer motor will be prevented from operating during regeneration by open switch **182**. However, the regeneration process will be initiated from L_1, timer blade **158**, contact **190**, solenoid switch **202**, solenoid switch **200**, line **204**, sump high limit thermostat **194**, regenerative heater **100** to L_2 through motor safety switch **174** and door switch **144**. In the same circuit relationship solenoid **134** will be energized to relax the action of spring clutch **118** on shaft segment **120** of drum shaft **24** to permit the drum **22** to remain motionless, while motor **80** operates to drive the blower **66** in exhausting moisture-laden air. Furthermore, solenoid **142** is energized at the same time to place exhaust damper **140** in air flow sealing relationship to the rear duct opening **74**, as shown in phantom in FIG. 3. During the regeneration process the motor **80** continues to operate, receiving power from L_1, line **164**, timer blade **158**, contact **190**, solenoid switch **202**, line **180**, line **168**, door switch **144** to L_2. The blower **66** thus continues to operate, sending a reduced air flow through the adsorbent chamber **12** due to the restricted air exhaust outlet afforded by the conduit **138**. As the heater **100** "boils off" the moisture from the liquid adsorbent, the reduced air flow carries this moisture from chamber **12** by way of outlet **68** and through stub outlet **136** to the exhaust conduit **138**.

In the regeneration process, temperatures will remain substantially constant within the air above the liquid sump while the moisture is being given up by the adsorbent. As this process nears its termination, the sensible temperature of the air will rise markedly to open the regeneration thermostat **192**, thereby terminating the regeneration process and placing the timer **148** in condition for a subsequent drying cycle.

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. A clothes dryer, including, a drum for said clothes, means to rotate said drum, means providing a closed circuit air duct system incorporating said drum, means for circulating air through said air duct system, first heating means for increasing the temperature of said air a first amount, an external power source for energizing said heating means, said circulating means and said drum rotating means, means to spray an adsorbent fluid into the air leaving said drum to increase the temperature of said air a second amount without energization from said external power source, sump means for receiving said adsorbent fluid, second heating means adjacent said sump means for regenerating said adsorbent fluid, and means including air flow reduction means for discharging air periodically from said aid duct system concurrently with the energization of said second heating means.

2. A clothes dryer, including an outer cabinet, a tumbling drum rotatable in said cabinet, means for rotating said drum, means for disconnecting said drum from said rotating means, said tumbling drum having perforated front and rear walls, a front duct in communication with said front wall, a rear duct in communication with said rear wall, first heating means in said rear duct, an adsorbent distribution system including a spray chamber, a sump in said chamber, an adsorbent in said sump, spray means above said sump and in air flow intercepting relationship between said front and rear ducts and adsorbent circulating means connecting said sump to said spray means, second heating means associated with said sump, a blower having an inlet connected to said front duct and operable to circulate air in a closed circuit including said tumbling drum, said spray chamber and said rear duct, bypass means including a damper between the spray chamber and said rear duct for selectively blocking said rear duct to discharge air from said closed circuit, and a circuit means including a timer for concurrently deenergizing said first heating means and energizing said second heating means, said disconnecting means, said bypass means and said blower after said clothes are dried for regenerating said adsorbent.

3. A clothes dryer, including, a drum for said clothes, means to rotate said drum, means providing a closed circuit air system incorporating said drum, heating means for said drum, means for circulating air through said air duct system, a liquid adsorbent arrangement adapted to filter air leaving said drum including a sump for said adsorbent, a filter element and means for directing said adsorbent over said filter element, heating means adjacent said sump for regenerating said liquid adsorbent, means including air flow reduction means in said duct system for discharging air periodically from said air duct system concurrently with the energization of said heating means for regenerating said liquid adsorbent, and means to interrupt the rotation of said drum during said discharge.

4. In combination, a clothes dryer having a cabinet, a perforated drum rotatably supported in said cabinet, means for selectively rotating said drum including a power driven shaft secured to said drum and rotatable therewith and a spring clutch on said shaft adapted for unidirectional shaft rotation, means providing a normally closed air flow system including said drum, a duct and

a fan for circulating air through said duct and said drum, a first heater in said closed system for aiding in the removal of moisture from said clothes, means for collecting lint from said air, an adsorbent fluid arrangement for removing moisture from said air including an adsorbent fluid, a spray means in said duct, a sump and a pump for circulating said fluid from said sump to said spray means and into moisture removing relationship to said air, a filter in said closed system over which said fluid is sprayed, a second heater in said sump for aiding in the subsequent removal of moisture from said adsorbent fluid, a relatively small bypass connected to said duct downstream from said sump and openable to said duct concurrently with the energization of said second heater for periodically discharging to the outside atmosphere the moisture removed from said air, and means for terminating the rotation of said drum during the operation of said second heater.

5. A clothes dryer, including, an outer cabinet, a tumbling drum rotatable in said cabinet, means for rotating said drum, said tumbling drum having perforated front and rear walls, a front duct in communication with said front wall, a rear duct in communication with said rear wall, first heating means in said rear duct, a moisture removal chamber including a sump in said chamber, means above said sump and in air flow intercepting relationship between said front and rear ducts for removing moisture from the air flow intercepted and depositing said moisture in said sump, second heating means associated with said sump, a blower having an inlet connected to said front duct and operable to circulate air heated by said first heating means in a closed circuit including said tumbling drum, said moisture removal chamber and said rear duct to remove moisture from said clothes, bypass means including a damper between the moisture removal chamber and said rear duct for selectively discharging air from said closed circuit, and a circuit means including a timer for concurrently deenergizing said first heating means and energizing said second heating means and said bypass means after said clothes are dried for removing the moisture from said clothes dryer to the atmosphere.

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