

July 30, 1963

H. E. VAN SCOYK

3,099,542

DRYING AIR HEAT CONTROL AND MOISTURE REMOVAL APPARATUS

Filed April 25, 1960

3 Sheets-Sheet 1

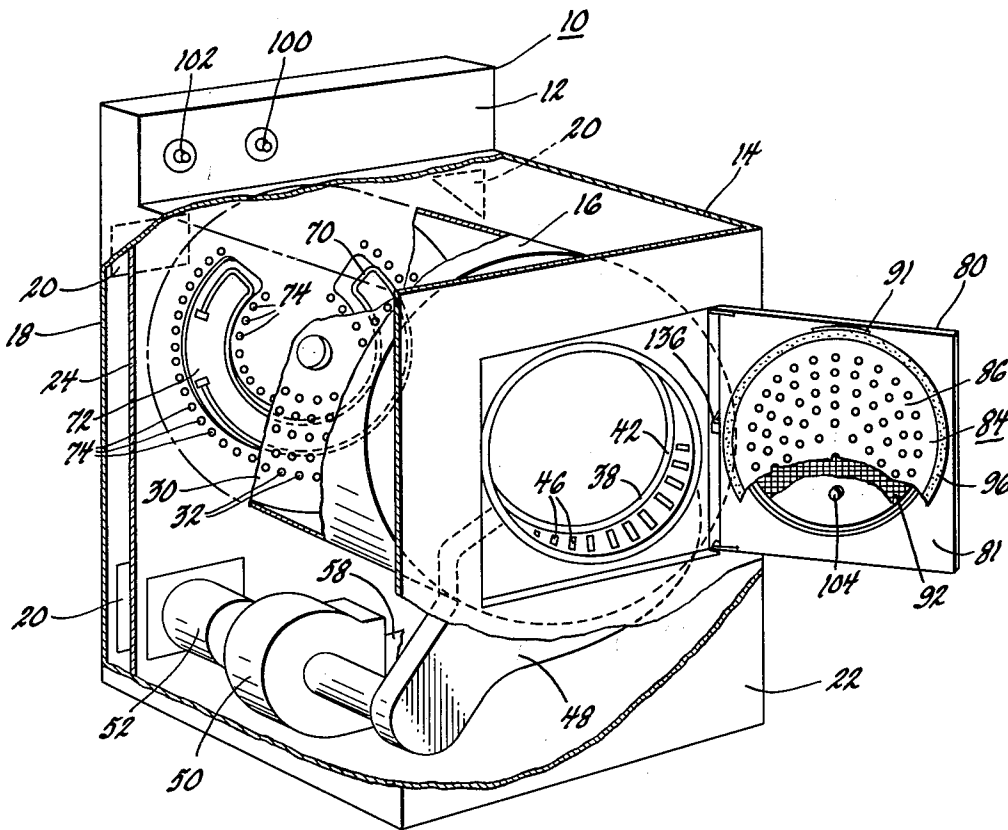


Fig. 1

INVENTOR

Howard E. Van Scoyk

BY

Frederick M. Ritchie

HIS ATTORNEY

July 30, 1963

H. E. VAN SCOYK

3,099,542

DRYING AIR HEAT CONTROL AND MOISTURE REMOVAL APPARATUS

Filed April 25, 1960

3 Sheets-Sheet 2

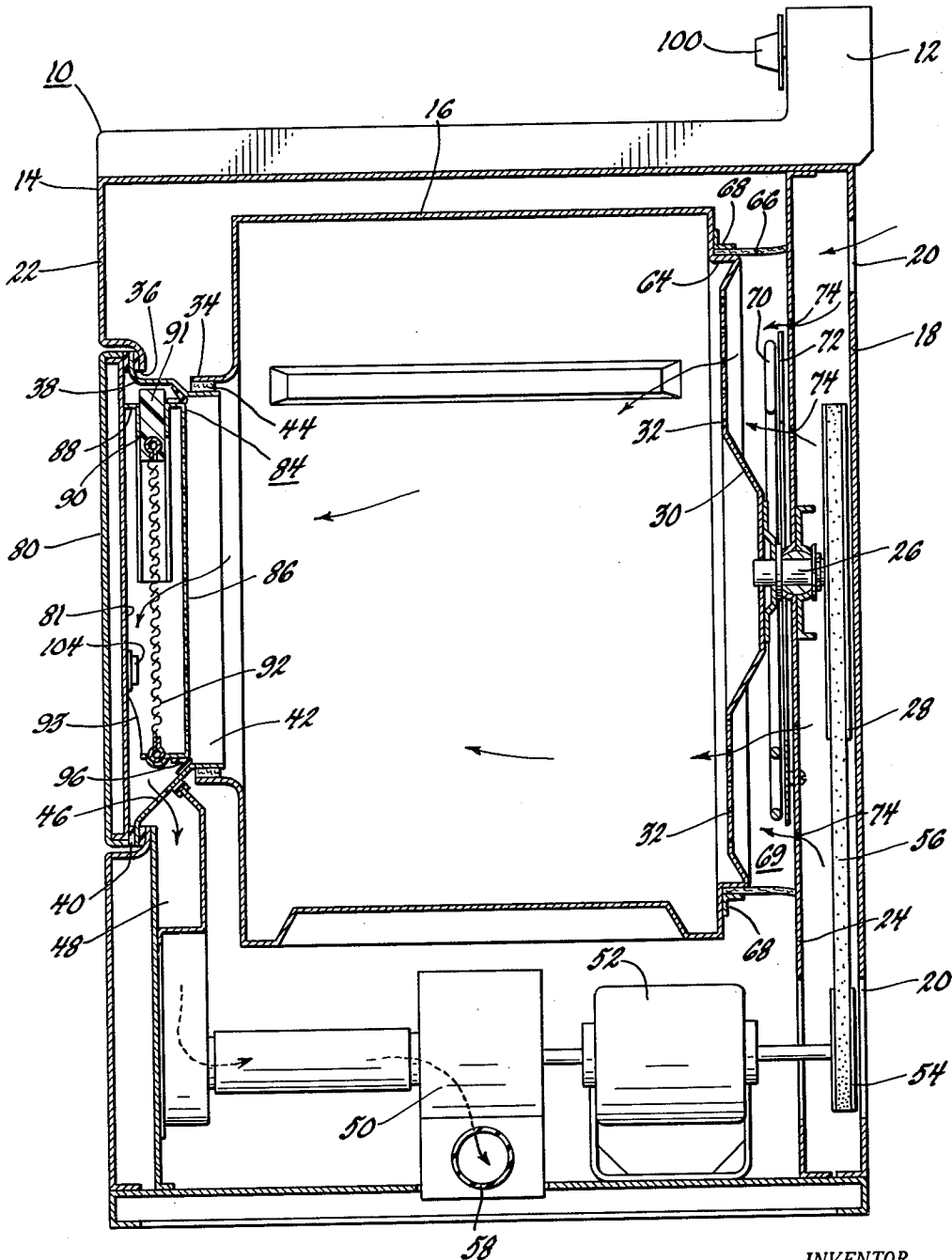


Fig. 2

INVENTOR

Howard E. VanScoyk

BY

Frederick M. Ritchie
HIS ATTORNEY

July 30, 1963

H. E. VAN SCOYK

3,099,542

DRYING AIR HEAT CONTROL AND MOISTURE REMOVAL APPARATUS

Filed April 25, 1960

3 Sheets-Sheet 3

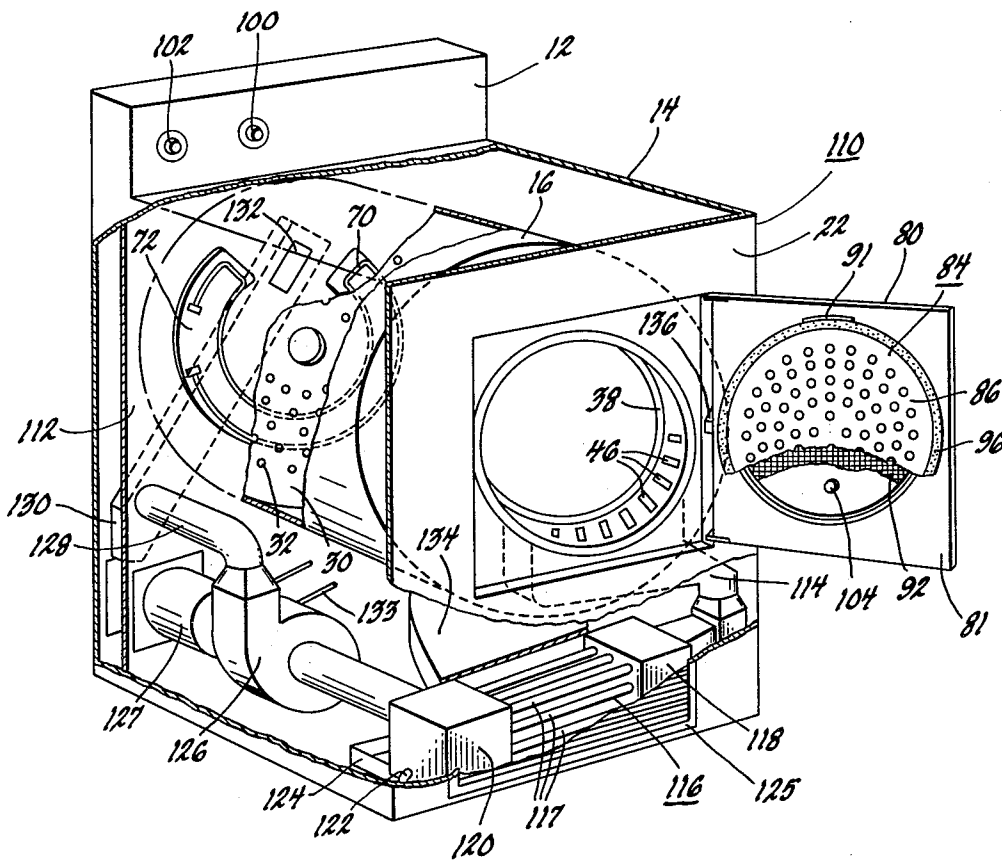


Fig. 3

INVENTOR

Howard E. Van Scoyk

BY

Frederick M. Ritchie
HIS ATTORNEY

1

3,099,542

**DRYING AIR HEAT CONTROL AND MOISTURE
REMOVAL APPARATUS****Howard E. Van Scoyk, Dayton, Ohio, assignor to General
Motors Corporation, Detroit, Mich., a corporation of
Delaware**

Filed Apr. 25, 1960, Ser. No. 24,365

6 Claims. (Cl. 34-48)

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

In the clothes drying art many attempts have been made at successful drying cycle termination using sensible heat thermostats to gauge the dryness end point. However, the prior art devices have not achieved fully satisfactory results and the drying cycle is ended with the clothes either under dried or over dried. Investigation has determined one cause for this inaccuracy lies in the fact that moisture condenses on the interior surfaces of the dryer during the drying cycle and is reevaporated near the end of the drying cycle. The cooling effect due to such moisture reevaporation adversely affects the temperature responsive means seeking to sense the dry bulb temperature change which indicates the clothes are dry. Further, the prior art dryer control systems have placed the thermostats in a position to sense only the temperature of the circulating air. But air temperature alone, sensed in a remote part of the dryer, is not truly indicative of the clothes dryness condition. The radiant heat of both the heating means and the tumbling clothes needs to be considered if the drying cycle is to be terminated when the clothes are properly dried. It is to the solution of these and other problems that this invention is directed.

Accordingly, it is a general object of this invention to position a dryer thermostat in a position to sense both radiant and conducted heat.

It is a more particular object of this invention to mount the heater controls for a clothes dryer on the access door to the dryer.

A further object of this invention is the provision of a drying control system for a fabric tumbling drum having a heater at one end thereof and an access opening at the other end wherein a thermostat is positioned in said access opening to sense the radiant heat of the heater and the fabric.

Another object of this invention is the provision of a dryer heater control means in outlet air temperature sensing relationship to a clothes tumbling drum and in radiant heat sensing relationship to said heater and said fabric.

Another general object of this invention is the provision of access door mounted thermostats for recirculating air condensing dryers.

Still another general object of this invention is the provision of an automatic drying cycle termination system for a clothes dryer in which the thermostats are positioned in a location which is relatively unaffected by the reevaporation of condensed moisture in the dryer air passage.

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

In the drawings:

FIGURE 1 is a schematic perspective view with parts broken away to show the interior of a vented clothes dryer;

FIGURE 2 is a side sectional view taken through the center of the clothes dryer shown in FIGURE 1; and

FIGURE 3 is a schematic perspective view with parts

2

broken away to show the interior of a recirculating air condensing dryer.

In accordance with this invention and with reference to FIGURES 1 and 2, a vented type clothes dryer is shown generally at 10. The dryer 10 includes a control housing 12 having suitable controls for temperature 100 and cycle termination 102 and a cabinet 14 which encloses a rotatably mounted clothes or fabric tumbling drum 16. The casing 14 is comprised of a rear wall 18 having air inlet openings 20 and a front wall 22. For supporting the tumbling drum 16, a rear bulkhead 24 extends from bottom to top in spaced parallel relationship to the rear wall 18. A drum support shaft 26 is journaled on the bulkhead 24 and carries a pulley 28 in the space between the bulkhead 24 and the casing rear wall 18. The tumbling drum 16 is formed in a cylindrical shape and includes a rear wall 30 ported or perforated, as at 32, for facilitating ingress of drying air to the tumbling drum. At the opposite end of the drum an axially directed collar 34 defines the air outlet or access opening for the tumbling drum. The opening formed by the collar 34 axially aligns with an opening 36 in the casing front wall 22. Interposed between the drum collar 34 and the casing opening 36 is a front port plate or drum front support member 38. This port plate 38 is fastened in a resilient seal 40 to the casing front wall 22 and has an inwardly extending collar 42 which nests in support relationship within the drum collar 34. Suitable felt sealing material 44 is interposed between the port plate collar 42 and the drum access collar 34 to minimize leakage at this point from the tumbling drum. The port plate 38 is provided with a plurality of exhaust outlets 46 which open into a front duct or air passage 48 leading to a blower 50.

Air circulation through the dryer is initiated by the blower 50. This blower is driven by a motor 52 which is, in turn, connected through a pulley 54 and belt 56 with the drum pulley 28. Thus, the motor 52 is utilized to initiate air flow through the tumbling drum and, at the same time, to rotate the tumbling drum. The blower 50 shown in FIGURE 2, includes an outlet duct 58 which may be connected to the side or rear walls of the dryer for connection therefrom with the atmosphere in accordance with conventional practice.

In the rear wall 30 of the tumbling drum, an annular shoulder 64 is formed to support an annular flexible, non-combustible seal 66 attached thereto by a plurality of L-shaped brackets 68. The seal 66 engages the inside of the bulkhead wall 24 to define a heater chamber 69 between the bulkhead and the rear wall of the tumbling drum. It is in the annular chamber 69 that a horseshoe-shaped clothes drying heater 70 is disposed. To the rear of the heater 70 is a juxtaposed generally horseshoe-shaped reflector panel 72 which reflects and radiates heat from the heater 70 through the perforations 32 of the tumbling drum rear wall into the tumbling chamber. A series of circumferentially arranged air inlet apertures 74 are positioned on both sides of the reflecting panel 72 so that air drawn through the apertures 74 is directed evenly over the heater 70 before it enters the tumbling drum.

It is desirable to filter lint from the circulating air as it leaves the tumbling drum. For this purpose an access door 80 is hinged at 82 to the front wall 22 of the clothes dryer and is adapted to close the access opening 36 in the dryer casing and support a lint collecting housing shown generally at 84. The housing 84 includes a perforated wall 86 in axial alignment with the port plate collar 42 and the drum inlet collar 34, when the door is closed. The side of the lint collecting housing is formed by a cylindrical wall 88 fastened at one end thereof to an inner panel 81 of the door and at the other end thereof to the perforated wall 86. At the top of the housing wall 88 a top opening 90 is formed for receiving a lint collec-

tor 91. The collector includes a filter means such as a nylon screen 92, and is slidably removable from the lint collecting housing 84 through the top opening 90. Along the bottom of the cylindrical wall 88 a cutout 93 is provided to facilitate egress of filtered air from the housing into the front duct 48 by way of the port plate openings 46. To facilitate an airtight relationship between the lint collecting housing 84 and the port plate 38, an annular seal 96 is fastened about the periphery of the perforated wall 86. Thus when the door 80 is closed, all air leaving the tumbling drum is channeled through the lint collecting housing 84.

The air flow system defined by the construction outlined hereinabove for a vented clothes dryer is as follows. With the energization of the motor 52, both the blower 50 and the tumbling drum 16 are actuated. Air is drawn through the openings 20 into the casing rear wall and enters the annular heater chamber 69 by way of the inlet openings 74. After being heated by the heater 70, the air then enters the tumbling drum through the perforations 32 in the drum rear wall.

Moisture and lint are entrained in the air from the tumbling moist clothes within the tumbling drum and this moist and lint laden air is withdrawn from the tumbling drum by way of the lint collecting housing 84. Air enters the housing through the perforated housing wall and filters through the lint collecting screen 92. Filtered air leaves the lint collecting housing by way of the cutout 93, entering the front duct 48 by way of the port plate openings 46 and is withdrawn by the blower 50 for subsequent disposal by way of outlet 58 to the atmosphere.

In accordance with conventional practice, the primary heater 70 is cycled on and off to maintain the interior of the tumbling drum at some desired temperature. Prior art devices have placed the temperature responsive means in areas which are substantially inaccessible for servicing and which do not reflect actual clothes dryness conditions. Thus, where it is sought to terminate the drying cycle by sensing a sudden increase in dry bulb temperature of the exhaust air, as taught in the patent to Broglie 2,398,880, issued April 23, 1946, the prior art dryers have lacked accuracy. Even where a control thermostat is used in an integrating timer such as taught in Hughes 2,882,610, issued April 21, 1959, the cycle termination has been affected adversely by the location of the control thermostat. The reason for the inaccuracy is believed due to small amounts of dust and lint which filter into the front duct system 48 and become lodged on the interior of the duct walls between the drum outlet and the exhaust outlet. During the drying cycle, this lint absorbs moisture from the humid air passing thereover. Moisture droplets also form on the metal surface of the duct work. Such moisture droplets and moistened lint are naturally the last thing to dry in the dryer since these are down stream of the tumbling drum 16. Thus, the clothes within the tumbling drum are actually dry prior to the time that the lint and dust coated ductwork is dry. Relatively dry air leaving the tumbling drum is then used to reevaporate the moisture from the lint coating. Such reevaporation produces an air cooling effect which will delay the proper actuation of any control thermostat seeking to sense the aforesaid sudden increase in dry bulb temperature, thereby creating a false indication at the thermostat of moisture remaining in the clothes. Consequently, the dryer heater 70 is not deenergized soon enough or for long enough periods and the drying cycle itself is not terminated until the clothes have over-dried.

For the above reason, this invention contemplates placing the thermostat 104 on the inside panel 81 of the door 80 and within the lint collecting housing 84. In the integrating timer type of automatic drying cycle set forth in the aforesaid Hughes patent, the thermostat 104 may be preset by the temperature control 100 in accordance with the fabric being dried, i.e., drying temperatures best suited for delicate loads approximately 130°

F., for regular loads approximately 180° F., and for wash and wear loads approximately 145° F. The thermostat 104 is selectively positioned in the control circuit for the heater 70 and acts to provide the correct temperature within the tumbling drum 16. It is within the purview of this invention to use a plurality of thermostats on the door, one for each temperature setting desired. In this arrangement, the desired thermostat could be switched selectively into the heater circuit.

With reference to FIGURE 2, it should also be noted that the door mounted location for the thermostat 104 positions the thermostat in relationship to the clothes in the tumbling drum 16 such that radiant heat from the clothes is sensed by the thermostat. This also makes the thermostat more responsive than a thermostat located in the duct work remote from the tumbling drum. Still further, the thermostat is able to see the radiant heat of the primary heater 70 through the lint collecting housing perforations and the perforations 32 in the rear wall of the tumbling drum. Thus, the door mounted thermostat not only responds to radiant as well as conducted heat, but it is positioned remote from any moisture laden surfaces which might collect lint and adversely effect the dryness end point control system.

The foregoing has been explained in connection with a vented clothes dryer. However, the door mounted location for a dryer control thermostat has been found even more effective in a recirculating air condensing dryer 110, as shown in FIGURE 3. The general construction is approximately the same as in the vented dryer 10, but the air passed through the tumbling drum is continuously recirculated. In explanation of the construction of FIGURE 3 parts like those in the vented dryer 10 will be given like reference numerals. Thus, the dryer 110 includes a casing 14 having a front wall 22 which is closed by a door 80 having a lint collecting housing 84 thereon. Within the casing 14 a tumbling drum 16 is adapted for rotation and includes a perforated rear wall 30 and an access opening in axial alignment with a front port plate 38. Adjacent the rear wall of the tumbling drum 16 is a rear bulkhead 112 which distinguishes over the bulkhead 24 in a vented dryer in that it is not perforated in the area of the annular chamber formed between the tumbling drum and the bulkhead. Thus, a closed chamber is formed by an annular seal (not shown) but substantially like that seal 66 shown in FIGURE 2 and an identical heater 70 is disposed therein. At the outlet end of the tumbling drum, perforations 46 in the port plate 38 open into a front duct 114 which leads to a condensing heat exchanger, shown generally at 116. The heat exchanger 116 is of tubular design such that air entering a header 118 is channeled through the tubes 117 to an outlet header 120 at the other end of the condenser tubes. Moisture forming in the tubes flows by gravity into the outlet header 120 and from there through an outlet conduit 122 into a sump pan 124 which may be periodically emptied through a removable front grill 125.

A blower 126 withdraws air from the tumbling drum through the condenser 116 and returns the air to the tumbling drum by way of a recirculating air return conduit 128 and a return conduit 130 which has an opening 132 into the otherwise closed annular chamber adjacent the rear wall of the tumbling drum. Thus, a closed circuit is established between the blower 126 and the tumbling drum 16 of the condensing dryer.

To facilitate more rapid condensation of the moisture from the recirculating drying air in the tubes 117, a second blower system is utilized including a cooling air blower (not shown) driven by a belt 133 from the motor 127. Air is delivered from this second cooling air system by way of a duct 134 to the condenser 116 and adapted to blow relatively cool air in counter flow relationship to the condenser tubes 117. For further details on the condensing dryer system shown schematically in this invention, reference may be had to our copending application

Serial No. 732,573, now Patent No. 3,032,887, which was filed May 2, 1958, and assigned also to the assignee of this invention.

Lint accumulation within the ductwork of the condensing dryer 110 is especially adverse to the proper operation of a drying cycle control system having thermostats disposed within the ductwork. Since the recirculating air is extremely humid, droplets of condensation are deposited inside the front duct 114, the condenser 116 and the return ducts or conduits 128 and 130. When the dryer 110 is being controlled by an automatic termination system such as shown in the patent to Broglie, the accuracy of the system depends on accurately sensing the sudden increase in dry bulb temperature as the clothing reaches its termination dryness condition. The problem involves the fact that small amounts of lint which become lodged on the interior surfaces of the various ducts in the recirculating system absorb some of the humidity and condensate from the circulating air flow. As the clothes become dry, the circulating air passing over the clothes becomes dry also. This relatively dry air then starts to evaporate the moisture droplets from the inside of the duct system, as well as drying out the slight lint film in the recirculating system. A cooling effect is produced and this cooling effect is normally reflected in an unwanted extension of the drying cycle. Such extension causes the clothes to be overdried.

Such cooling effect also impairs the accuracy of an automatic drying cycle using the integrating timer technique of Hughes. The heater control thermostat, sensing the misleadingly relatively cool air, will maintain the heater 70 energized longer than is desirable. When the heater is energized in the Hughes system, the timer is deenergized and the cycle progress interrupted. Thus, the duration of the drying cycle is extended and the clothes overdried.

As with the vented dryer 10, the control thermostat 104 is positioned in the lint collecting housing on the door 80 of the dryer. This thermostat senses the true dryness condition of the clothes since it is not affected by any moisture condition within the ductwork itself. It is also disposed in a position to sense the radiated heat from both the heater 70 and the clothes within the tumbling drum. Consequently, a control system utilizing door mounted thermostats is far more accurate and the drying cycle is terminated when the clothes are at the proper end point dryness.

Since thermostat 104 is carried on the door 80 of either dryer 10 or dryer 110, it is necessary that the electrical conduits be supported between the movable door 80 and the fixed cabinet 14. For this purpose a floating conduit carrying hinge 136 is positioned on the door to receive and support the wires (not shown) leading from the thermostat to the automatic drying control. For further details relating to this floating conduit housing 136, reference may be had to a copending application to Haslup, Serial No. 853,151, now Patent No. 3,042,471, filed November 16, 1959, and assigned to the same assignee as this invention.

Although the foregoing construction has been explained primarily as desirable for use with automatic drying cycles, it should be obvious that the ability of the door mounted thermostats to sense the radiated heat of both the heater and the tumbling clothes results in a more responsive timed drying system. The readily accessible location of the thermostat 104 also enhances the servicing of the appliance. This is an important factor since a lint or dust coated thermostat will not reflect the true air condition. Especially is this so when the lint coating is damp and reevaporating moisture from its surface. The resultant cooling effect hampers thermostat operation. Aside from the ease with which this invention permits cleaning the thermostat, it should be noted that the constant opening and closing of the dryer door

80 will help to dislodge any lint and dust from the surface of the thermostat.

While the embodiments of the present invention as herein disclosed, constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In combination, means forming a chamber for tumbling fabric, said forming means having means including a perforated chamber wall for defining an air passage through said chamber, means adjacent the perforations of said chamber wall for heating said chamber, a pivotally mounted door for said chamber, a lint collecting housing on said door, said housing having a perforated housing wall facing said perforated chamber wall through the interior of said chamber and interposed in said air passage when said door is closed, a lint collector in said housing behind the perforations of said housing wall for filtering air from said chamber, temperature responsive means in said housing adjacent the perforations of said housing wall and behind the lint collector and said housing wall in straight line exposed radiant heat receiving relationship to said heating means through the perforations of said housing wall and said chamber wall for controlling said heating means, and means for inducing an air flow sequentially into heat receiving relationship with said heating means, into moisture and lint receiving relationship with said fabric, into lint depositing relationship with said lint collector, and into temperature sensing relationship with said temperature responsive means.

2. A dryer for moist fabrics comprising a chamber for said fabrics, said chamber having an access opening, means for closing said opening, means for heating said chamber to remove moisture from said fabrics, a lint collecting housing on said closing means, an air-cooled condenser including a plurality of open-ended elongated tubular air passageways, means including a first blower for recirculating drying air through said chamber into moisture absorbing relationship with said fabrics, through said lint collecting housing and through the interior of said tubular air passageways in series flow relationship, means including a second blower for circulating cooling air across the exterior of said tubular air passageways to remove moisture from said recirculating drying air, and temperature responsive means on said closing means upstream from said tubular air passageways for controlling said heating means.

3. A dryer for moist fabrics comprising a chamber for said fabrics, said chamber having an access opening, means for closing said opening, means for heating said chamber to remove moisture from said fabrics, a lint collecting housing on said closing means, an air-cooled condenser including a plurality of open-ended elongated tubular air passageways each having an inside portion and an outside portion, means including a first blower for recirculating drying air through said chamber into moisture absorbing relationship with said fabrics, through said lint collecting housing and into engagement with one of said portions of said tubular air passageways in series flow relationship, means including a second blower for circulating cooling air into engagement with the other of said portions of said tubular air passageways to remove moisture from said recirculating drying air, and temperature responsive means on said closing means upstream from said tubular air passageways for controlling said heating means.

4. A dryer for moist fabrics comprising a chamber for said fabrics, said chamber having an access opening, means for closing said opening, means for heating said chamber to remove moisture from said fabrics, an air-cooled condenser including a plurality of open-ended elongated tubular air passageways each having an inside portion and an outside portion, blower means including a first section for recirculating drying air through said chamber into moisture absorbing relationship with said fabrics and into engagement with one of said portions of

7

said tubular air passageways in series flow relationship and a second section for circulating cooling air into engagement with the other of said portions of said tubular air passageways to remove moisture from said recirculating drying air, and temperature responsive means on said closing means upstream from said tubular air passageways for controlling said heating means.

5. In combination, a fabric dryer including a container having an access opening and a perforated container wall, a door for closing said opening and having a perforated door wall adapted to be positioned in said access opening when said door is closed, means for moving said container to agitate said fabric, means for initiating moisture absorbing air currents through said perforated container wall, said container, and said access opening and said perforated door wall and including air impelling means, heating means adjacent the perforations of said container wall and in heat transfer relationship to said air currents for heating said air currents to dry said fabric, and enclosed condenser means having one end connected to said access opening through the perforations of said door wall when said door is closed and another end connected to said air impelling means for returning said air currents to said air impelling means, said enclosed condenser means being elongated in a manner whereby air currents moving therethrough are cooled below the dewpoint and moisture is condensed from said air currents on the inside of said enclosed condenser means, and temperature responsive means on said door adjacent the perforations of said door wall and behind said door wall upstream from said enclosed condenser

8

means and in straight line exposed radiant heat receiving relationship to said heating means through the perforations of said container wall and said door wall when said door is closed for controlling said heating means.

6. A dryer for moist fabrics comprising a chamber for said fabrics, said chamber having an access opening, means for closing said opening, means for heating said chamber to remove moisture from said fabrics, an air-cooled condenser including an open-ended elongated tubular air passageway having an inside portion and an outside portion, air circulating means including a first section for recirculating drying air through said chamber into moisture absorbing relationship with said fabrics and into engagement with one of said portions of said tubular air passageway in series flow relationship and a second section for circulating cooling air into engagement with the other of said portions of said tubular air passageway to remove moisture from said recirculating drying air, and temperature responsive means on said closing means upstream from said tubular air passageway for controlling said heating means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,019,011	Johnson	Oct. 29, 1935
2,589,284	O'Neil	Mar. 18, 1952
2,675,628	O'Neil	Apr. 20, 1954
2,769,246	Shapter	Nov. 6, 1956
2,814,130	Cayot	Nov. 26, 1957
2,878,580	Hughes	Mar. 24, 1959
2,885,789	Conkling et al.	May 12, 1959