DOMESTIC CLOTHES DRYER
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This invention relates to clothes dryers and more particularly to such units having heat economizers in association therewith.

In many domestic clothes dryer constructions, one problem is that a substantial part of the heat input to the dryer for removing moisture from clothes being tumbled in its rotatable drum is exhausted exteriorly of the drum through duct work leading from the appliance. Various arrangements have been suggested for utilizing the waste heat in the exhausted air from the dryer to preheat inlet air to the tumbling drum to reduce the drying cycle time. Such systems, however, require a separate heat exchanger construction that must be located within the limited dimensional configuration of the outer cabinet of the dryer. Furthermore, to produce an effective heat exchange between such exhaust flow and the inlet air flow, a relatively expensive heat exchange construction is necessary.

Accordingly, an object of the present invention is to improve the economy of operation of domestic clothes dryer apparatus by the provision of a compact combination heat exchanger and fan circulating fan construction including impeller means for directing an exhaust air stream from a tumbling drum and for circulating a cool air stream separately of and in heat transfer relationship with the exhaust air stream for condensing moisture from the exhaust air stream.

Another object of the present invention is to improve the operation of a domestic dryer having a tumbling drum with a circulating heated air stream passing therethrough by the provision of a combination heat exchanger and fan construction including impeller means therefor for producing the circulating air stream in the tumbling drum and means for condensing moisture in said circulating air stream on said impeller means whereby substantial moisture is removed from the tumbling drum to reduce the time period for the drying cycle of operation of the dryer.

A further object of the present invention is to improve the economy of operation of a domestic dryer by the provision of a combination heat exchanger and fluid circulating fan means including impeller portions for directing an exhaust air stream from the tumbling drum while simultaneously and separately directing an inlet air stream into said drum and wherein said impeller portions include heat transfer surfaces for directing heat from said exhausted air stream to said inlet air stream for preheating it prior to passage into said tumbling drum.

Still another object of the present invention is to improve domestic dryers by the provision of a fan construction for circulating heated air through the interior of a tumbling drum wherein the fan construction includes a plurality of separate fluid flow passageways arranged to selectively exhaust heated air from the tumbling drum and to direct cool air from exteriorly of the tumbling drum to its interior and wherein the fluid flow passageways have common surfaces for directly conducting heat from the heated exhaust flow into the cool inlet flow for preheating it prior to its passage interiorly of the tumbling drum.

Yet another object of the present invention is to improve the economy of operation of a domestic dryer by the provision of a combination heat exchanger and fan construction including means for producing a cross flow pattern thereacross including separate exhaust and inlet air flow streams that pass across a common heat transfer surface that serves to direct heat from the exhaust air flow stream to the inlet air flow stream for preheating it prior to passage interiorly of a tumbling drum in the dryer construction.

Still another object of the present invention is to improve the operation of a domestic unvented dryer unit of the recirculating type by the provision of a combination heat exchanger and fan construction including impeller means for continuously recirculating a heated fluid stream through a tumbling drum while simultaneously recirculating a cold air stream separately through said fan construction and providing a direct heat conductive path between said separate fluid streams whereby moisture in the heated fluid stream recirculating through the tumbling drum is condensed.

A still further object of the present invention is to improve domestic unvented dryers of the recirculating fluid stream type by the provision of a combination heat exchanger and fan structure as mentioned above including means for collecting condensate from the fan construction and passing it exteriorly of the dryer unit.

Yet another object in the present invention is to improve domestic dryers of the unvented type having a tumbling drum with a recirculating heated air stream therein by the provision of a combination heat exchanger and fan construction including means therefor for producing parallel separate flow patterns including the circular pattern in the tumbling drum and a cold air stream separated therefrom by a heat exchange surface common to both of the parallel streams whereby heat is transferred from the recirculating air stream into the circulating cold air stream to produce condensation of moisture in said recirculating fluid stream and said combination heat exchanger and fan structure which is associated with means for collecting the condensate and removing it from the system so that the length of the drying cycle operation is reduced.

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 view in vertical section taken through a domestic dryer unit including one embodiment of the present invention.

FIGURE 2 is an enlarged view in elevation and partially in section of a combination heat exchanger and fan construction in the embodiment of FIGURE 1.

FIGURE 3 is a view in vertical section taken along the line 3—3 of FIGURE 2.

FIGURE 4 is a view in vertical section taken along the line 4—4 of FIGURE 2.

FIGURE 5 is fragmentary vertical sectional view of a dryer unit including another embodiment of the present invention.

FIGURE 6 is an enlarged fragmentary view in elevation and partially broken away of a combination heat exchanger and fan unit in the embodiment of FIGURE 5.

FIGURE 7 is an enlarged, fragmentary sectional view taken along the line 7—7 of FIGURE 5.

Referring now to the drawings, in FIGURES 1 through 4, one embodiment of the invention is illustrated in a domestic dryer unit 10 having an outer housing 12 forming a top 14, a front wall 16 and a rear wall 18 enclosed at their ends by side walls 20, one of which is shown in FIGURE 1. The front wall of the outer housing has
3 an access opening 22 therein closed by an outwardly swinging door member 24. Within the opening 22 on the wall 18 is carried an annular seal member 26 that sealingly supports the radially outer flange of a collar 28 including an annular extension 30 thereon directed interiorly of the outer housing to be received in telescoping relationship with an outwardly directed tubular inset portion 32 on a rotatable tumbling drum 34. The extension 30 and tubular portion 32 serve as bearing surfaces for the front end of the dryer drum 34 and they have an annular sealing member 33 disposed therebetween to prevent air leakage from the drum 34. The tumbling drum 34 includes suitable vanes or paddles 36 supported on the inner surface of the drum to extend radially inwardly thereof to tumble articles in the drum 34 upon its rotation. The drum 34 also includes a rear wall 38 having a plurality of radially outwardly located circumferentially spaced inlet openings 40 therein and a plurality of radially inwardly located circumferentially spaced outlet openings 42. The outlet openings 42 are covered by a circular filter member 44 that is held in place on the inner surface of the rear wall 38 by a cover 46 removably attached to the wall 38. The cover 46 includes a plurality of openings 48 therein for communication of the outlet openings 42 across the filter member 44 with the interior 49 of the drum 34.

The rear wall 38 has the central portion thereof bent outwardly at 50 where it is secured to a low speed shaft end portion 52 of a direct drive motor and speed reducer assembly 54 having a peripheral flange 56 fixedly secured to the rear wall 18 of the outer cabinet of the dryer unit. The direct drive motor and speed reducer assembly 54 also includes a high speed shaft end portion 58 for operating an improved combination heat exchanger, blower fan and condensate separator assembly 60 constructed in accordance with certain principles of the present invention. The motor and speed reducer assembly 54 is more specifically set forth in U.S. Patent No. 3,167,409 issued Jan. 26, 1965 to Brucken and is included in association with the improved assembly 60 and tumbling drum 34 as a representative prime mover means for rotating the assembly 60 and drum 34 under the control of a dryer cycle control unit 62 located on a rearwardly disposed control panel 64 located between the top 14 and the rear wall 18.

The combination heat exchanger and fluid circulating assembly 60 more particularly includes an annularly central partition 66 surrounding the low speed drive shaft end portion 52 at a point located outwardly of the rear wall 38 of the tumbling drum 34 where radially inward edge of the partition 66 is connected to the high speed output shaft 58 of the motor 54. The annular partition 66 has an outer peripheral edge 68 thereof offset outwardly of the drive shaft end of the motor 54 to support an annular impeller 70 in surrounding relationship to the motor 54. The impeller 70 has a radially outwardly directed flange 72 thereon directed continuously therearound that is received within an annular grooved member 73 supported on a vertical divider wall 74 supported in turn off the rear wall 18 by an annular plate 76.

Referring now more particularly to the annular impeller 70, as best seen in FIGURES 2 through 4, the impeller is shown as including a sheet metal member 77 circumferentially continuously formed between partitions 66 and flange 72. The member 77 is convoluted to include inner peripheral, circumferentially spaced wall portions 78 in the inner surface of the partition 66 that join the inner ends of radially outwardly directed spaced vanes 80, 82 that form a plurality of spaced peripheral openings 84 on the outer periphery of the impeller 70 on its inside surface. Each of the radial vanes 82 is joined at its outer peripheral end by a wall member 86 to a circumferentially spaced adjacent radially directed vane member 87. Each of the vane members 82, 87 inwardly of the inside surface of the partition

66 have an opening 88 formed therebetween at their radially innermost ends. Each of the radially outwardly directed vanes 80, 82, 87 extend across the full width of the impeller 70 and as shown in FIGURE 2 outwardly of the outer surface of the partition 66 the vane ends 80, 82 are spaced apart at their radially inner ends to form an opening 90 therebetween and are joined at their radially outer peripheral ends by a wall 92. The radial vanes 82, 87 on this side of the impeller are joined at their radially inner end by a wall member 94 and at their radially outer end are spaced apart to form an opening 96 therebetween. The members 94 are placed on either side thereof by annular side surface members 97, 99.

The openings 90 communicate with an air inlet chamber 98 formed by the partition 66, the rear wall 18 and an annular member 100 on the wall 18 directed inwardly thereof into close spaced relationship with the outer side surface of the impeller 70. Openings 102 in the rear wall 18 communicate the inlet chamber 98 with ambient air outside of the outer housing 12 of the dryer unit 10. The outlet openings 96 on the outside surface of the impeller 70 communicate with an exhaust discharge chamber 104 formed by the member 106, the rear wall 18, the annular plate 76 and the divider wall 74. The discharge chamber 104 is communicated in turn through an opening 106 in the rear wall 18 for directing fluid therefrom outwardly of the outer housing 12 of the dryer unit 10.

The openings 104 on the outer periphery of the impeller 70 located inwardly of the inside surface of the partition 66 communicate with an annular chamber 108 formed by a radially inwardly located portion of the wall 74, an inwardly directed annular member 110 supported thereon that is slidably received within an annular sealing member 112 located on the rear wall 38 of the drum 34 and an outwardly directed annular member 114 on wall 38 that has its outer edge in close spaced relationship with the inside face of impeller 70. The chamber 108 has a heat source 115 therein, representatively shown as being an energizable electrical heater element. The inlet openings 40 in the drum 34 communicate the chamber 108 with the interior 49 of the drum 34. The inner peripheral openings 88 in the impeller 70 on its inside surface communicate with an annular chamber 116 that is formed by the partition 66, the rear wall 38 of the drum 34 and annular member 114.

As best seen in FIGURE 3, between each of the radially directed vanes 82 and 87 an exhaust fluid flow passageway 118 is formed. Exhausted air thereby can flow from the interior 49 of the drum 34 through the outlet openings 42 therein thence through the chamber 116 into the impeller inlet openings 88, thence out the outer peripheral openings 96 into the discharge chamber 104 and the opening 106 to the outside of the dryer unit.

Between each of the vanes 80, 82 a fluid flow passageway 120 is formed whereby fluid directed through the inlet openings 102 in wall 18 into the inlet air chamber 98 can pass through the inner peripheral openings 90 on the outside face of impeller 70 and thence through the passageways 120 and out the outer peripheral openings 96 on the inner face of the impeller into the annular chamber 108 to be heated by the heat source 115 prior to passage through the inner openings 40 in the drum 34 thence to the interior 49 thereof.

By virtue of the above-described air inlet and exhaust fluid circuits into and out of the tumbling drum 34, when impeller 70 is rotated by the motor 54, air within the impeller passageways 118, 120 will flow outwardly out the peripheral openings 84, 96 on either side of the impeller 70 to produce a plurality of inlet air flows and another plurality of exhaust air flows of heated air from the tumbling drum 34 through the fluid circuits described above. The air inlet streams, by virtue of the above-described structure, are passed in a cross-flow pattern, as best seen in FIGURE 1, with respect to the exhaust air.
streams and, as described above, the heat from the exhaust air streams is transferred through vane portions on the impeller to preheat the air inlet flow whereby the economy of operation of the dryer is noticeably improved since the otherwise wasted heat of the exhaust stream is passed in part into the inlet air stream for use in drying articles in the drum 34.

While in the above-described embodiment of the invention the inlet and outlet openings on the impeller 70 are located at the inner and outer peripheries thereof, it will be appreciated that these openings may be rearranged depending upon the configuration of the adjacent duct-work in the dryer to produce a similar cross flow pattern through the impeller for effecting the desired heat exchange therein.

In addition to the preheating and fluid circulation action of the impeller 70, the moist exhaust air flowing through the passageways 118 is effectively cooled by the inlet air stream flowing through the passageways 120 so as to cause condensate to form on the impeller. This condensate is flying from the impeller at the outer peripheral openings 96 therein into the chamber 104 which has an opening 122 thereto formed in the bottom of the annular member 76 that can be connected to suitable means for directing the condensate externally of the dryer. Any condensate collected in the annular channel member 72 is drained therefrom into chamber 164 through an opening 123 in the low point of the channel.

One feature of the present invention is that the impeller 70 is disposed with respect to the tumbling drum 34 within the outer cabinet in a very compact manner and furthermore the impeller 70 is constructed and arranged to perform in addition to the normally expected fluid circulation the additional functions of a heat exchange between the exhaust air streams and the inlet air streams and addition that of removing condensate from the system prior to the passage of exhaust air therefrom to a point exteriorly of the drum.

Another embodiment of the invention is illustrated in FIGURES 5 and 6 where the combination fluid circulation impeller, heat exchanger and condensate separation is shown in conjunction with an invented dryer of the recirculating type. In this arrangement, versus the impeller 136 is continuously recirculated through the interior of a tumbling drum and a second coolant air stream is circulated separately of the heated air stream through the impeller for cooling the impeller so that moisture in the heated recirculated air stream is condensed externally of the impeller. Furthermore, means are associated with the recirculation of the impeller removing the condensate therefrom from the system whereby the recirculated heated air stream serves as a means for removing moisture from articles being processed within the tumbling drum. More particularly, FIGURE 5 is a fragmentary view of a dryer structure like 10 in the first embodiment. In this arrangement, a tumbling drum 124 has a rear wall 126 thereon fastened by a bracket 128 to a low speed output shaft 130 of a motor of the type shown at 54 in the first embodiment. The motor like in the first embodiment is supported on the rear wall 134 of the drum. The axis of the low speed drive shaft end portion 130 is co-linear with the axis of rotation of the tumbling drum 124.

In this embodiment, a combination heat exchanger and recirculating impeller assembly 136 is connected to a high speed output shaft 138 through an annular partition 140. On the side surface of the path of the component 140 is a continuously circumferentially formed convoluted vane 142 formed including a series of radially outwardly directed portions 144, 146, 148 with the vane portions 144, 146 being joined at their radially inwardly located ends by a curved portion 150 and the radially outwardly directed vane 146, 148 being joined at their radially outer end by a curved portion 152 as best seen in FIGURE 6.

On the opposite side of the disk 140 a like convoluted vane 154 is formed continuously circumferentially around the impeller 136 to include a series of radially outwardly directed portions 156, 158, 160, best seen in the broken away part of FIGURE 6. The vanes 156, 158 are joined at their radially innermost ends by a curved portion 162 and the vanes 158, 160 are joined at their radially outermost ends by a curved portion 164. In the illustrated arrangement, the continuously formed vane portion 154 is located by the partition 140 within an inlet air space 166 formed by the partition 140, the rear wall 168 of the dryer and an annular member 170 directed inwardly of the rear wall 168 into close spaced relationship to the edge of vane portion 154 adjacent its radially outer peripheral edge as defined by curved portion 164. The space 166 is communicated with the air space of the dryer through openings 172 in the rear wall 168 and the inlet space 168 in communication with fluid flow passageways 174 between the vane portion 156, 158 which in turn are communicated with openings 176 formed between the radially outer end portions of the vanes 156, 158 whereby fluid will pass axially into the passageways 174 between the vanes 156, 158 and will flow through the passageways 174 and out the radially outer peripheral openings 176 of the impeller vane portion 154 into a discharge chamber 178 formed by the rear wall 168 and a bulkhead 180 located interiorly of the rear wall 168 along with an annular member 182 that joins the bulkhead 180 to the rear wall 168. The discharge space 178 is communicated with the exterior of the dryer through an opening 184 in the rear wall 168.

The bulkhead 180 has a radially inwardly located annular channel portion 186 thereto formed continuously around the inner peripheral edge of the bulkhead 180 to receive an outer peripheral edge 188 on the portion 140 to effect a labyrinth seal between the inlet chamber 166 and the discharge chamber 178 and the inside surface of the partition 140. On the inside surface of the partition 140 the vane portion 143 is located in an inlet chamber 186 formed by the partition 140, the rear wall 126 of the rotatable tumbling drum 124 and an annular member 188 directed outwardly of the rear wall into close spaced relationship with the outer periphery of the vane portion 142. The inlet chamber 186 communicates with the interior 190 of the tumbling drum through outlet openings 192 in the rear wall 126. The circumferentially located outlet openings 192 are covered by a filter member 194 removably secured to the inside surface of the rear wall 126 by a perforated plate 196.

The impeller vane portions 144, 146, 148 formed on the inside on the surface of the drum 140 form axial inlet openings into the impeller 136 on the radial portions 150 joining the radially innermost ends of the vane portions 144, 146, 148. Fluid flows from the inlet chamber 186 into the impeller at this point, thence through fluid flow passageways 198 between the vane members 144, 146 to an outer peripheral opening 200 therebetween which communicates with an inlet chamber 202 formed by the bulkhead 180, the rear wall 126 of the tumbling drum 124 and an annular member 204 supported by the bulkhead 180 and directed inwardly thereof into sliding sealing engagement with an annular seal member 206 located on the outer surface of the rear wall 126 adjacent the outer periphery thereof. The inlet chamber 202 has a heat source 208 located therein which is representative shown as being an electrical resistance element that heats air flowing thereacross prior to passage from the chamber 202 through inlet openings 210 in the rear wall 126 radially outwardly of the openings 192 therein.

Upon energization of the motor portion 132 to rotate the impeller 136, a recirculating heated air stream is circulated through the interior 190 of the drum 124 by the impeller vane 142 that centrifugally discharges fluid through the peripheral openings 200 therein, thence into the inlet chamber 202 to pass across the heat source 208 and through the inlet openings 210, thence interiorly of the drum 190. The heated air removes moisture from the articles being processed within the interior 190 and is
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7 drawn across the perforated plate 196 and the filter element 198 thence through the outlet openings 192 into the inlet chamber 196. From the chamber 196 fluid flows axially into the fluid passageways 198, thence back into the chamber 202 to the peripheral openings 200.

In accordance with certain other of the principles of the present invention, the heated recirculating air passing through the impeller vane 142 is cooled by an air stream circulating across the impeller vane 154 that serves to direct air from exteriorly of the dryer through the openings 172 in the rear wall 168, thence into the inlet chamber 166 and axially into the impeller vane 154 to flow through the fluid flow passageways 174 and radially out of the impeller port 152 into the discharge chamber 178. The cool air circulating through the impeller portion 154 cools the impeller vane portion 142 whereby moisture in the recirculating heated air stream is condensed thereon.

One feature of the present invention is that the radially disposed vane 154 is corrugated as best seen in FIGURE 7 in a radial direction to form a plurality of ridges 212 thereon to increase the cooling surface area of the impeller construction 136 to increase the cooling effect of the circulating cool air stream on the impeller portion 142 located inwardly of the disk 140. The corrugations in the vane portion 142 are disposed axially of the outer periphery of the vane portion 142.

2. In a domestic dryer, the combination of a rotatable drum having inlet and outlet openings therein, prime mover means for driving said drum, an impeller operatively associated with said prime mover means to be rotated thereby including means defining first fluid passageways therethrough for circulating air through said drum inlet openings and outlet openings, said impeller including means defining second fluid passageways separate from said first fluid passageways for circulating cool air with respect to heated exhaust air from the interior of said drum, and a common heat transfer surface between first and second fluid passageways for transferring heat from said exhaust heated air stream to said cooler air stream whereby moisture is condensed from said exhaust air stream into said drum.

3. In a domestic dryer, the combination of a rotatable drum having inlet openings and outlet openings therein, prime mover means for driving said drum, an impeller operatively associated with said prime mover means including means forming a first plurality of fluid passageways therethrough for directing cool air from exteriorly of said drum to drum inlet opening and passing it through said drum inlet openings thereinto thereof, said impeller including means forming a second plurality of fluid flow passageways separated from said first plurality of fluid flow passageways for directing exhaust heat from said drum to said outlet openings and directing said drum heat transfer means between said first and second plurality of fluid passageways for transferring heat from said exhaust air stream to said cool air stream for preheating it prior to passage into said drum.

4. In a domestic dryer, the combination of a rotatable drum having inlet and outlet openings therein, prime mover means for driving said drum, an annular impeller operatively associated with said prime mover means to be driven thereby, said impeller including means forming a plurality of circumferentially located separate fluid flow cells, each of said cells having an inlet and an outlet opening thereinto, at least one of said cells having the inlet thereof communicating with cool air exteriorly of said drum and an outlet opening for directing the cool air into the drum through the inlet openings therein, at least another of said fluid flow cells having the inlet opening thereto in communication with the outlet openings from said drum for drawing exhaust air from said drum, said other of said cells having its outlet opening communicating exteriorly of said drum for directing exhaust air from said drum, said fluid flow through said one and said other fluid flow cells being separated by a common heat transfer surface, said inlets and outlets of said one and another fluid cells being arranged so that said exhaust flow and said cool air inlet flow crosswise with respect to one another whereby heat from said exhaust air is directed by said heat exchange surface into said cooler air for preheating it prior to passage into said drum.

5. In a domestic dryer, the combination of a rotatable drum having inlet openings and outlet openings therein, prime mover means for driving said drum including a shaft end portion, an annular impeller surrounding said shaft end portion being operatively connected thereto for rotation by said shaft end portion, said impeller including means forming an air inlet passageway therein with an inlet and an outlet thereto, means forming an inlet chamber for receiving air from exteriorly of said drum for passage into the inlet of said impeller air inlet passageway, means forming an outlet chamber communicated with said exhaust inlet port therefrom, and said exhaust inlet port therefrom, means in said outlet chamber for heating inlet air prior to passage into said drum through the inlet openings therein, said impeller including means forming a discharge passageway therein having an inlet opening and an outlet opening, the inlet opening of said dis-
charge passageway communicating with the outlet openings from said tumbling drum for drawing heated moist exhaust air from said tumbling drum, means forming a chamber for receiving fluid from the outlet of said impeller discharge passageway for directing the exhaust air stream exteriorly of said tumbling drum, and a heat transfer surface between said heat inlet passageway and said discharge passageway in said impeller including means forming a plurality of fluid flow passageways therethrough, selected ones of said fluid flow passageways serving to draw air from the outlet openings of said tumbling drum and to discharge the exhaust air stream exteriorly of the tumbling drum, selected other of said fluid flow passageways serving to draw inlet air from exteriorly of said tumbling drum and to direct it through the inlet openings in said tumbling drum, heat transfer surfaces between these surfaces and selected others of said fluid flow passageways for serving said inlet air stream from said exhaust air stream and for transferring heat from the exhausted air stream into the inlet air stream for preheating it prior to passage through said inlet openings, said heat transfer surfaces further serving to condense moist air from said exhaust air stream, and means associated with said impeller for collecting the condensate on said heat transfer surfaces and discharging it exteriorly of said tumbling drum.

In a domestic dryer, the combination of a rotatable tumbling drum having inlet and outlet openings therein, prime mover means for rotating said drum, an annular impeller operatively associated with said prime mover means including means forming a plurality of fluid flow passageways therethrough, selected ones of said fluid flow passageways serving to draw air from the outlet openings of said tumbling drum and to discharge the exhaust air stream exteriorly of the tumbling drum, selected other of said fluid flow passageways serving to draw inlet air from exteriorly of said tumbling drum and to direct it through the inlet openings in said tumbling drum, heat transfer surfaces between these surfaces and selected others of said fluid flow passageways for serving said inlet air stream from said exhaust air stream and for transferring heat from the exhausted air stream into the inlet air stream for preheating it prior to passage through said inlet openings, said heat transfer surfaces further serving to condense moist air from said exhaust air stream, and means associated with said impeller for collecting the condensate on said heat transfer surfaces and discharging it exteriorly of said tumbling drum.

In a domestic dryer, the combination of a rotatable tumbling drum having inlet and outlet openings therein, prime mover means for driving said drum, an annular impeller operatively associated with said prime mover means to be rotated thereby, means forming first fluid flow passageways on said impeller for recirculating air through the inlet and outlet openings in said tumbling drum, means for circulating the recirculating air stream through said tumbling drum, said impeller including means forming a second plurality of fluid flow passageways for circulating cool air through said impeller, a heat transfer surface for separating said recirculating air stream from said cool air stream, said heat transfer surface serving to remove heat from said recirculating air stream whereby moisture therein is condensed on said impeller, and means for collecting said condensate from said impellerprior to passage of said recirculating air stream across said recirculating air stream heating means.

In a domestic dryer, the combination of a rotatable tumbling drum having inlet and outlet openings therein, prime mover means for driving said drum including a shaft end portion, an annular impeller surrounding said shaft end portion being operatively connected thereto for rotation thereby, said annular impeller including an imperforate wall portion, means on one side of said wall portion for recirculating air in said tumbling drum from the outlet openings therein through the inlet openings thereof, means for heating the recirculating air, means on the opposite side of said imperforate wall portion for circulating a cool air stream through said impeller, said cool circulating air stream serving to remove heat from said recirculating air stream for condensing moisture therein on said impeller, and means disposed between said impeller and said heating means for collecting said condensate and directing it exteriorly of said tumbling drum.

In a domestic dryer, the combination of a rotatable tumbling drum having inlet and outlet openings therein, prime mover means for rotating said drum including a shaft end portion, an annular impeller surrounding said shaft end portion operatively connected thereto for rotation thereby, said impeller including a radially extending imperforate wall portion, a first plurality of vanes on one side of said wall portion for recirculating air in said tumbling drum from the outlet openings therein through the inlet openings thereof, means for heating the recirculating air stream prior to passage interiorly of said tumbling drum, a second plurality of vanes on the opposite side of said wall portion for circulating a cool air stream through said impeller, means including said wall portion for separating said recirculating air stream from said cool air stream, said impeller vanes serving to transfer heat from said recirculating air stream into said circulating cool air stream for condensing moisture from said recirculating air stream on said second plurality of vane portions, means located radially outwardly of annular impeller between said impeller and said recirculating air stream heating means for collecting condensate from said impeller and directing it exteriorly of said tumbling drum whereby articles being tumbled in said drum continually have the moisture therein removed therefrom.

In the combination of claim 9, said vanes for circulating cool air having a surface area in excess of the surface area of said vanes for recirculating air through said tumbling drum.

In the combination of claim 10, said first plurality of vanes for circulating cool air having corrugations formed therein for increasing heat transfer therefrom.

In the combination of claim 11, said corrugations being disposed generally parallel to the flow of circulated cool air thereacross.

In a domestic dryer, the combination of a rotatable tumbling drum having inlet and outlet openings therein, prime mover means for driving said drum including a shaft end portion having an axis co-linear with the axis of rotation of said drum, an annular impeller surrounding said shaft end portion including a radially directed imperforate wall secured to said shaft end portion for rotating said impeller, a first plurality of vanes on one side of said wall portion, a second plurality of vane portions on the opposite side of said wall portion, means for directing inlet air into said second plurality of vane portions, means for directing inlet air from said second plurality of vanes and directing it exteriorly of the dryer unit, means for directing heated exhaust air from the outlet openings in said tumbling drum into said first plurality of vanes, means for recirculating the recirculated air from said first plurality of vanes and directing it through the inlet openings in said drum interiorly thereof, heater means for heating said recirculated air stream prior to passage thereof through said drum inlet openings, said circulating cool air stream through said impeller removing heat from said recirculating heated air stream causing moisture to condense therefrom onto said first plurality of vanes, and means disposed radially outwardly of said impeller for collecting condensate on said first plurality of vanes prior to passage of said recirculating air stream across said heater means, said collecting means including means for directing said condensate exteriorly of the dryer unit.

In a domestic dryer, the combination of a rotatable tumbling drum having inlet openings and outlet openings therein, prime mover means for driving said drum, an annular impeller operatively associated with said prime mover means including means forming a plurality of separate fluid flow passageways therethrough each including an inlet and an outlet opening, at least one of said fluid flow passageways having its outlet opening arranged to direct fluid interiorly of said drum through the inlet openings therein, at least another of said fluid flow passageways having its inlet opening receiving fluid circulating from said drum through the outlet openings therein, said fluid flow from said drum into said inlet opening of said at least another of said fluid flow passageways being in heat transfer relationship with a cooler air stream passing through still another of said fluid flow passageways in said impeller for producing heat exchange between said exhausted air stream from said tumbling drum and the
cooler air stream whereby moisture is condensed from said exhaust stream and deposited on said impeller, and means for removing condensate from said impeller.

15. In a domestic dryer, the combination of a rotatable tumbling drum having inlet openings and outlet openings therein, prime mover means for driving said drum, an impeller operatively associated with said prime mover means being rotatable thereby, said impeller including means forming a plurality of separate fluid flow cells therein, each of said cells having an inlet and an outlet opening thereto, at least one of said cells serving to direct an inlet air stream from exteriorly of said tumbling drum through the inlet openings therein, at least another of said cells receiving exhaust air from the outlet openings in said drum and directing it exteriorly thereof, a heat transfer surface between said at least one and another of said cells, said exhaust air stream passing across said heat transfer surface whereby heat is directly transferred therethrough into said inlet air stream for preheating it prior to passage interiorly of said tumbling drum.

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