

[54] **DRYER DAMPER AND CONTROL MECHANISM**

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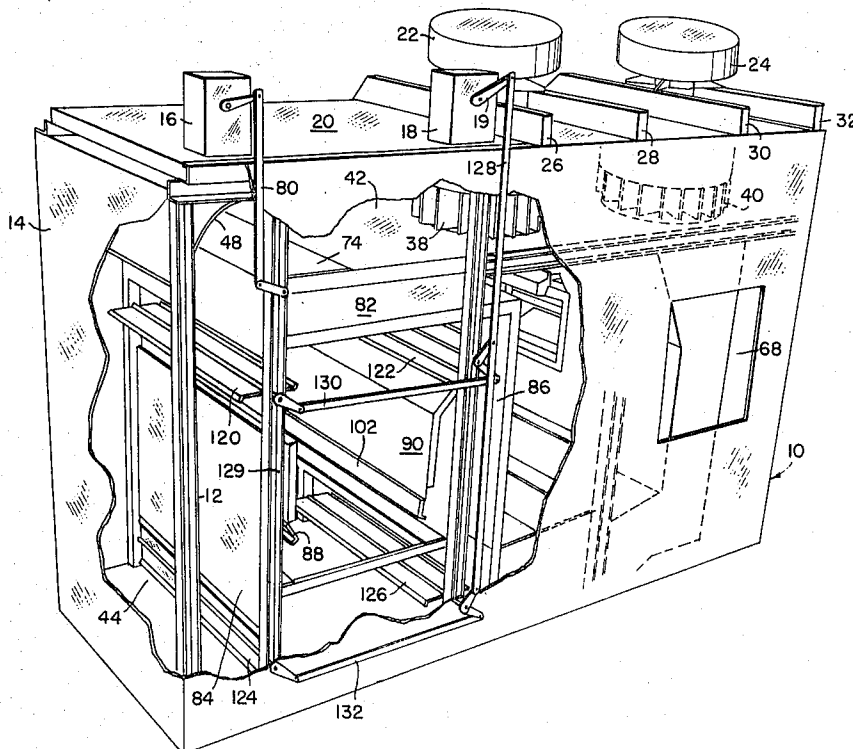
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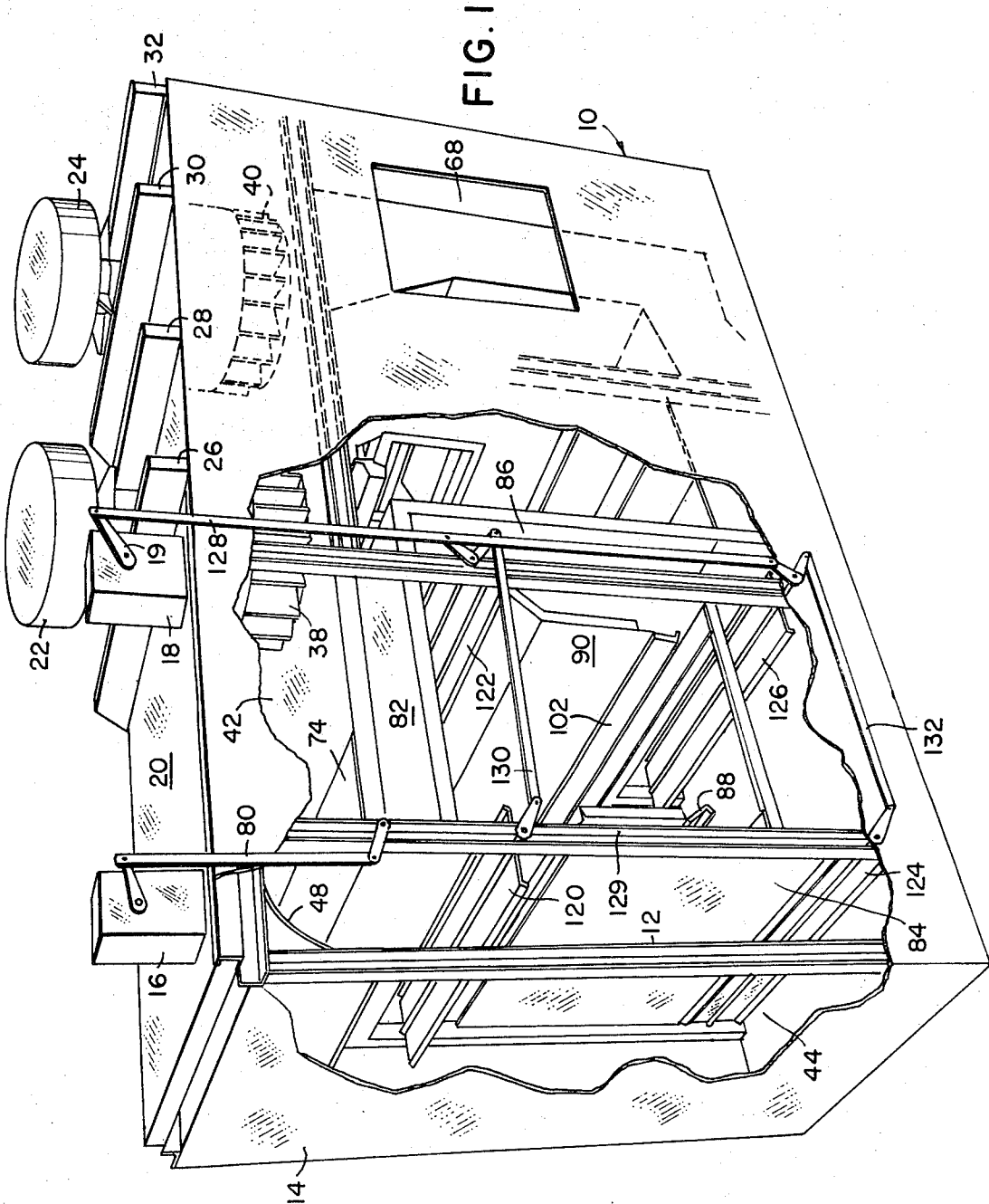
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[57] **ABSTRACT**

A dryer and damper control mechanism designed to dry articles by forced warm air including a plurality of internal baffles directing the flow of heated air through the dryer, a first set of dampers co-operating to guide the air downwardly through the articles being dried, a second pair of dampers to direct the heated air upwardly through the articles being dried and, controls to precisely regulate the temperature, humidity, and volume of the heated air through all portions of the apparatus.

5 Claims, 3 Drawing Figures





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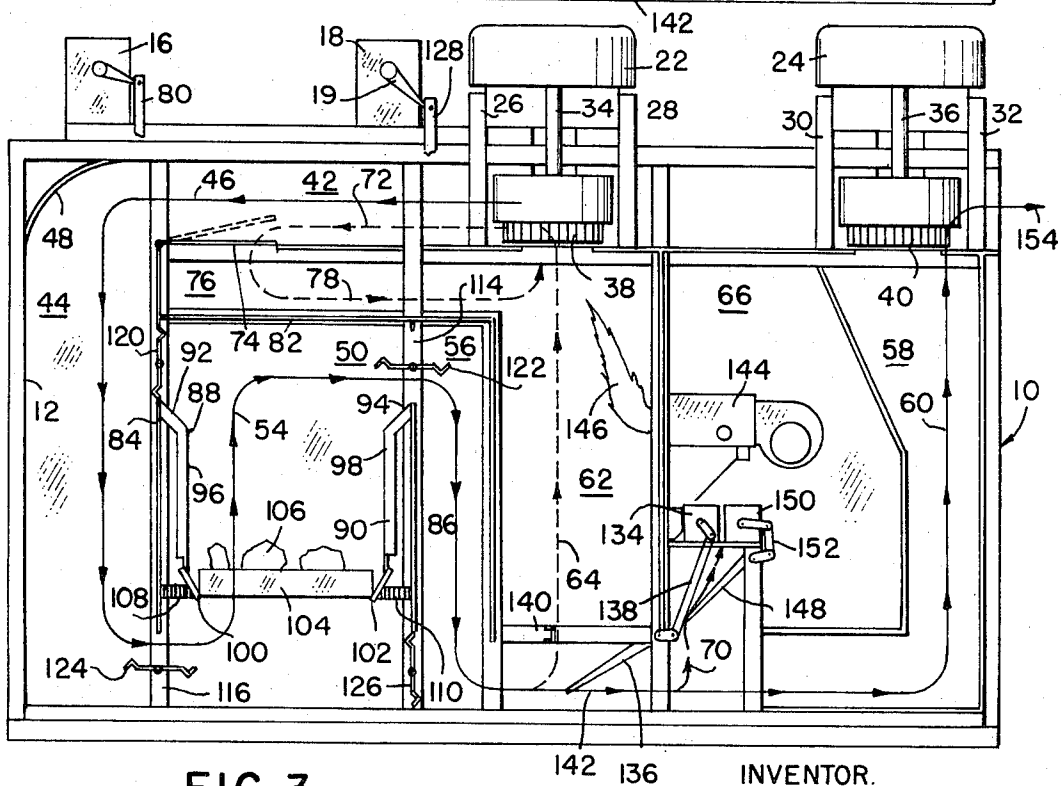
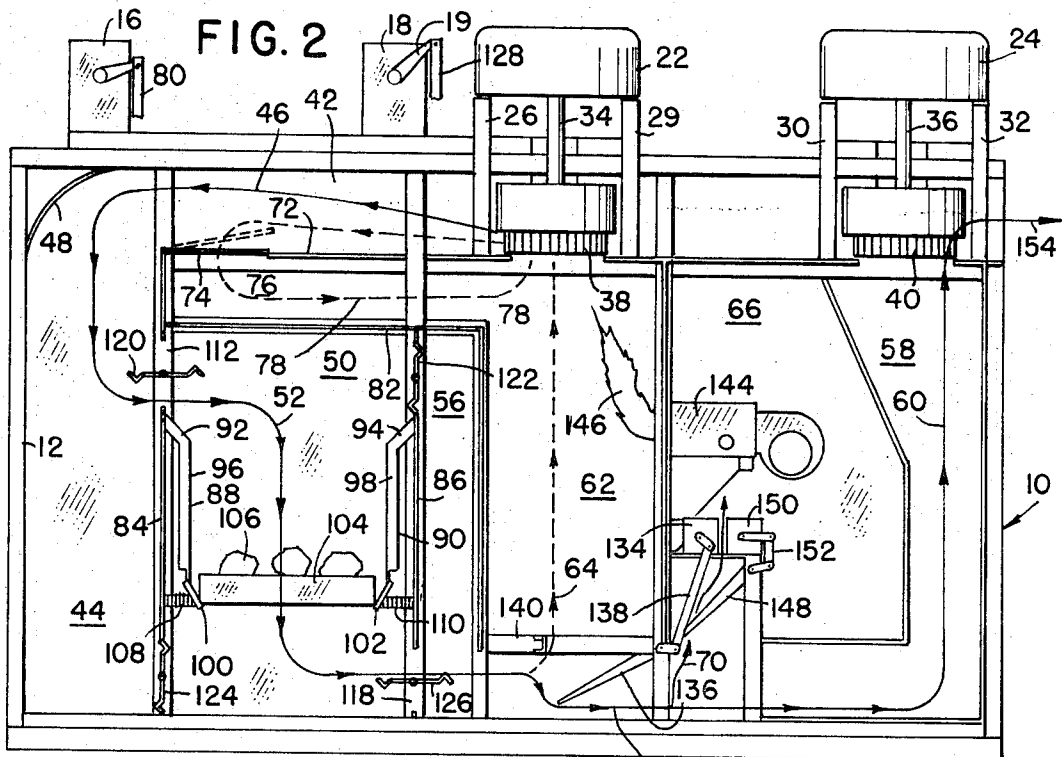


FIG. 3

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DRYER DAMPER AND CONTROL MECHANISM

BACKGROUND OF THE INVENTION

This invention relates generally to the art of material drying and, more particularly, is directed to a dryer apparatus including specific controls to accurately regulate the direction, temperature and volume of flow of heated air through the apparatus.

Prior workers in this field have developed various types of drying apparatus employing both oil and gas air heaters which function to heat air within the dryer for introduction to a drying chamber by means of fan type air handling units. In most prior art devices, the air handling units included a fan having specific output characteristics and, accordingly, the prior art devices could not satisfactorily and easily vary the volume of air introduced to the drying chamber during the drying cycle. Additionally, the prior art dryers of which I am familiar, operate at temperatures directly related to the temperatures developed at the air heater, and controls and apparatus have not to date been developed to precisely regulate the temperature of the heated air flowing through the drying chamber. Some prior workers have attempted to develop methods to regulate temperature, volume and direction of flow of heated air through the drying chamber, but all prior art control systems have tended to be complicated, expensive and relatively unreliable in use, due to the complexity of the apparatus.

Due to such variables as bed depth, moisture content of the articles being dried, porosity or permeability to air flow, the ability of the product to withstand drying from one side without degrading by surface carbonization or caramelization, it is the usual practice in presently available apron conveyor type dryers to reverse and/or modify the temperature and volume of air flow by prefixed zones or increments of dryer length. This present method necessitates preliminary testing which is customarily accomplished in a small laboratory unit. Such sample testing may introduce inaccuracies in that the product tested on a small scale may not be representative of the commercial product when considering operating conditions such as time, temperature, direction, and air flow characteristics.

When providing directional flow through a dryer, it is the present practice to fabricate dryers with up-through or down-through air flow by providing a plurality of fans arranged for operation through predetermined fixed directional zones. Drying conditions have customarily been controlled as a function of the dryer length, thereby creating operating difficulties when it is desired to vary internal conditions.

SUMMARY OF THE INVENTION

The present invention relates to a dryer damper and control mechanism, and includes interior baffle construction and co-operating pairs of damper blades which co-act to regulate the direction of flow of heated air through the drying chamber. Additionally, controls have been provided to easily and precisely regulate the volume of air moving through the apparatus, and also to systematically and efficiently adjust air temperatures to the optimum operating conditions for the goods being dried. Volume damper and directional regulators have also been included to permit the operator a wide range adjustment to most effectively utilize the equip-

ment in terms of both time and efficiency of operation and results.

The dryer damper and control mechanism of the present invention incorporates an air generating system which employs air by-pass dampers to control the volume of air passing through the product and directional dampers including pre-programming means to regulate air flow either up-through or down-through the drying bed regardless of fan location or zone position with relation to the bed. The directional dampers permit pre-programmed controlled air intake and exhaust relative to total air intake and exhaust. A plurality of co-operating dampers position within the dryer construction to permit time, volume, direction and temperature adjustments to the air flow through the bed to be readily made on an automatically variable basis.

The mechanism includes means for automatically reversing the direction of air flow to match the diffusion rate of a product to thereby permit higher temperature and diffusion rates. The reversing air flow avoids carbonization or caramelization to thus both increase the drying rate and improve the quality of the final product.

It is a purpose of this invention to increase the versatility of this type of dryer by providing automatic timing, temperature and volume pressure control mechanism that may be re-programmed by zones to alternately reverse air flow and/or re-set the same to correspond with commercial product drying requirements and to increase capacity. This is accomplished by a series of dampers which automatically or manually respond to a re-evaluated or automatically sensed program for drying; accomplished from a "pulsation" through reversal of air flow at timed intervals per zone to a static or conventional pattern. This system has proved valuable in maintaining an evaporation cooling effect with products such as starch or onions where cooking occurs with higher temperatures caused by a continuous directional air flow pattern to thus eliminate former problems resulting in "pinking" or "slumping" of onions and the "modification" of starch.

It is therefore an object of the present invention to provide an improved dryer damper and control mechanism of the type set forth.

It is another object of the present invention to provide a novel dryer damper control mechanism including interior baffle construction and means to control the flow of heated air through the baffle arrangement.

It is another object of the present invention to provide a novel dryer damper and control mechanism incorporating precise air volume control apparatus designed to quickly and efficiently adjust air quantities.

It is a further object of the present invention to provide a novel dryer damper and control mechanism including a plurality of interior baffles and co-operating dampers to direct heated air flow about the baffle construction, including recirculation, direction, application and exhaust.

It is another object of the present invention to provide a drying system that can automatically be programmed to direct air flow up-through or down-through the product being dried for predetermined varying periods of time without regard to zoning, by utilizing a plurality of dampers and precise damper positioning mechanisms.

It is another object of the present invention to provide damper control means to regulate air flow through a dryer, including means to control air volume for multiple selective periods as predetermined and programmed, including balancing inlet and exhaust air volumes.

It is another object of the present invention to provide apparatus capable of programming pulsating drying techniques incorporating alternating air flow directional changes at short time intervals and including temperature control mechanisms.

Another object of the present invention is to provide a novel dryer damper and control mechanism incorporating readily adjustable means to regulate air temperature and humidity conditions within the drying chamber.

It is another object of the present invention to provide a novel dryer damper and control mechanism that is rugged in construction, simple in design, and trouble-free when in use.

Other objects and a fuller understanding of the invention will be had by referring to the following description and claims of a preferred embodiment thereof, taken in conjunction with the accompanying drawings, wherein like reference characters refer to similar parts throughout the several views.

IN THE DRAWINGS

FIG. 1 is a perspective view of a dryer constructed in accordance with the present invention and partially broken away to expose interior construction details.

FIG. 2 is a side elevational view of the invention of FIG. 1 with the side casing removed to expose interior construction, and showing the arrangement of drying chamber dampers in the first operating position.

FIG. 3 is a view similar to FIG. 2 and showing the arrangement of drying chamber dampers in the second operating position.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Although specific terms are used in the following description for the sake of clarity, these terms are intended to refer only to the particular structure of my invention selected for illustration in the drawings, and are not intended to define or limit the scope of the invention.

Referring now to the drawings, I show a dryer 10 generally comprising a structural steel frame 12 and a substantially air-tight casing 14 which may be fabricated of sheet steel or other sturdy construction and bolted or otherwise affixed to the frame 12, in well-known manner. A gear motor control operator 18 mounts upon the roof 20 of the dryer for operation of the drying chamber air control dampers 120, 122, 124, 126, as hereinafter more fully set forth. A pair of fan motors 22, 24, affix to frame roof structural members 26, 28, 30, 32, above the roof 20 in well-known manner, and rotate the fan shafts 34, 36, to operate the fans 38, 40, as hereinafter more fully set forth. The shafts 34, 36, respectively journal through the dryer roof construction 20 in well known manner, to provide sturdy, vibration free fan operation to direct heated air through the interior of the apparatus.

The interior of the dryer 10 is subdivided into a plurality of connecting chambers, by utilizing a plurality of

horizontal and vertical baffles and dampers which position within the baffles to precisely regulate volume, direction, and temperature of the heated air as it travels within the dryer unit. As best seen in FIGS. 2 and 3, the heated air fan 38 pushes the heated air horizontally through the initial chamber 42 towards the forward vertical chamber 44 in the direction indicated by the arrow 46. The curved baffle 48 directs the flow of heated air from the horizontal direction in the initial chamber 42 to a vertical direction in the forward chamber 44 in a smooth transition and vibration-free manner. The drying chamber 50 receives the heated air either downwardly as indicated by the arrow 52 in FIG. 2, or upwardly as indicated by the arrow 54 in FIG. 3, in the manner hereinafter more fully explained. The heated air exits the drying chamber 50 through the after chamber 56 where it may be directed through the exit chamber 58 as indicated by the arrow 60, or else all, or a portion, of the air is guided through the combustion chamber 62 as indicated by the arrow 64 in the manner hereinafter more fully set forth. The heater chamber 66 positions rearwardly of the combustion chamber 62 and receives combustion air either through the side wall opening 68 (FIG. 1), or from the exhaust gas stream as indicated by the arrow 70. (See FIGS. 2 and 3).

As best seen in FIGS. 2 and 3, a horizontal baffle 72 defines the floor of the initial chamber 42 which directs heated air forwardly through the dryer 10. A pivoted damper 74 journals through upright members of the frame 12 and opens as indicated in phantom lines in the direction of the flow of heated air to provide a recirculation path through the recirculating chamber 76 as indicated by the arrow 78. Recirculation may be indicated when it is desired to increase temperatures. A gear motor control 16 mounts upon the roof 20 and pivots the damper 74 about its pivot through the external linkage 80 in response to additional controls (not shown). The damper 74 serves to closely regulate the volume of air recirculated through the recirculation chamber 76 and the volume of air introduced to the drying chamber 50 through the forward vertical chamber 44.

The drying chamber 50 is defined between the recirculation chamber baffle 82 which serves as the roof, the forward vertical chamber baffle 84 which serves as the forward wall and the after chamber baffle 86 which forms the rear wall thereof. A pair of intermediate, transverse sheet steel arms 88, 90, medially depend respectively from the baffles 84, 86, and form substantially air-tight, upper, transverse junctions 92, 94, therewith. The depending sheet steel sections 96, 98, terminate downwardly in co-operating, facing ledges 100, 102, which space apart a sufficient distance to carry the tray 104 to support the articles 106 being dried medially within the drying chamber 50. Each depending section 96, 98, forces inwardly at the respective ledges 100, 102, under urging of the compression springs 108, 110, which bias between a fixed portion of the frame 12 and the baffle side of the depending sections 96, 98. The springs 108, 110, continuously urge the arms 88, 90, into substantially air-tight, transverse contact with the forward and rearward edges of the tray 104 at the respective bottom ledges 100, 102, to assure complete heated air impingement upon the articles

106, either downwardly through the tray as in FIG. 2, or upwardly through the tray as in FIG. 3.

The vertical chamber baffle 84 and the after chamber baffle 86 each transversely divide to form the upper air passage openings 112, 114, and the lower air passage openings 116, 118, to facilitate air movement both upwardly and downwardly through the drying chamber 50 in the directions illustrated by the arrows 52, 54, in FIGS. 2 and 3. Each air passage opening 112, 114, 116, 118, is equipped with a respective, pivoting damper blade 120, 122, 124, 126, for opening or closing the associated air passage in response to operation of the gear motor control operator 18 as desired by the operator of the equipment.

Referring now to FIG. 1, the gear motor control operator 18 functions the external vertical linkage 128, and the connecting, external horizontal linkage 130, 132, which pin together in a manner to assure simultaneous operation. As illustrated, the horizontal linkage 130 functions the damper blades 120, 122, and connects to the vertical linkage 128, in a manner to open the damper blade 120 when damper blade 122 closes, and vice versa. Similarly, the horizontal linkage 132 connects to the vertical linkage 128, to operate the lower dampers 124, 126, simultaneously in a manner to open the damper 124 when damper 126 closes, and vice versa. Also, as best seen in FIGS. 2 and 3, the upper damper 120 opens when the lower damper 124 closes, and the upper damper 122 closes when the lower damper 126 opens. All four dampers 120, 122, 124, 126, function in unison upon operation of the gear motor control operator 18 from an initial position as in FIG. 2 to a final position as in FIG. 3.

When the operator 18 rotates its operating arm 19 to its initial position, the dampers 120, 126, open and the dampers 124, 122, close to direct the heated air downwardly through the drying chamber in the direction indicated by the arrow 52. See FIG. 2. When the operator 18 rotates its operating arm 19 to its final position, the dampers 120, 126, close and the dampers 124, 122, open to direct heated air from the forward vertical chamber 44 upwardly through the tray 104 in the direction indicated by the arrow 54. See FIG. 3. Thus, by simple function of the operator 18 from a first position to a second position, either a downward flow path through the drying chamber 50 results as illustrated in FIG. 2, or an upward flow path through the drying chamber 50 may be provided as illustrated in FIG. 3.

The gear motor control operator 134 affixes to a stationary portion of the frame and pivots the second recirculation damper 136 from an open position as illustrated in FIGS. 2 and 3, toward a closed, horizontal position, (not shown), by utilizing the internal connecting linkage 138 in the usual manner. The recirculation damper 136, when in a closed position, closes upon the solid stop 140 to thereby direct all air from the after chamber 56 towards the exit chamber 58 along the path indicated by the arrow 142. In this manner, humid air from the drying chamber 50 may be completely exhausted. When it is desired to recirculate the air from the after chamber 56, the operator 134 functions to open the damper 136 to the position illustrated in FIGS. 2 and 3 where impingement of the air stream on the damper 136 allows some of the air to recirculate

through the combustion chamber 62 along the path of the arrow 64. More or less recirculated air may be directed into the combustion chamber 62 by regulating the opening position of the chamber 136 to thereby precisely control humidity conditions in the drying chamber.

The air heater 144, of any well known design, pulls its combustion air through the opening 68 and directs its flame 146 into the combustion chamber 62 wherein the heated air flows to the suction of the fan 38. A secondary air damper 148 journals within the frame 12 and pivots from an open position as illustrated in FIGS. 2 and 3, to a closed position to optionally admit or bar the entrance of heated air into the heater chamber 66 along the path indicated by the arrow 70. A gear motor control operator 150 functions the damper 148 through the internal linkage 152 in response to external controls (not shown), thereby to provide convenient, economical utilization of the waste heat whenever so desired. It will be appreciated that the exit gases traveling along the path 142 have already been pre-heated in the combustion chamber 62 and, accordingly, any heated air reintroduced into the heater chamber 66 about the damper 148 will require less fuel to reheat to operating temperatures.

The exhaust fan 40 positions near the dryer roof 20 with its suction at the top of the exit chamber 58, and cooperates to pull the heated air through the dryer 10 in conjunction with the pressurizing effect of the fan 38. The exhaust air exits the dryer 10 at the fan 40 discharge, as illustrated by the arrow 154.

In operation, the air heater 144 heats the drying air in the combustion chamber 62 where it then travels upwardly toward the suction of the heated air fan 38. The heated air travels through the horizontal, initial chamber 42 under impetus of the fan 38 and downwardly into the forward vertical chamber 44. If it is desired to reduce the volume of air introduced into the combustion chamber 50 as determined by the drying requirements of the articles 106, the operator 16 is energized to function the vertical linkage 80 to open the damper 74 for recirculation of a pre-determined volume of air along the path of the arrow 78. Air follows the path 46 through the forward vertical chamber 44 and enters the drying chamber 50, either above the tray 104 along the path 52 as in FIG. 2, or from below the tray 104 along the path 54, as in FIG. 3. The path through the drying chamber 50 may be readily controlled by functioning the operator 18 from an initial position as in FIG. 2 to a final position as in FIG. 3, thereby to simultaneously pivot the respective damper blades 120, 122, 124, 126, to provide either desired flow path. After exiting the drying chamber 50 through either the opening 114 or the opening 118, all of the exhaust air may be discharged through the exit chamber 58 by the exhaust fan 40. Optionally, a portion of the exhaust air may be recirculated along the path 64 upon opening the damper 136 by operation of the linkage 138 through the operator 134. External controls, (not shown), function the operator 134, thereby to allow heated exhaust air either to recirculate upwardly through the combustion chamber 62 or to exit the dryer 10 along the path of the arrows 142, 60, 154.

Combustion air for the air heater 144 enters the heater chamber 66 through the opening 68. If desired,

the operator 150 may be functioned through external controls (not shown), to move the linkage 152 to swing the damper blade 148 to an open position to allow heated air to enter the combustion chamber 66 along the path illustrated by the arrow 70. Thus it is shown that a novel dryer damper and control mechanism has been demonstrated which permits utilization of the device most efficiently, in accordance with the options permitted through use of the several dampers and baffles. External controls responsive to various interior climatic conditions such as temperature, humidity, velocity, and volume, may be incorporated in well known manner to monitor dryer environmental conditions and to automatically function the various operators 16, 18, 134, 150, to vary the interior conditions.

What I claim is:

1. In an article dryer of the type including an enclosing casing, an air heater operatively positioned within the casing and fan means directing a heated air stream through a drying chamber, the combination consisting of:

- A. a frame supporting the said casing,
 - B. baffle means interiorly affixed to portions of the said frame,
 - 1. said baffle means subdividing the interior of the dryer into a plurality of chambers,
 - 2. a first portion of said baffle means defining an article drying chamber,
 - said first portion of the baffle means including a forward drying chamber baffle and a rearward drying chamber baffle, each of said drying chamber baffles being provided with respective upper and lower openings;
 - C. first damper means positioned in the first portion of the baffle means and journaled into the frame for rotative movement with respect thereto,
 - 1. said first damper means having a first position and a second position,
 - 2. said first damper means directing heated air upwardly through the drying chamber when in the said first position,
 - 3. said first damper means directing heated air downwardly through the drying chamber when in the said second position,
 - 4. said first damper means rotating within the said upper and lower openings,
 - a. said first damper means including upper and lower forward dampers, and upper and lower rearward dampers,
 - b. the said upper forward damper closing the forward baffle upper opening, and the lower forward damper opening the forward baffle lower opening when the first damper means assumes the said first position.
2. The invention of claim 1 wherein the upper rear-

ward damper opens the rearward baffle upper opening, and the lower rearward damper closes the rearward baffle lower opening when the first damper means assumes the said first position.

3. The invention of claim 1 wherein a second portion of the said baffle means defines a combustion chamber, said combustion chamber being positioned downstream of the drying chamber, said combustion chamber being equipped with a recirculation damper which is movable between an open position and a closed position, said second recirculation damper directing a portion of the heated air stream effluent from the drying chamber into the combustion chamber when in the said open position.

4. The invention of claim 3 wherein a third portion of said baffle means defines a heater chamber, said heater chamber being positioned downstream of the drying chamber, said heater chamber being equipped with a damper which is movable between an open position and a closed position, said damper directing a portion of the heated air stream effluent from the drying chamber into the heater chamber when in the said open position.

5. In an article dryer of the type including an enclosing casing, an air heater operatively positioned within the casing, and fan means directing a heated air stream through a drying chamber, the combination consisting of:

- a. a frame supporting the said casing,
- b. baffle means interiorly affixed to portions of the said frame,
 - said baffle means subdividing the interior of the said dryer into a plurality of chambers,
 - a first portion of said baffle means defining an article drying chamber,
- c. first damper means positioned in the first portion of the baffle means and journaled into the frame for rotative movement with respect thereto,
 - said first damper means having a first position and a second position,
 - said first damper means directing heated air upwardly through the drying chamber when in the said first position,
 - said first damper means directing heated air downwardly through the drying chamber when in the said second position,
- d. second damper means positioned upstream from the first damper means,
 - said second damper means recycling a portion of the heated air to the fan means, and
- e. third damper means positioned within the casing downstream from the drying chamber, said third damper means recycling a portion of the heated air effluent from the drying chamber to the said fan means.

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