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R. A. WASSON ETAL

3,217,790

AIR CONDITIONING UNIT

Filed April 14, 1961

3 Sheets-Sheet 1

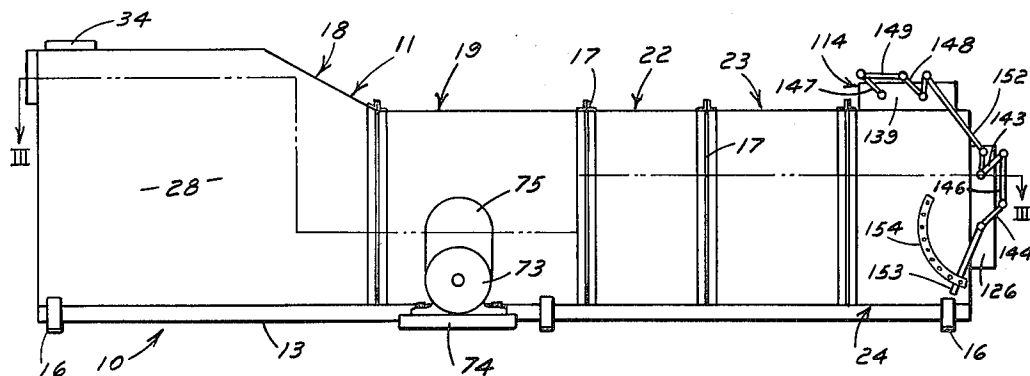


fig. 1

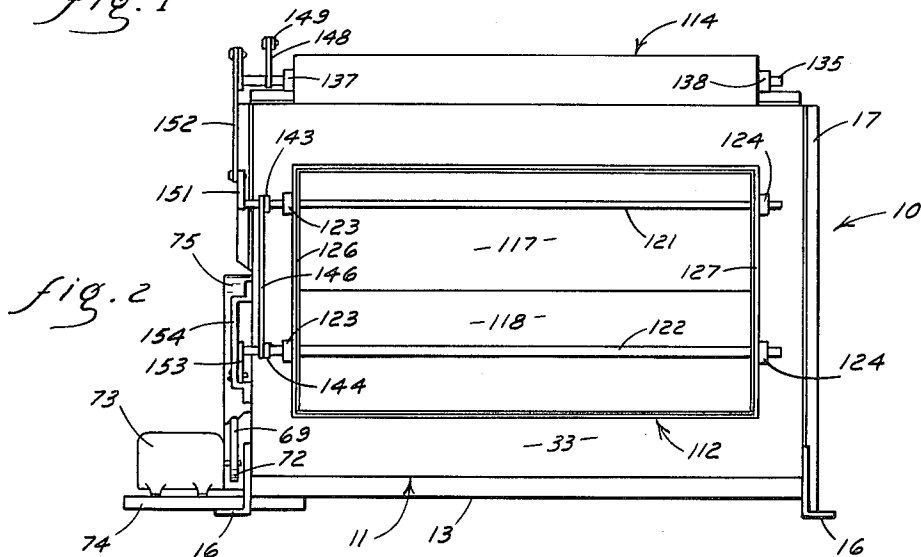


fig. 2

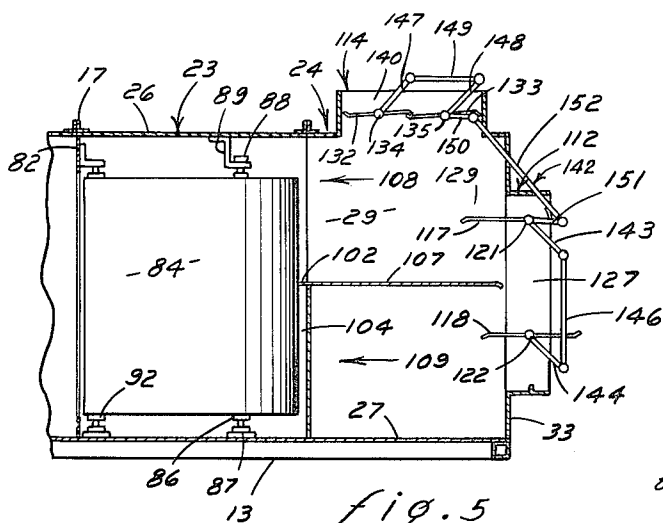


fig. 5

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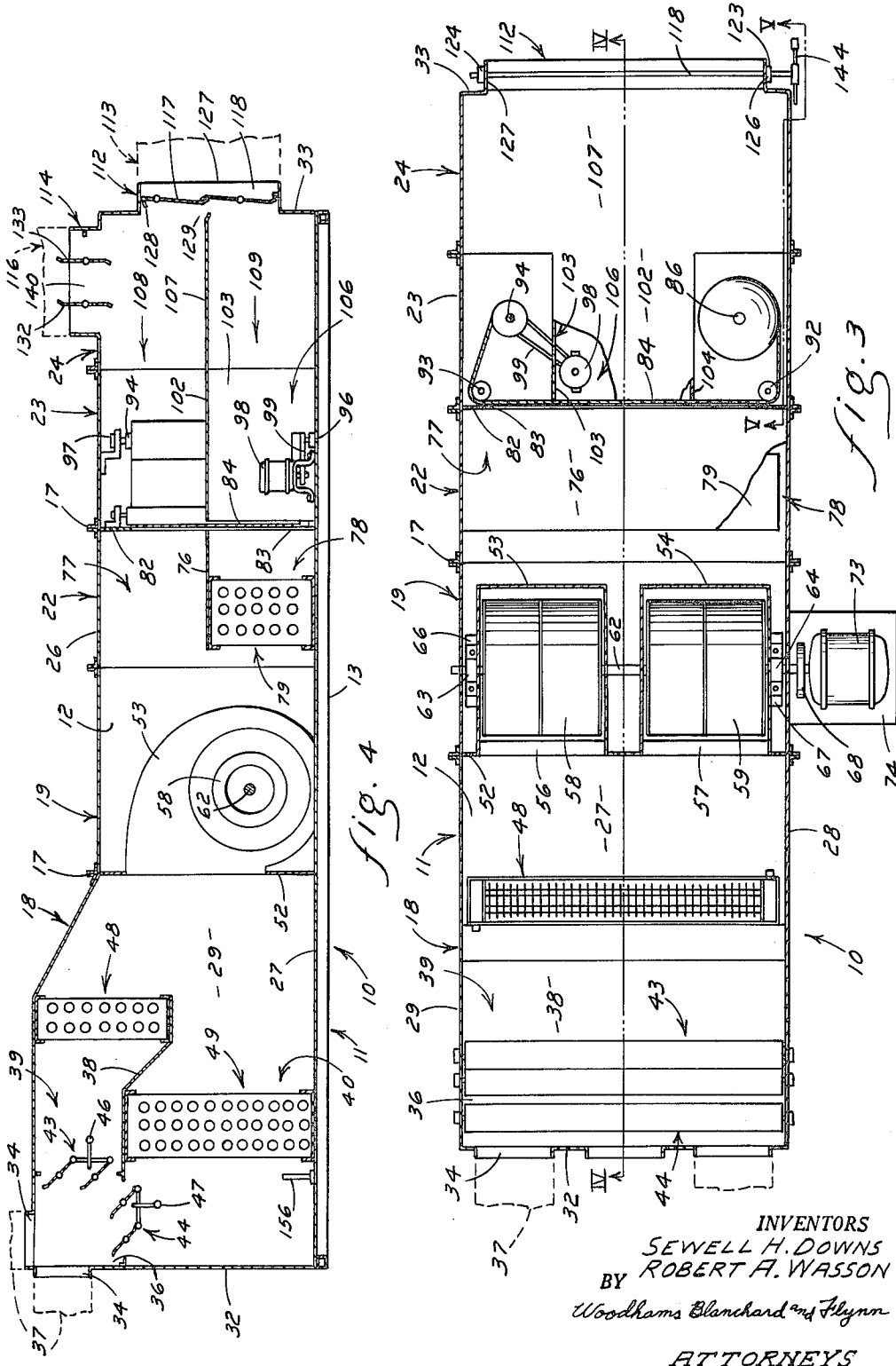
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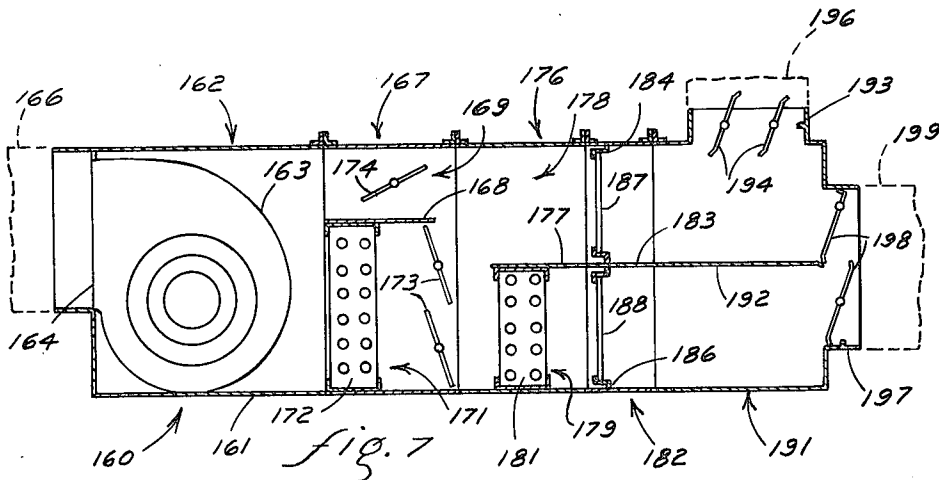
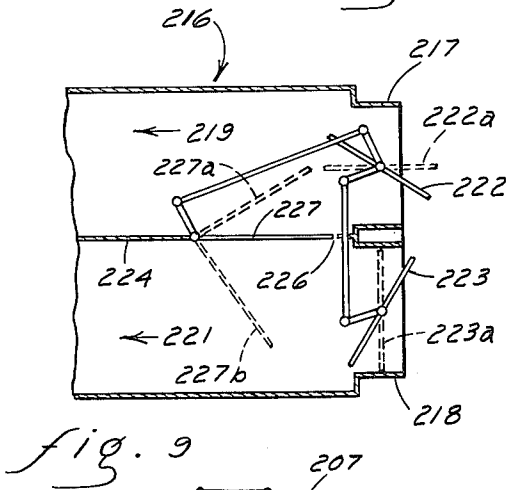
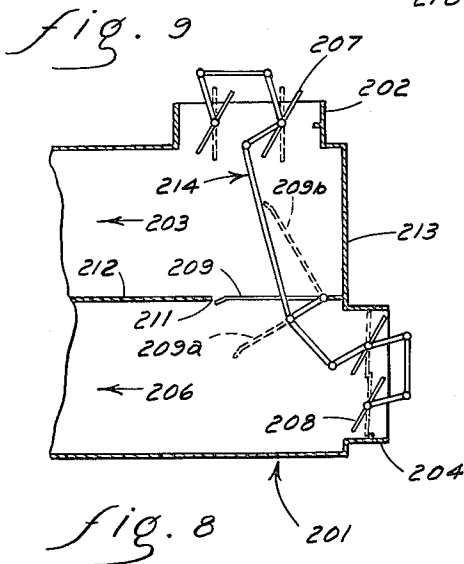
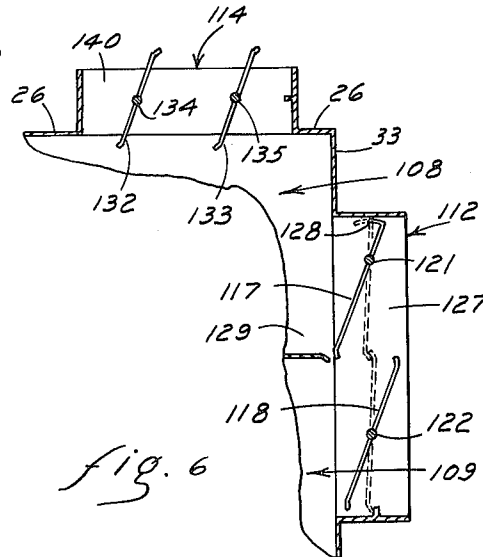
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AIR CONDITIONING UNIT

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5 Claims. (Cl. 165—16)

This invention relates in general to an apparatus for conditioning air and, more particularly, to an apparatus for moving air and, at the same time, controlling both the temperature and humidity of the moving air.

The use of air conditioning equipment has been wide spread, and the advantages of such use have been well known for many years. It has been common practice to use the same air conditioning unit for the purposes of both heating the air during cold weather and cooling the air during warm weather. Generally speaking, air conditioning apparatus of this type adds greatly to both the comfort and efficiency of workmen in buildings where it is installed. Thus, air conditioning apparatus has very nearly become a necessity in commercial and industrial buildings occupied by substantial numbers of people.

It has long been recognized, however, that air conditioning equipment, particularly of the unit type, does not always produce satisfactory results during certain types of warm weather, even though the equipment is operating and performing properly. That is, there are times during the warm weather operation of such units that they do not remove enough moisture from the air moving through the unit. Thus, a dank, clammy and uncomfortable condition may develop in the space served by the unit. This problem arises, as a rule, on warm cloudy days, during early morning hours, or when the number of occupants in the conditioned space is below normal and, at the same time, when the outside air is humid. Under any one of these circumstances, there is little or no demand for cooling so that the cooling coils in existing air conditioning units will be operated substantially below design conditions.

Dehumidification in unit air conditioners is generally effected by the cooling coil of the unit. Thus, where there is little or no demand for cooling, the mixture including the humid fresh air and the recirculated air, which is also often humid, bypasses the cooling coil. Accordingly, the recirculated air will often contain an excessive amount of moisture, even though it is cool, after a prolonged period of recirculation without material cooling. The continual addition of fresh air (often as much as 25 percent of the mixture) is required for a healthful condition.

The invention is described and discussed herein in terms of air since the conditioning of air for human comfort gave rise to the invention. However, it will be apparent that an apparatus embodying the invention can be used to condition gases other than air. Moreover, it will be recognized that apparatus of the character described herein can also be used for industrial process conditioning wherein outside air is used and/or wherein the process creates variations in the load on the conditioning apparatus.

Accordingly, the primary object of this invention has been the provision of an apparatus for moving gas through a zone and for controlling the temperature and humidity of said gas as it moves through the zone.

A further object of this invention has been the provision of an apparatus, as aforesaid, which is capable of controlling the humidity of a mixture of fresh and recirculated air being urged into a substantially confined space and within a wide range of temperatures, and par-

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ticularly under conditions where the demand for cooling of such air is at a minimum.

A further object of this invention has been the provision of an air conditioning apparatus, as aforesaid, which can be adjusted to dehumidify all or a part of the fresh air which is drawn into the apparatus and which is mixed with the recirculated air under normal, warm weather operating conditions, even when the demand for cooling of the air moving through the conditioning apparatus is at a minimum.

A further object of this invention has been the provision of an air conditioning apparatus, as aforesaid, in which the above-mentioned objects can be met without materially increasing the size, cost and/or operating problems normally encountered in and with air conditioning equipment of the same general character and intended for the same general purposes.

A further object of this invention has been the provision of an air conditioning apparatus, as aforesaid, which is capable of performing with substantially the same efficiency and at no substantial increase in cost by comparison with existing conditioning equipment which does not embody the invention but is intended for similar purposes.

Other objects and purposes of this invention will become apparent to persons familiar with this type of equipment upon reading the following descriptive material and examining the accompanying drawings, in which:

FIGURE 1 is a side elevational view of an air conditioning apparatus embodying the invention.

FIGURE 2 is an end elevational view of said air conditioning apparatus taken from the inlet end thereof, that is, the right-hand end of the apparatus as appearing in FIGURE 1.

FIGURE 3 is a sectional view taken along the line III—III in FIGURE 1.

FIGURE 4 is a sectional view taken along the line IV—IV in FIGURE 3.

FIGURE 5 is a broken sectional view taken along the line V—V in FIGURE 3.

FIGURE 6 is an enlarged fragment of the structure appearing in FIGURE 4 near the inlet end thereof and showing the dampers in a different position of operation.

FIGURE 7 is a central, substantially vertical sectional view of a modified air conditioning apparatus embodying the invention.

FIGURE 8 is a fragment of FIGURE 7 showing an alternate damper section.

FIGURE 9 is a fragment of FIGURE 7 showing another alternate damper section.

For the convenience in description, the terms "upper," "lower" and words of similar import will have reference to the conditioning apparatus in its normal position of operation and as shown in FIGURES 1 and 4. The terms "inlet or upstream end," "outlet or downstream end" and words of similar import shall have reference to the right and left ends, respectively, of the conditioning apparatus as appearing in FIGURES 3, 4 and 7. The terms "inner," "outer" and derivatives thereof will have reference to the geometric center of said conditioning apparatus and parts thereof.

General description

The objects and purposes of the invention, including those set forth above, have been met by providing an elongated and substantially tubular, sheet metal casing defining a chamber having a discharge or outlet opening at one end and a pair of inlet openings at the other end. An air-moving device, such as a centrifugal blower, is disposed within the chamber for moving air through said chamber, lengthwise thereof. The downstream end of the chamber may be divided by wall means into first and

second passageways which communicate between the air-moving device and the outlet opening. Controllable, heat exchange means, such as cooling and/or heating coils, is preferably disposed in the first and second passageways. Damper means may be provided at the downstream ends of these passageways to control the movement of air through said outlet opening.

As shown in the drawings, the relative positions of the air-moving device and the heat exchange means may be reversed within the casing where a draw-through unit (instead of a blow-through unit) is desired.

The upstream end of the chamber is divided by wall means into third and fourth passageways which communicate at their downstream ends with said air-moving device. The upstream ends of the third and fourth passageways communicate with said inlet openings. In the preferred embodiment, dampers are arranged in and adjacent said inlet openings so that both of said inlet openings can be caused to communicate with one or both of the third and the fourth passageways. Filter means intersects both of said third and fourth passageways, and an air-cooling device is provided in the fourth passageway downstream of the filter means. The dampers are connected to control mechanism for adjusting the movement of air through said inlet openings.

The second cooling device reduces the absolute humidity of the air moving through the fourth passageway so that its addition to the air moving through the third passageway also reduces the absolute humidity of the mixture below that of the recirculated air.

Detailed construction

The conditioning apparatus 10 (FIGURES 1 and 2), which has been selected to illustrate a preferred embodiment of the invention, is comprised of an elongated, substantially tubular casing 11 defining an elongated chamber 12. The casing 11 is supported upon a substantially rectangular frame 13, which may be fabricated from metallic, structural members. A plurality of brackets 16 are secured to the lengthwise edge elements thereof for the purpose of suspending or supporting the entire apparatus in a substantially conventional manner, preferably near the zone to be conditioned thereby. The casing 11 may be fabricated from metallic, sheet material of relatively light gauge and appropriately re-enforced by steel, brace elements 17 located at intervals lengthwise thereof. Under normal circumstances, the casing 11 is built in sections for convenience of manufacture and maintenance, such sections being held together by the frame 13 and the brace elements 17, which are located along the adjacent edges of the sections.

In this particular embodiment, and for convenience in description, the casing 11 and its chamber 12 (FIGURES 3 and 4) are divided into a controllable, heat exchange section 18, a fan section 19, a cooling and dehumidification section 22, a filter section 23, and a damper section 24. It will be apparent that the heat exchange section 18 can be subdivided into additional sections, if desired. Moreover, and as appearing in FIGURE 7, the heat exchange section can be placed upstream of the fan section to provide a draw-through unit. The casing 11, hence the above-mentioned sections thereof, are defined by the top sheet 26, the bottom sheet 27, the side sheets 28 and 29 and the end sheets 32 and 33.

One or more flanged outlets 34 (FIGURE 4) are provided in one or both of the top sheet 26 and end sheet 32 adjacent the junction thereof for connection with outlet pipes 37. The outlets 34 communicate with a mixing zone 36 within the adjacent portion of the heat exchange section 18. A substantially horizontal wall 38 extends across the heat exchange section 18 between the side sheets 28 and 29 to define upper and lower passageways 39 and 40, which communicate at their outlet ends with the side and bottom, respectively, of the mixing zone 36. Damper assemblies 43 and 44 are disposed across the

passageways 39 and 40, respectively, at their junctions with the mixing zone 36 for the conventional purpose of controlling the amount of gas or air moving from said passageways into said mixing zone 36. A pair of damper controllers 46 and 47 may be connected to the damper assemblies 43 and 44, respectively, for the purpose of effecting temperature responsive, remote control of the air moving into the mixing zone 36, hence through the outlet openings 34.

A substantially conventional heating coil 48 (FIGURE 4) may be provided in the upper passageway 39 for raising the temperature of air moving therethrough. A substantially conventional cooling coil 49 is provided in the lower passageway 40 for cooling and dehumidifying the air moving therethrough. The upper and lower passageways 39 and 40 communicate with each other at their inlet ends which are spaced downstream from the partition 52 which separates the heat exchange section from the fan section 19.

In this particular embodiment, the fan section 19 (FIGURES 3 and 4) contains a pair of centrifugal fan housings 53 and 54 which may be, and preferably are, substantially identical. Said fan housings have outlets 56 and 57 which communicate with appropriate openings in the partition 52. The air discharged from said housings 53 and 54 by the centrifugal impellers 58 and 59, respectively, therewithin enters the heat exchange section 18 at the junction therein of the upper and the lower passageways 39 and 40, respectively. The impellers 58 and 59 are preferably, but not necessarily, mounted upon a single shaft 62 which is supported by the bearings 63 and 64 which in turn are mounted upon the bearing supports 66 and 67, respectively. The fan housings 53 and 54 and their impellers 58 and 59 are preferably of the double inlet type to effect a maximum movement of air through the fan section 19 and into the heat exchange section 18.

One end of the shaft 62 extends through the side sheet 28 and a pulley 68 is secured thereto (FIGURE 3). The pulley 68 is connected by a belt 69 (FIGURE 2) to a pulley 72 mounted upon the shaft of a motor 73. A bracket 74 for supporting the motor 73 is mounted upon the frame 13 adjacent the side sheet 28. A drive housing 75, which surrounds the pulleys 68 and 72, is mounted upon the side sheet 28.

The precooling and dehumidification section 22 (FIGURE 4) has a horizontal wall 76 between the top sheet 26 and bottom sheet 27 which divides the dehumidification section into upper and lower compartments 77 and 78. A heat exchanger, such as a cooling coil 79, is disposed within the lower compartment 78. The dehumidification section 22 is separated from the filter section 23 by a partition 82 (FIGURES 3 and 4) having a large opening 83 therethrough which is normally covered by a filter panel 84 which extends from a point near the lower end of the lower compartment 78 to a point near the upper end of the upper compartment 77.

In this particular embodiment, the filter panel 84 (FIGURES 3 and 4) is part of an elongated sheet of filter material which is connected to and rolled upon a spindle 86 (FIGURE 3), which spindle is rotatably supported in a substantially vertical position by the bearings 87 and 88 (FIGURE 5). The lower bearing 87 is mounted upon the bottom sheet 27 near the side sheet 28 and the upper bearing 88 is supported upon a bracket 89 which may be secured to the top sheet 26 (FIGURE 5). The filter sheet 84 passes around a pair of vertical guide rollers 92 and 93, which are rotatably supported adjacent the partition 82 near the opposite, side edges thereof. The guide rollers 92 and 93 are rotatably supported within upper and lower bearings in substantially the same manner as set forth above with respect to the spindle 86. The filter sheet 84 is also connected to and is rolled upon the take-up spindle 94 (FIGURES 3 and 4), which is supported in a substantially vertical position by the

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bearing members 96 and 97 in substantially the same way as set forth above with respect to the spindle 86. The spindle 94 is connected to the motor 98 by drive means 99 for intermittent rotation thereby, whereby the portion of the filter sheet 84 disposed across the opening 83 in the partition 82 is periodically changed to insure the continuous movement of clean air through said filter sheet 84 and a minimum of obstruction to such movement of said air.

The filter section 23 (FIGURE 4) has a substantially horizontal wall 102 between the top sheet 26 and the bottom sheet 27, which wall is preferably coplanar with the wall 76 in section 22. The wall 102, which extends from adjacent the partition 82 to the inlet side of said filter section 23, is spaced a substantial distance from the side sheets 28 and 29 to prevent interference thereof with the portion of the filter sheet 84 on the spindles 86 and 94. A pair of substantially parallel walls 103 and 104 are secured along their upper edges to the lateral edges of the horizontal wall 102 and extend downwardly therefrom to the bottom sheet 27 to define a tunnel 106 which communicates through the opening 83 in the partition 82 with the lower compartment 78, only, of the dehumidification section 22. Thus, any air drawn through the lower compartment 78 must pass through the tunnel 106 and the cooling coil 79. The motor 98 is disposed within the tunnel 106 to facilitate the cooling thereof.

The damper section 24 (FIGURE 4) has a substantially horizontal wall or splitter plate 107 which may, at least in effect, be a continuation of the horizontal wall 102 in the filter section 23. Thus, ignoring the existence and effect of the filter 84, the splitter plate 107 (FIGURE 4), the horizontal wall 102 and the horizontal wall 76 combine to define the lower wall of an upper path 108 through the damper section 24, the filter section 23 and the dehumidification section 22. The same walls define the upper side of a lower path 109 through the same sections.

The splitter plate 107 (FIGURE 4) is preferably arranged so that it intersects horizontally, the flanged, fresh air inlet 112 in the end wall 33 of said damper section 24. The flange of the inlet 112 may be connected to a source of fresh air by a duct 113. The recirculation inlet 114 in the top of the damper section may be connected to a duct 116 for returning to the upper path in the damper section 24 the air to be recirculated by the apparatus 10.

Two substantially horizontal damper blades 117 and 118 (FIGURE 6) are secured to damper shafts or rods 121 and 122, respectively, which extend horizontally through the inlet 112. The opposite ends of the damper shafts 121 and 122 (FIGURE 2) are rotatably supported within bearings 123 and 124, which are respectively supported upon the side flanges 126 and 127 (FIGURE 2) of the inlet 112. The upper damper shaft 121 is secured to its blade 117 nearer to the upper edge than to the lower edge thereof. Said upper damper blade 117 has an inwardly extending integral flange 128 along its upper edge, for blocking movement of fresh air past said upper edge and into the upper path 108 when said blade is in any position between its broken and solid line positions appearing in FIGURE 6.

The lower damper shaft 122 (FIGURE 6) is secured to its blade 118 approximately midway between its upper and lower edges so that fresh air can move past said lower damper blade 118 into the lower path 109 whenever the blade 118 is moved away from its substantially vertical, solid line position of FIGURE 4.

A pair of damper blades 132 and 133 (FIGURE 6) are mounted upon horizontal shafts or rods 134 and 135 substantially midway between their lengthwise edges for pivotal support thereby within the return air inlet 114. Said shafts 134 and 135 are pivotally supported at their opposite ends by bearings 137 and 138 (FIGURE

2) upon the side flanges 139 and 140, respectively, of the return air inlet 114.

As shown in FIGURES 1 and 5, the shafts 121, 122, 134 and 135 are interconnected by linkage 142 for effecting simultaneous adjustment of the damper blades 117, 118, 132 and 133. Said linkage 142 includes a pair of cranks 143 and 144 which are secured upon the damper shafts 121 and 122, respectively, adjacent the side flange 126 so that they extend in the same relative direction when their damper blades 117 and 118 are substantially parallel. The outer ends of the cranks 143 and 144 are pivotally connected to a link bar 146. A pair of cranks 147 and 148 are secured respectively to the ends of the damper rods 134 and 135 adjacent the side flange 139 so that they extend in the same relative radial direction when their respective blades 132 and 133 are substantially parallel. The outer ends of the cranks 147 and 148 are pivotally connected to the opposite ends of a link bar 149.

A pair of cranks 150 and 151 (FIGURE 5) are secured to the shafts 135 and 121, respectively, and are pivotally connected to the opposite ends of a link bar 152. Accordingly, pivotal movement of any one of the cranks in the linkage 142 effects simultaneous pivotal movement of the damper shafts secured thereto and of the damper blades 117, 118, 132 and 133 on said shafts. However, the individual blades may be adjusted with respect to each other, if desired.

In this particular embodiment, the link bars 146, 149 and 152 (FIGURE 5) are arranged so that their pivotal connections to the cranks involved are at the same radial distance from their respective shafts, whereby the damper blades 117 and 118 (FIGURE 4) are fully closed when the damper blades 132 and 133 are fully opened, and vice versa as seen in FIGURE 5. The damper blades are preferably arranged within the inlets 112 and 114 so that the upper damper blade 117 with its flange 128 substantially blocks the movement of fresh air through the inlet 112 into the upper path 108 whenever the lower damper blade 118 is in any position between its fully closed (broken line) position shown in FIGURE 6 and its partially open (solid line) position in FIGURE 6. The relative angular positions of the blades 117 and 118 may be adjusted to vary the relationship of the airflow through the two inlets into the passageways.

In one blade relationship, for example, the lower damper blade 118 (FIGURE 6) is set so that it can permit an amount of fresh air to enter into the lower path 109, which amount can be varied from zero to about twenty-five percent of the air discharged from the apparatus 10, without permitting any fresh air to move through the upper path 108. The fresh air which enters the lower path 109 must pass through the cooling coil 79 and be dehumidified before it is mixed with the recirculated air moved through the upper path 108. When the ratio of fresh air to recirculated air is increased by appropriate movement of the linkage 142, hence the dampers 117 and 118, some of the fresh air will be permitted to move past the damper blade 117 into and through the upper path 108. Where the damper 117 is positioned (by the linkage 142) between its broken and solid line positions in FIGURE 6, then some of the recirculated air will tend to move between the blade 117 and the splitter plate 107 into the lower path 109.

A control lever 153 (FIGURES 1 and 2) is secured to the end of the damper shaft 122 adjacent the crank 144 so that it extends beneath the quadrant 154 mounted upon the side sheet 28 whereby the damper blades 117, 118, 132 and 133 can be releasably locked in any selected position, in a conventional manner.

Operation

With the conditioning apparatus 10 constructed and arranged as described above, warm weather operation may be effected by connecting the cooling coils 49 and

79 to a source of coolant, such as cold water, in a substantially conventional manner. After appropriate adjustment of the damper blades 117, 118, 132 and 133, said blades can be simultaneously moved so that they will admit the desired amount of fresh air in proportion to return air through the flanged inlets 112 and 114, respectively. In climates where the ambient, atmospheric air is relatively humid, it will normally be advantageous to position said damper blades so that the upper damper blade 117 in the fresh air inlet 112 is between its solid and broken line positions of FIGURE 6. As stated above, this will permit the entry of adequate fresh air into the lower path 109 to satisfy the normal minimum requirements for healthy conditions according to the established standards, without permitting such fresh air to bypass the cooling coil 79. In this particular embodiment, up to about 25 percent of the mixture moved through the fan section 19 can be fresh air without permitting such fresh air to bypass the coil 79. However, this amount of fresh air can be reduced by moving the lower damper, only, so that the fresh air still moves through the lower path 109 and the recirculated air still moves only through the upper path 108. However, if the fresh air intake is reduced by moving the linkage 142, then some recirculated air can move into and through the lower path 109. Conversely, if the fresh air intake is increased by moving the linkage 142, then some of the fresh air will bypass the coil 79 through the upper path 108.

If the fan motor 73 is energized when the damper blades are in their solid line positions of FIGURE 6, fresh air will be drawn through the lower path 109 while the recirculated air is drawn through the upper path 108 and mixed by the fan impellers 58 and 59. Thereafter this air is discharged into the passageways 39 and 40 in proportion to the settings of the damper assemblies 43 and 44, which may be controlled by remotely located thermostats, for example. When the coil 79 is operating, the fresh air passing through the lower path 109 is cooled and dehumidified by the coil 79 so that it decreases the absolute humidity of the recirculated air moving through the upper path 108 when they are mixed in the fan section 19. A suitable control, including a temperature sensitive device 156 (FIGURE 4) located downstream of the cooling coil 49, for example, may be provided to operate the coil 79 automatically. That is, such control is arranged so that coolant will be moved through the coil 79 when the device 156 indicates that the temperature downstream of coil 49 is above a certain limit. Thus, if the air mixture discharged from fan section 19 is so cool that it bypasses the coil 49, or if the coil 49 does not have sufficient capacity to cool the mixture enough, then the coil 79 is operated. Obviously, the coil 79 can be used as the main cooling coil, and the coil 49 can be controlled by a temperature sensitive device located adjacent the downstream side of the coil 79.

If the ambient atmosphere is relatively dry, larger amounts of fresh air can be brought into the damper section 24 by moving the main control lever 153 so that the upper damper blade 117 does not block the entrance of fresh air into the upper path 108. The fresh air which bypasses the cooling coil 79 can be cooled, if required, by the cooling coil 49 in the temperature control section 18, in response to the operation of the damper assemblies 43 and 44.

Periodically, the motor 93 will be operated to advance the filter sheet 84 so that a relatively clean portion of said filter sheet will be stretched across the opening 83 in the partition 82 at all times.

Alternate structure

The structure disclosed in FIGURES 1 through 6 includes those sections (such as fan section 19, filter section 23, etc.) which are most frequently found in air conditioning units for commercial and industrial use. However, it will be recognized that the invention may be

applied to air conditioning units having different arrangements of the same sections or more or less sections than those disclosed. For example, the alternate air conditioning apparatus 160 includes an elongated, substantially tubular casing 161 having a fan section 162 at the outlet end of the casing 161. The centrifugal fan 163 disposed within the fan section 162 has its outlet communicating with and discharging through the outlet opening 164 in the casing 161, which may be connected to an outlet duct 166 in a substantially conventional manner.

The casing 161 also includes a controllable, heat exchange section 167 immediately upstream of the fan section 162. The heat exchange section 167 contains a substantially horizontal splitter plate 168 defining upper and lower passageways 169 and 171, respectively, through the heat exchange section. A heat exchange device, such as the coil 172, is disposed within and extends across the lower passageway 171 near the downstream end thereof. Face dampers 173 are disposed within the lower passageway 171 adjacent the upstream end thereof. A bypass damper 174 is mounted within the upper passageway 169, which is normally substantially smaller in cross-sectional area than the lower passageway. The coil 172 may be used alternatively to cool or heat the gas moving there-through.

The cooling and dehumidification section 176 is located directly upstream from the heat transfer section 167 and has a horizontal splitter plate 177 dividing the section into upper and lower passageways 178 and 179, respectively. A dehumidification device, such as a cooling coil 181, is located within the lower passageway 179. The downstream ends of the passageways 178 and 179 are spaced upstream from the passageways 169 and 171 so that the recirculated and fresh air can mix and flow through the coil 172, the bypass 169 or through both.

The filter section 182, which is connected to the dehumidification section 176 on the upstream side thereof, has a splitter plate 183 which is preferably coplanar with the splitter plate 177 and thereby extends the passageways 178 and 179 into and through the filter section 182. Support frames 184 and 186 are mounted within, and around the walls defining, the upper and lower passageways 178 and 179, respectively, for the purpose of supporting substantially conventional flat filter pads 187 and 188 within the section 182.

A damper section 191 (FIGURE 7) is connected to and communicates with the upstream end of the filter section 182 and may be similar to, if not substantially identical with, the damper section 24 shown in FIGURE 5. The damper section 191 (FIGURE 7) includes a splitter plate 192 which is preferably coplanar with the splitter plate 183 in the filter section 182 so that said upper and lower passageways 178 and 179 are continued through the damper section 191. The damper section 191 has an upwardly opening inlet 193 in which dampers 194 are mounted and to which a duct 196 may be connected for the purpose of returning air from the space or zone being conditioned by the apparatus 160. The damper section 191 also has an endwardly opening inlet 197 in which the dampers 198 are disposed. The inlet 197 may be connected by a duct 199 to a source of fresh air. The dampers 194 and 198 are preferably arranged and constructed so that they may operate in the same manner as the corresponding dampers discussed above with respect to the damper section 24 of FIGURE 5. Thus, as dampers 194 are opened, dampers 198 are closed and vice versa.

By appropriate setting of the dampers in the alternate air conditioning apparatus 160, a variety of different controlled and conditioned air flows can be produced to satisfy all reasonable demands for comfort conditioning in the conditioned space. For example, with the dampers set as appearing in FIGURE 7, all of the fresh air is directed through the lower passageway 179 and all of the recirculated air is moved through the upper passageway 178. The recirculated and fresh air are then mixed and

part of the mixture is directed through the heat exchange coil 172 and the remainder moves through the bypass passageway 169 after which such air is again mixed and discharged from the conditioning unit by the fan 163. Under these conditions, the operation of the cooling coil 181 can be controlled either automatically, as discussed above with respect to coil 79, or manually when the need arises to reduce the absolute humidity of the air moving through the lower passageway 179. By thus reducing the absolute humidity of the air moving through the lower passageway 179, the relative humidity in the conditioned space is also reduced. Further cooling (or heating) of the air may be effected as it passes through the heat exchange section 167 by appropriate operation of the face and bypass dampers 173 and 174, respectively, and the coil 172.

The dampers 194 and 198 may be interconnected for simultaneous operation in the same manner as the dampers of the damper section 24 (FIGURE 5). Thus, the dampers 194 and 198 can be operated to control the amount of recirculated air moving or flowing through the upper passageway 178 and the amount of fresh air moving or flowing through the lower passageway 179. Moreover, when the dampers 194 are completely or nearly closed, fresh air will pass through both of the upper and lower passageways 178 and 179 from the inlet opening 197. On the other hand when the dampers 198 are nearly or fully closed, recirculated air will pass through the upper passageway 198 and through the lower passageway 179. In this latter arrangement, part of the recirculated air is moved through the cooling coil 181 for the purpose of reducing its absolute humidity.

FIGURE 8 illustrates a modified damper section 201 wherein the upper inlet opening 202 communicates with the upper passageway 203, only, and the end inlet opening 204 communicates with the lower passageway 206, only. The dampers 207 are mounted in the upper inlet 202 and dampers 208 are mounted in the end inlet 204. The section 201 includes a splitter plate 212 having an opening 211 near the end wall 213. A damper 209 is hingedly supported upon the splitter plate 212 adjacent the end wall 213 and within the opening 211 so that said damper 209 is pivotally movable around an axis parallel with the axes of the dampers 207 and 208. The damper 209 is movable between a first broken line position 209a, projecting into the lower passageway 206, and a second broken line position 209b, extending into the upper passageway 203. The damper 209 is connected by linkage 214 to the dampers 207, 208 so that the dampers 207, 208 and 209 can be either manually or automatically moved simultaneously. However, it is contemplated that any one or more of the dampers 207, 208 and 209 can be manually adjusted with respect to the remaining dampers, if desired or required.

When the damper 209 is in its neutral, solid line position of FIGURE 8, fresh air moves from the inlet 204 through the lower passageway 206, and recirculated air moves from the inlet 202 through the upper passageway 203. However, when the damper 209 is moved into its broken line position 209b, the dampers 207 are closed and the dampers 208 are opened so that fresh air moves through the inlet 204 and thence not only through the lower passageway 206 but also through the opening 211 in the splitter plate 212 into and through the upper passageway 203. Alternatively, when the damper 209 is moved into its broken line position 209a, the dampers 208 are fully closed and the dampers 207 are fully opened so that recirculated air moves not only through the upper passageway 203 but downwardly through the opening 211 and into and through the lower passageway 206. The section 201 may be used in place of the damper section 191 of the apparatus 160 or the damper section 24 of the apparatus 10.

The modified damper section 216 (FIGURE 9) includes two, endwardly opening inlets 217 and 218 com-

municating respectively and exclusively with the upper and lower passageways 219 and 221, respectively, defined by the splitter plate 224. Dampers 222 and 223 are mounted in the inlets 217 and 218, respectively, for controlling the movement of air through such inlets into the upper and lower passageways 219 and 221, respectively. The splitter plate 224 has an opening 226 adjacent said inlets in which a damper 227 is hingedly supported upon the splitter plate 224. The hinge axis of damper 227 is remote from the inlets 217 and 218, and parallel with the pivot axes of the dampers therein.

With the inlet dampers 222 and 223 disposed in their solid line positions of FIGURE 9, the damper 227 will close the opening 226 so that recirculated air, for example, will move through the upper passageway 219 and fresh air will move through the lower passageway 221. With the dampers 222, 223 and 227 in their broken line positions 222a, 223a and 227a, respectively, recirculated air will move not only through the upper passageway 219 but through the opening 226 into and through the lower passageway 221. Alternatively, when the damper 222 is closed and the damper 223 is fully opened, the damper 227 will be in its broken line position 227b whereby fresh air will move through both the upper and lower passageways 219 and 221, respectively.

It will be recognized from the above detailed disclosures of modified and alternate constructions, particularly involving the damper section, that a variety of additional, physical arrangements can be provided to achieve substantially the same results. However, it is at least preferred, if not essential, that such various arrangements be capable of permitting either fresh or recirculated air to flow through one or both of the two passageways located at the upstream end of the conditioning apparatus. Moreover, it is essential for the dew point of the air discharged from the coil 79 to be lower than the dew point of the air moving through the path 108, when the coil 79 is in operation, to reduce the absolute humidity of the air moving through said path 108. Only by this arrangement is it possible to use a dehumidification device in one of the passageways to effect a reduction in the absolute humidity of the mixture of air from the path 108 and 109 (or passageways 178 and 179) under circumstances where the sensible heat load in the space being conditioned is lower than the design conditions.

Although a particular preferred embodiment of the invention has been disclosed in detail above for illustrative purposes, it will be understood that variations or modification of such disclosure, which lie within the scope of the appended claims, are fully contemplated.

What is claimed is:

1. An air conditioning unit having a temperature and humidity control apparatus, comprising:

a casing defining an elongated chamber with an outlet opening at one end thereof and first and second, spaced inlet openings at the other end thereof;

air-moving means located within said chamber and connected to said outlet opening for moving air from said inlet openings through said outlet opening;

wall means dividing said chamber into first and second passageways extending lengthwise within said chamber upstream of said air-moving means, said first and second passageways communicating at the downstream ends thereof with said air-moving means, said first inlet opening being connected to the first passageway, only, near the upstream end thereof, and said second inlet opening being connected to the second passageway near the upstream end thereof;

means defining a damper opening in said wall means between said first and second passageways near their upstream ends;

air movement control means consisting of first damper means mounted on said casing in said first inlet opening, second damper means mounted on said cas-

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ing in said second inlet opening and third damper means mounted on said casing in said damper opening;

linkage means connected to and between said first and second damper means so that movement of said linkage means effects simultaneous movement of said first and second damper means, and the total amount of unobstructed area in said first and second inlet openings remains substantially constant when said first and second damper means are moved;

actuating means for effecting said movement of said linkage means; and

dehumidification means in said second passageway between the downstream end thereof and said damper opening.

2. An air conditioning unit having a temperature and humidity control apparatus, comprising:

a casing defining an elongated chamber with an outlet opening at one end thereof and a return air opening and a fresh air opening spaced from each other at the other end of said casing;

centrifugal fan means located within said chamber and connected to said outlet opening for moving air from said return air and fresh air openings through said outlet opening;

wall means dividing said chamber into first and second passageways extending lengthwise within said chamber upstream of said fan means, said first and second passageways communicating at the downstream ends thereof with said fan means, said return air opening being connected to the first passageway, only, near the upstream end thereof, and said fresh air opening being connected to the second passageway near the upstream end thereof;

means defining a damper opening in said wall means between said first and second passageways near their upstream ends;

air movement control means consisting of first damper means mounted on said casing in said return air opening, second damper means mounted on said casing in said fresh air opening and third damper means mounted on said casing in said damper opening;

linkage means connected to and between said first, second and third damper means so that movement of said linkage means effects simultaneous movement of said first, second and third damper means, and the total amount of unobstructed area in said return air opening and said fresh air opening remains sub-

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stantially constant throughout said movement of said first and second damper means;

actuating means connected to said linkage means for effecting said movement of said linkage means; and

dehumidification means in said second passageway between the downstream end thereof and said damper opening.

3. An apparatus according to claim 2 including filter means in said first and second passageways downstream of said damper opening and upstream of said dehumidification means;

heat exchange means disposed within said casing downstream of said fan means; and

damper means within said casing downstream of said heat exchange means.

4. An apparatus according to claim 2 wherein said air movement control means has a first position in which said first and third damper means are open when said second damper means is closed so that return air, only, will move through both said first and second passageways, wherein said air movement control means has a third position in which said first damper means is closed and said second and third damper means are open so that fresh air, only, will move through said first and second passageways.

5. The structure of claim 1 wherein said first and second inlet openings are on opposite sides of a plane substantially defined by said wall means; and

wherein said third damper means is pivotally supported for movement from one open position within said first passageway to a second open position within said second passageway through a closed position blocking said damper opening in said wall means.

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