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W. S. OSTRANDER
AIR CONDITIONING SYSTEM

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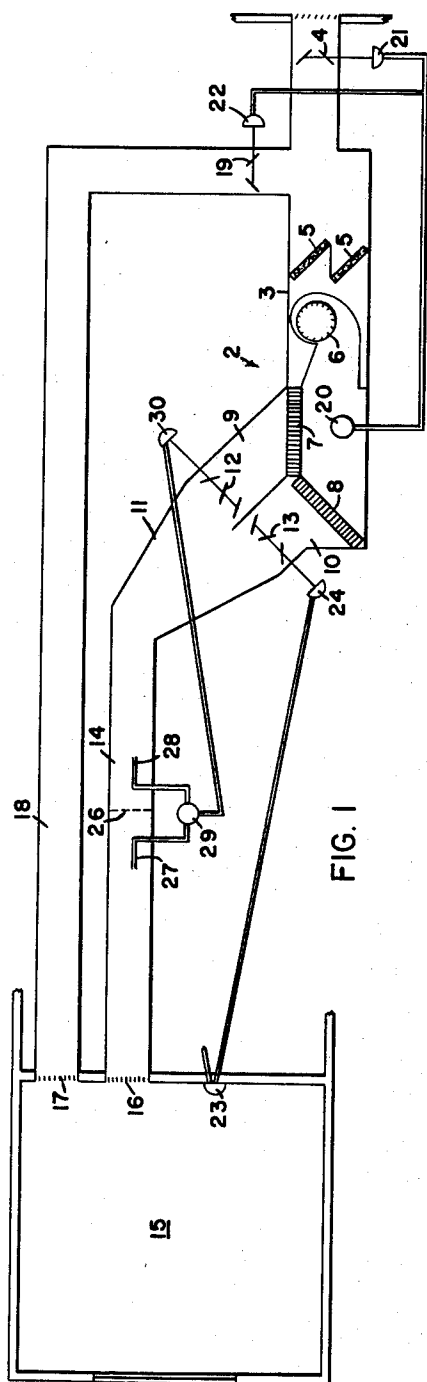


FIG. 1

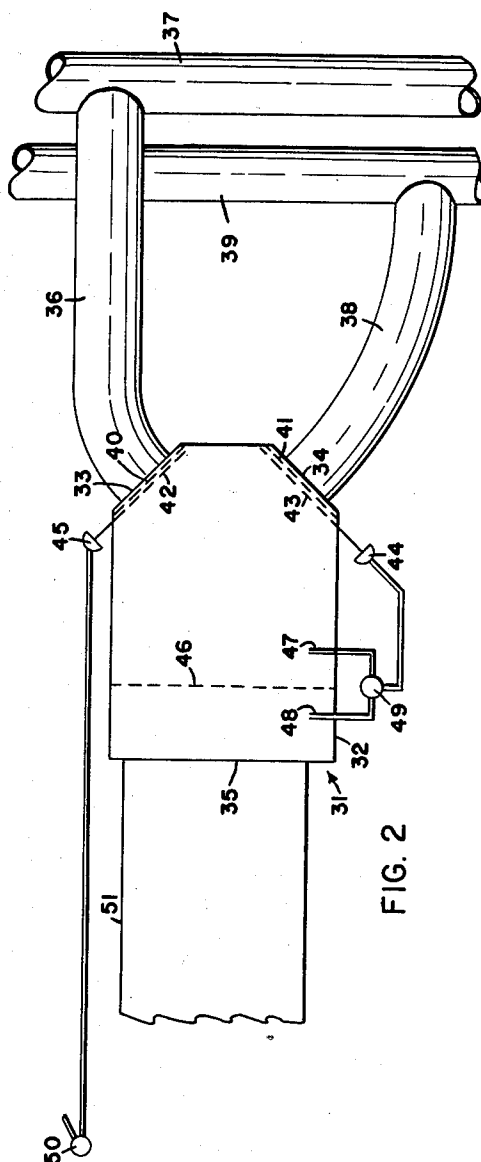


FIG. 2

INVENTOR.
WILLIAM S. OSTRANDER
BY *Leymore Rothstein*
ATTORNEY.

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3,179,338

AIR CONDITIONING SYSTEM

William S. Ostrander, Atlanta, Ga., assignor to Carrier Corporation, Syracuse, N.Y., a corporation of Delaware
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This invention relates to air conditioning systems and more particularly to an air conditioning system wherein warm air and cold air are supplied from a suitable source to a plurality of local air distributing units from each of which the air is discharged into a space to be conditioned.

In air conditioning systems of this type, commonly called dual-duct systems, the warm air supply duct and the cool air supply duct communicate with a distribution unit from which air is discharged directly into an enclosed area to be treated or into a duct which leads to the enclosed area to be treated. The warm air and the cool air are mixed in the distribution unit prior to discharge into the enclosed area to be treated. Generally, dampers are provided into the distribution unit adjacent each supply duct. Often these dampers are regulated by a control mechanism which is responsive to both the room thermostat and the volume of air passing to the room to be conditioned. The control mechanism is designed to balance the supply of warm and cold air to maintain a constant air volume discharge from the distribution unit. The control mechanism necessary to maintain a constant volume of air discharging into the room to be treated at all conditions of operation is complex and costly. This type of air conditioning system is dependent upon an accurate load estimate during both heating and cooling and upon high quality field air balancing of each distribution unit. In systems of this type the quantity of air supplied from each distribution unit into each area to be treated is unnecessarily large during certain operating conditions. This is because such air conditioning systems are designed based upon maximum cooling requirements. More air is required for proper cooling than for heating, thus each of the distribution units must handle a maximum air quantity simultaneously. More air is being handled during may operating conditions than might otherwise be necessary. The cost of operation is thereby increased.

An object of this invention is to provide an improved dual-duct air conditioning system which is less costly to operate than prior dual duct air conditioning systems.

Another object of this invention is to provide a dual duct air conditioning system wherein the quantities of warm air and cold air supplied to each distribution unit are regulated by separate control mechanisms.

Another object of this invention is to provide a dual duct air conditioning system having a distribution unit communicating with each room to be conditioned, the supply of cold air to the common duct being regulated by a room thermostat and the supply of warm air to the common supply duct being regulated in response to the volume of air discharged into the common supply duct.

It is another object of this invention to provide a simplified and improved control apparatus for an air distribution unit.

A still further object of this invention is to provide an improved method of operating a dual duct air conditioning system.

These and other objects of this invention will become apparent from a reading of the following description and claims.

Briefly, this invention relates to a dual duct air conditioning system comprising means for supplying cool air, means for supplying warm air, a distribution unit having a casing including a cool air inlet connected to the

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cool air supplying means, a warm air inlet connected to the warm air supplying means, an air outlet communicating with an enclosed area to be treated, first damper means adjacent the warm air inlet, second damper means adjacent the cool air inlet, first control means responsive to the pressure differential across a restriction means in the casing for actuating the first damper means to regulate the flow of warm air through the warm air inlet, and second control means responsive to the temperature of the enclosed area for actuating the second damper means to regulate the flow of cool air through the cool air inlet.

This invention further relates to a method of air conditioning a building containing an enclosed area to be treated comprising the steps of supplying cool air to a distribution chamber communicating with the enclosed area, regulating the admission of cool air into the distribution chamber in response to the temperature of the enclosed area, supplying warm air to the distribution chamber, regulating the admission of warm air into the distribution chamber in response to the pressure differential cross a restriction member in the distribution chamber, and discharging the air from the distribution chamber into the enclosed area.

The specific details of the invention and their mode of functioning, will be made most manifest and particularly pointed out in clear, concise and exact terms in conjunction with the accompanying drawings wherein:

FIGURE 1 is a schematic view of an air conditioning system embodying this invention; and

FIGURE 2 is a diagrammatic view of a preferred form of air distribution unit for use in a dual-duct air conditioning system.

Referring first to FIGURE 1 of the drawing there is shown a central station air conditioner 2 comprising a casing 3. Outside air may be drawn into the casing through the dampers 4 and the air filter 5 by means of the centrifugal fan 6. The fan 6 blows the air through the heating coil 7 and the cooling coil 8 into the warm air supply duct 9 and the cool air supply duct 10, respectively. The heating coil 7 may be suitably connected to a source of either hot water or steam. The cooling coil 8 is connected to a cold source, as for example, to a refrigerating system or to a suitable source of cold water, as for example, a water chiller or a source of well water.

The air from the supply ducts 9 and 10 is discharged into a common mixing duct 11 which communicates with an enclosed area to be conditioned. A damper 12 is provided in the warm air supply duct 9 to regulate the quantity of air discharged into the mixing duct. A similar damper 13 is provided in the cool air supply duct 10 to regulate the quantity of cool air discharged into the mixing duct. The blended air is discharged through duct 14 into the room 15 to be conditioned. Suitable grille means 16 are provided to direct the air into the room in a substantially horizontal line. If desired, the blended air may be discharged directly into the room from the mixing duct.

Disposed above the duct 14 is an exhaust duct 18. Return air is drawn from the top of the room 15 through the grille 17 into the exhaust duct and then discharged into the ventilation air being supplied to the central station from outdoors. A damper 19 may be provided in duct 18 to control the quantity of return air mixed in the fresh air being supplied to the central station 2.

Upstream of the fan 6 there is disposed a thermostat 20 which is connected to an operator 21 for the damper 4 and to the operator 22 for the damper 19. The operators may be pneumatic or electrical or mechanical as is well known to those persons skilled in the art.

As is readily apparent in FIGURE 1, the dampers 12 and 13 are separately controlled. Thermostat 23 which is disposed in the area to be treated is connected with the operator 24 for the damper in the cold air duct 10. Operator 24 is illustrated as being of the pneumatic type, though a self-contained electric or mechanical operator can be used.

Constant volume control means are provided to regulate the quantity of air passing from the warm air duct 9 through the damper 12. Disposed downstream of the mixing duct 11 in the discharge duct 14 is a restriction plate 26. The restriction plate 26 is disposed in the duct 14 so that the total air stream is passed therethrough. Static pressure sensors or probes 27 and 28 are provided on each side of the restriction plate to measure the pressure drop thereacross. The pressure sensors 27 and 28 connect with a constant volume regulator 29 which may be of a well known pneumatic type or of a self-contained type as aforesaid. The regulator 29 is suitably connected through pneumatic lines with the operator 30 for the warm air damper 12. The pneumatic system shown is connected to a suitable source of compressed air (not shown).

In the system illustrated in FIGURE 1, the blending of the hot air and the cold air is accomplished in a portion of the duct leading to an area to be conditioned. It will of course, be understood that the ducts 9 and 10 may communicate with a plurality of mixing ducts 11, each discharging directly into a separate enclosed area to be conditioned, or that the mixing ducts each communicate with a duct discharging into an enclosed area to be treated.

In operation the constant volume regulator 29 is adjusted to provide sufficient air for air motion and heating. Normally, such adjustment will not be of a highly critical nature for the air quantity provided for heating is usually not critical, and will be less than that required for maximum cooling. During heating and light cooling load operation, the room thermostat 23 will modulate the cooling damper 13 to control the room temperature and the volume regulator 29 will modulate the heating damper 12 to maintain a constant air quantity. As the cooling load increases, the cold air damper 13 will be progressively opened by the room thermostat and the warm air damper will be closed by the volume regulator 29 until the system is handling 100 percent cold air. As the cooling load further increases, the cold air damper 13 will open further to provide additional cold air, and the air quantity will rise sufficiently above a minimum volume setting to handle the desired load. Thus the air quantity is controlled at the minimum actually required to handle the cooling load, and is not dependent upon the accuracy of the design load estimate and the field adjustment of the air quantity and of the constant volume regulator.

In FIGURE 2 there is shown a preferred distribution unit 31 for use in a dual-duct air conditioning system. Treated air is supplied into each of the ducts 37 and 39 from suitable sources for example, the hot air source may be steam or hot water and the cold air source may be a refrigerating system.

The distribution unit 31 includes a casing 32 having therein a cold air inlet 33, a warm air inlet 34 and an air outlet 35. Cold air inlet 33 is connected to duct 36 which communicates with the cold air supply duct 37. Warm air inlet 34 is connected to duct 38 which communicates with the warm air supply duct 39.

Damper means are provided in the casing to regulate the admission of warm and cool air. Disposed across each of the inlets is a multi-slotted plate 40 and 41, respectively. Adjacent each of the multi-slotted plates and cooperating therewith is a multi-slotted sliding damper blade 42 and 43 for regulating the flow of air through each of the inlets.

Connected to the damper blades 42 and 43 are operators 44 and 45. The damper blade operator 45, which

may be of the pneumatic type, is suitably connected to the room thermostat 50 disposed in the area to be treated.

Extending within the casing 32 is a perforated plate 46. The plate is so disposed in the casing that all air received in the casing must pass through the resistance plate or perforated plate 46 before being discharged into the supply duct 51. Static pressure probes 47 and 48 are disposed at each side of the resistance plate 46. The probes 47 and 48 are connected to a constant volume regulator 49, which may be of the pneumatic type.

It is thus seen that the admission of cold air into the distribution unit or blender box 31 is regulated responsive to the temperature of the room to be treated. The admission of warm air into the distribution unit 31 is regulated by means of constant volume regulator 49 which senses the pressure differential across a restriction means in the casing through which the total volume of air passes.

It will be apparent that the operators 44 and 45 may be of the pneumatic type or of the self-contained electrical or mechanical type.

The operation of the dual-duct system employing the distribution unit 31 of FIGURE 2 is similar to that of the operation of the system disclosed in FIGURE 1. The constant volume regulator is adjusted for the proper air quantity for heating. Normally, this adjustment is not highly critical. After recognizing this factor, I was able to provide a simplified, efficient control scheme wherein the complexity and attendant cost of the controls has been materially reduced. During heating operation, the room thermostat will modulate the cooling damper blade 42 to control the room temperature, and volume regulator 49 will modulate the heating damper blade 43 to maintain a constant air quantity through the casing 32. For light cooling load operation the control will function in a similar fashion. As the cooling load increases, the cold air damper will be progressively opened by thermostat 50 and the warm air damper will be closed by volume regulator 49 until the system is handling all cold air. If the cooling load further increases, the cold air damper will open further to provide additional cold air and the air quantity will rise sufficiently above the minimum volume setting to handle the load. The system thus advantageously employs the resulting variable air volume to handle the cooling load.

The improved air conditioning system provides sufficient outside air to compensate for the ventilation requirements of each enclosed area being treated. Such outside air may be treated to compensate for conditions of humidity and transmission gains or losses in each separate area being treated.

Separate warm and cool air streams are supplied to each mixing duct or distribution unit. Within the mixing duct or distribution unit, the air is properly blended and then the treated air is discharged into the enclosed area associated with each mixing duct or distribution unit. By basing the system design upon heating requirements, the difficulties of accurately estimating the load and of field-balancing each system installation are minimized, for each system is largely self-balancing. There is a resultant savings in operating costs.

In winter, the improved dual-duct system provides essentially a constant volume of blended air to each area to be treated. Lower heating costs will result, because only sufficient cold air will be blended with the warm air to maintain the minimum predetermined air quantity. In summer, sufficient cold air is provided to each distribution unit to cool the enclosed area associated therewith. The variable volume of cold air provided is thus at the minimum actually required to handle the cooling load. In the spring or fall, that is, during intermediate season operations, the total air quantity is reduced to a minimum before any reheat is required.

Under peak load conditions, the outside air damper may be closed to reduce the heating or cooling requirements of the central station.

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While I have described and illustrated a preferred embodiment of my invention, it will be understood my invention is not limited thereto since it may be otherwise embodied within the scope of the following claims.

I claim:

1. A dual-duct air conditioning system comprising means for supplying cool air; means for supplying warm air; a distribution unit having a casing including a cool air inlet connected to said means for supplying cool air, a warm air inlet connected to said means for supplying warm air, an air outlet communicating with an enclosed area to be treated, first damper means adjacent the warm air inlet, and second damper means adjacent the cool air inlet; first control means responsive to the pressure differential across a restriction plate in the casing for actuating the first damper means to regulate the flow of warm air through the warm air inlet during cold and intermediate season operation and for closing the warm air inlet during warm season operation when maximum cooling is needed; and second control means responsive to the temperature of said enclosed area for actuating the second damper means to regulate the flow of cool air through the cool air inlet.

2. In a dual-duct air conditioning system, an air distribution unit comprising a casing having an air outlet, a cold air inlet, a warm air inlet, and a cold air and warm air mixing chamber, means regulating the flow of warm air through the warm air inlet in response to the pressure differential across a restriction means in the mixing chamber, and means regulating the flow of cold air through the cold air inlet in response to the temperature of the area to be treated.

3. In a dual-duct air conditioning system, an air distribution unit comprising a casing having an air outlet, a

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cold air inlet, a warm air inlet, and a cold air and warm air mixing chamber, means for regulating the flow of warm air through the warm air inlet in response to a pressure differential across a restriction means in the mixing chamber, and means regulating the flow of cold air through the cold air inlet in response to the temperature of the area to be treated, each of said regulating means including a damper mechanism.

4. In a dual-duct air conditioning system, an air distribution unit comprising a casing having an air outlet, a cold air inlet, a warm air inlet, a cold air and warm air mixing chamber, means regulating the flow of warm air through the warm air inlet in response to the volume of air flowing through the mixing chamber, and means regulating the flow of cold air through the cold air inlet in response to the temperature of the area to be treated, said warm air regulating means including a damper mechanism adjacent the warm air inlet, a perforated plate disposed in the casing so that all the air leaving the casing passes through said plate, means sensing the pressure drop across the perforated plate, and a control responsive to said pressure drop to actuate said damper mechanism.

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EDWARD J. MICHAEL, *Primary Examiner.*

HERBERT L. MARTIN, CHARLES SUKALO,
Examiners.