Feb. 7, 1961 B. E. CURRAN 2,970,768

DAMPER CONTROL APPARATUS FOR DUAL DUCT AIR CONDITIONING SYSTEM

Filed April 9, 1957 4 Sheets-Sheet 1

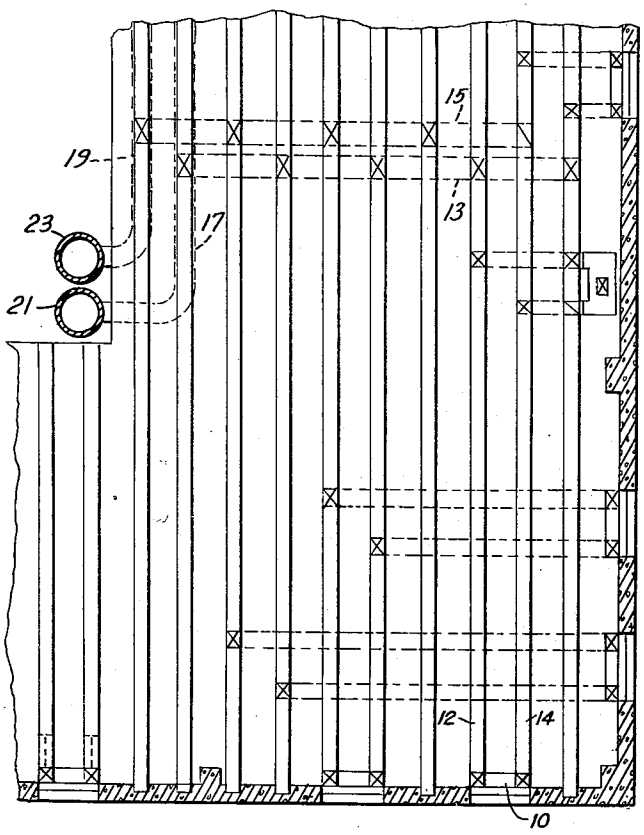


FIG. 1

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DAMPER CONTROL APPARATUS FOR DUAL DUCT AIR CONDITIONING SYSTEM

Filed April 9, 1957 4 Sheets-Sheet 2

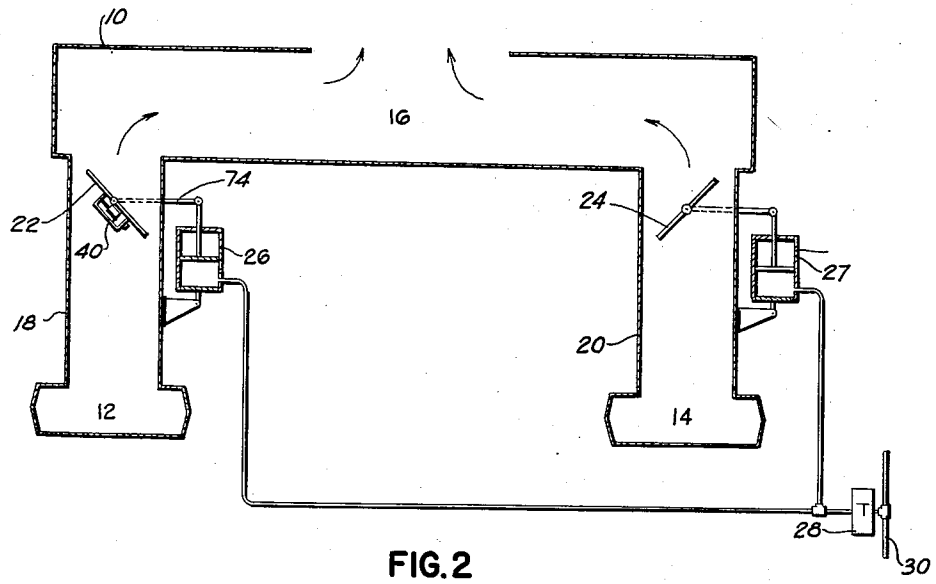


FIG. 2

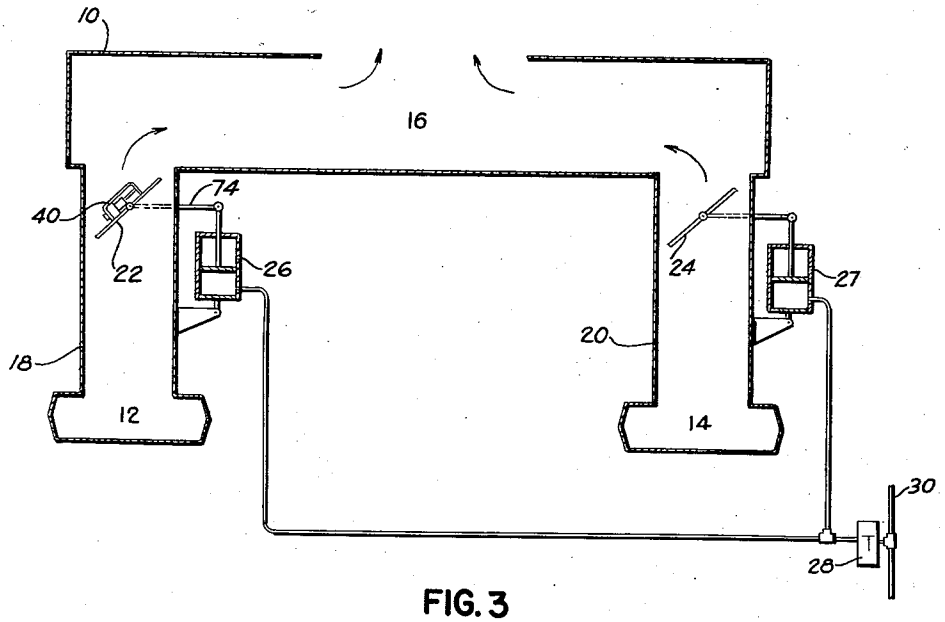


FIG. 3

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DAMPER CONTROL APPARATUS FOR DUAL DUCT AIR CONDITIONING SYSTEM

Filed April 9, 1957 4 Sheets-Sheet 3

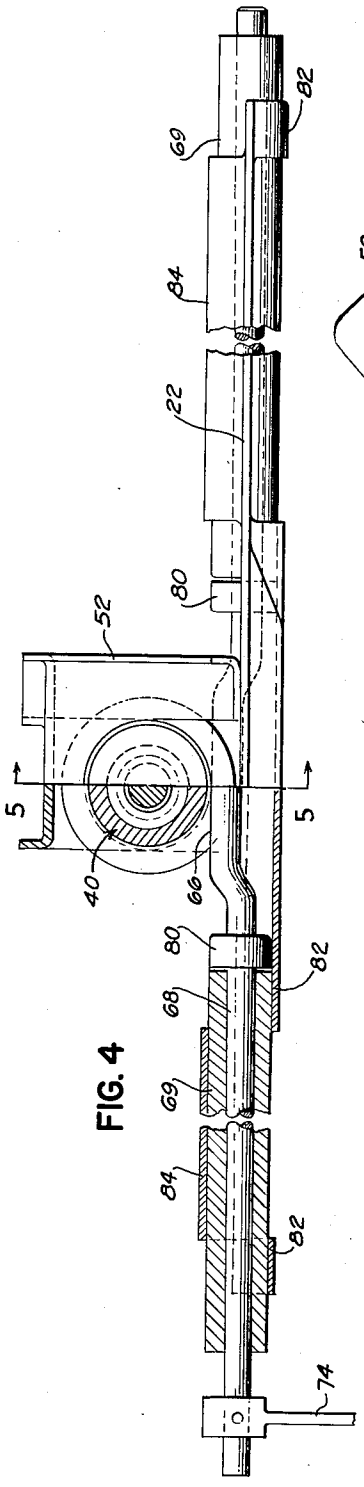


FIG. 4

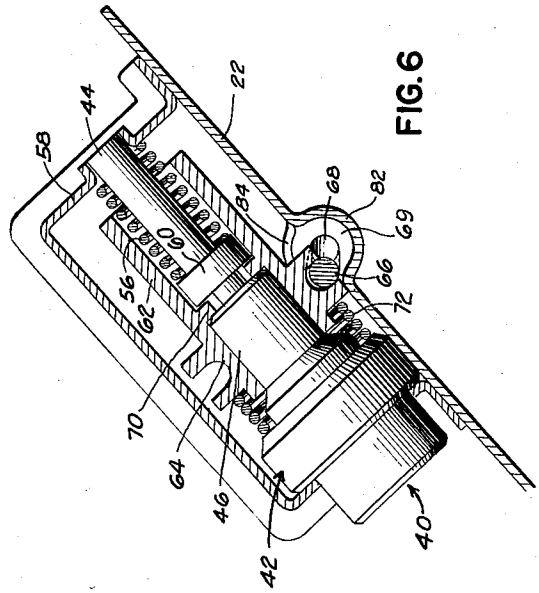


FIG. 6

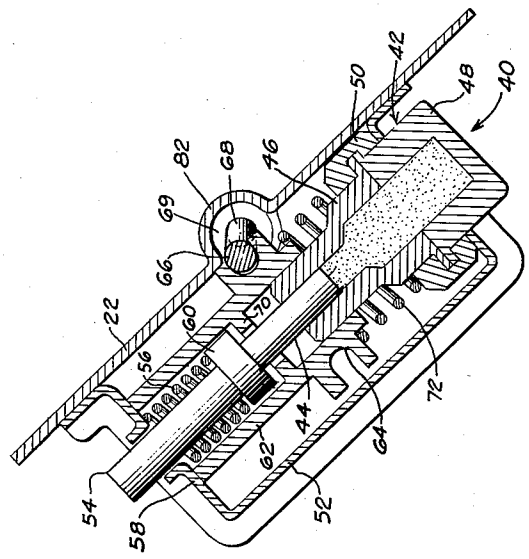


FIG. 5

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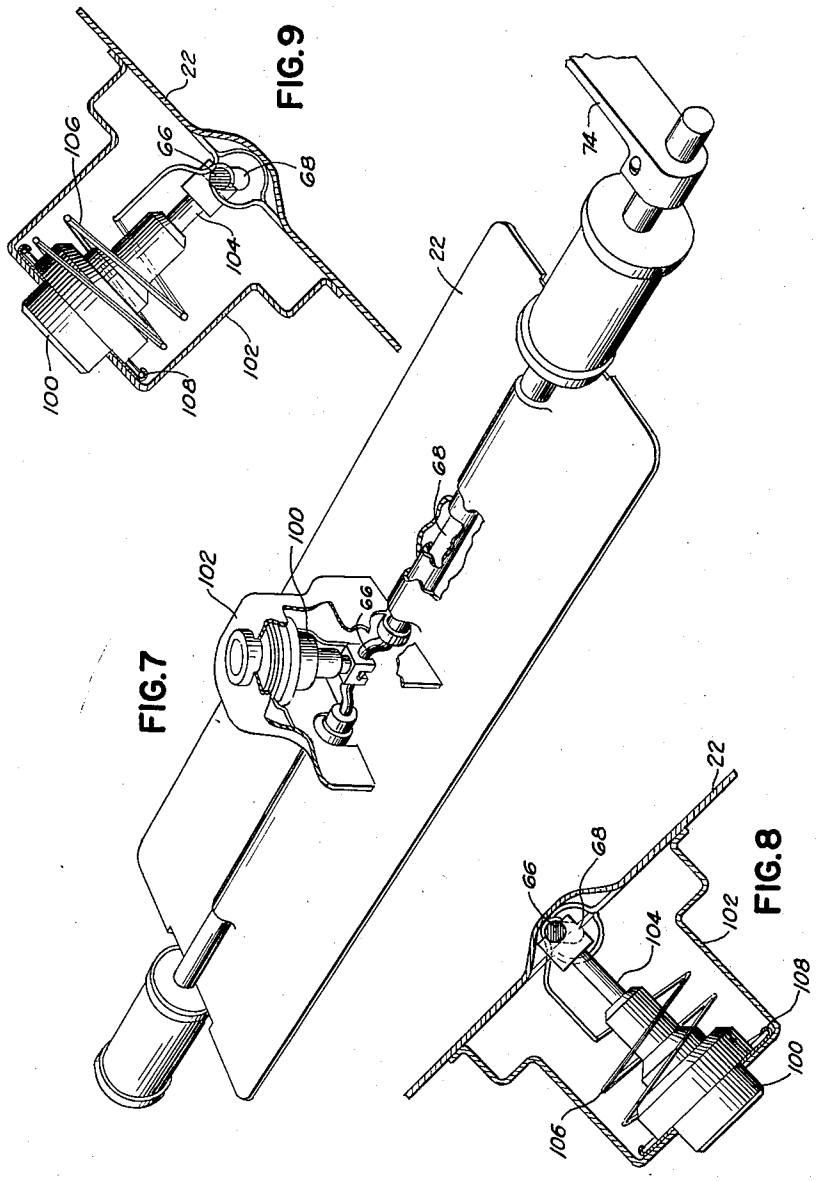
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DAMPER CONTROL APPARATUS FOR DUAL DUCT AIR CONDITIONING SYSTEM

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4 Sheets-Sheet 4



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DAMPER CONTROL APPARATUS FOR DUAL DUCT AIR CONDITIONING SYSTEM

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9 Claims. (Cl. 236—1)

This invention relates to novel damper control apparatus for a dual duct air conditioning system.

The invention has for an object to provide novel and efficient apparatus for controlling the two modulating volume control dampers used in controlling the air flow from each pair of dual ducts into a single outlet box from which the air is discharged into the building to the end that the pair of ducts may be used for supplying hot and cold air for winter operation and also to permit both ducts to be used for supplying cool air during the summer or cooling season.

A further object of the invention is to provide novel apparatus of the character described which may be used with advantage in the air conditioning system forming the subject matter of the Goemann Patent No. 2,729,429, issued January 3, 1956.

With these general objects in view and such others as may hereinafter appear, the invention consists in the damper control mechanism hereinafter described and particularly defined in the claims at the end of this specification.

In the drawings illustrating the preferred embodiment of the invention:

Fig. 1 is a diagrammatic plan view of a portion of a building embodying an air conditioning system provided with sill or outlet boxes in which the present damper control apparatus may be used;

Fig. 2 is a more or less diagrammatic front elevation in cross section of an outlet box illustrating the relative positions of the dampers during the winter heating season;

Fig. 3 is a similar view showing the relative positions of the dampers during the summer cooling season;

Fig. 4 is a front elevation partly in cross section of a damper provided with a thermoresponsive power unit mounted directly thereon;

Fig. 5 is a cross sectional view taken on the line 5—5 of Fig. 4 showing the operative elements of the thermoresponsive power unit, the damper being shown in a winter heating position;

Fig. 6 is a similar view showing the same damper moved to a summer cooling position;

Fig. 7 is a perspective view of a modified form of thermoresponsive power unit mounted directly on the damper;

Fig. 8 is a cross sectional view of the damper and thermoresponsive power unit with the damper shown in a winter heating position; and

Fig. 9 is a view similar to Fig. 8 showing the damper moved to a summer cooling position.

The present invention contemplates novel damper control mechanism for controlling the movements of and relationship of each pair of dampers employed in controlling the supply of hot and cold air to a discharge outlet in a dual duct air conditioning system and particularly in an air conditioning system of the type forming the subject matter of the Goemann patent above referred to. The novel control mechanism enables the convenient conversion of each pair of the ducts serving the outlets from winter operation, wherein hot and cold air flow through the different ducts of each pair, to summer operations, wherein both ducts carry cool air. In accordance with the present invention the conversion of the ducts from winter operation to summer cooling operation is accomplished by thermoresponsive mechanism actuated by selected high and low temperatures of the conditioned air passing through one of the ducts.

The invention will be described in connection with the preferred system as embodied in the structure shown generally in the Goemann patent above referred to.

Referring now to the drawings, the present damper control mechanism is an improvement upon the damper control mechanism illustrated in Figs. 17, 18 and 21 of the Goemann patent above referred to wherein the air distributing outlets 10 are in communication with hot and cold air conducting cells 12, 14 forming a part of the flooring structure as indicated in Fig. 1. As also shown in Fig. 1, the air conducting cells 12, 14 are connected to supply manifolds 13, 15, respectively, which in turn are connected by ducts 17, 19 to main supply risers 21, 23. The sill box 10 is provided with a mixing chamber 16 having a pair of stacks 18, 20 connected to the hot and cold air ducts 12, 14 respectively, and each stack is provided with a damper 22, 24 respectively arranged at substantially right angles to each other for the winter heating season as shown in Fig. 2. The dampers are arranged to be rotated by connections to individual air cylinders 26, 27 actuated by a direct acting thermostat 28 common to both air cylinders which is connected in a compressed air supply line 30. The thermostat acts as a valve to increase or decrease the air pressure from line 30 upon an increase or decrease in the room temperature. As thus arranged, an increase in room temperature will effect opening of the cold air damper 24 and closing of the hot air damper 22, and a decrease in room temperature will effect closing of the cold air damper and opening of the hot air damper whereby to modulate the hot and cold air dampers against each other during the winter heating cycle and thereby to vary the proportions of hot and cold air flowing to the chamber 16.

For summer cooling operation wherein both air conducting cells 12, 14 carry cold air, it is preferred to change the position of the dampers from a position at right angles to each other to a position parallel to each other so as to effect a simultaneous increase or decrease in the volume of the cold air from both stacks in response to variations in room temperature and to maintain the proportions of the air from both stacks substantially constant.

The present invention is directed particularly to apparatus for automatically changing the position of one of the dampers through 90° when the seasonal changeover is made so as to arrange both dampers in parallel relation at this time.

In accordance with the present invention provision is made for automatically changing the position of the air damper 22 through 90° when the seasonal changeover is made by means of thermoresponsive apparatus comprising a thermoresponsive power unit indicated generally at 40 which is mounted directly on the damper 22 and is adapted to be actuated by predetermined and selected high and low temperatures of the air passing through the duct. As herein shown, the thermoresponsive apparatus 40 includes a commercially available thermoresponsive power unit comprising a sealed casing or cylinder 42 having a plunger or piston 44 extended therein and cooperating therewith. The casing 42 is provided with an expansible material, such as a modified wax material, which is subject to expansion to project the plunger outwardly when heated by the air passing

through the duct above a selected high temperature and which is subject to contraction to permit retraction of the plunger when cooled by the air passing through the duct below a selected low temperature.

The casing 42 includes two flanged cup-shaped members 46, 48 assembled with the flanged ends face to face and a sealing collar 50 forced about the flanges in sealing relation as shown. The member 46 is provided with an opening in which the plunger 44 is slidingly inserted for cooperation with the expansible material sealed in the casing. The casing 42 may be mounted in a frame member 52 which is welded or otherwise secured directly to the damper blade 22. The outer end 54 of the plunger is supported for longitudinal movement in an opening in the frame 52 and is arranged to be urged inwardly by a relatively strong spring 56 interposed between the leg 58 of the frame and a collar 60 formed on the plunger. A shifting sleeve indicated generally at 62 arranged to be moved longitudinally upon movement of the plunger 44 is provided with an annular groove 64 arranged to cooperate with an offset or crank portion 66 of the damper blade shaft 68. The sleeve 62 is provided with a medial partition member 70 through which the plunger extends. The inner end of the sleeve is slidingly supported about the extended end of the casing member 46, and the outer end of the sleeve is extended over and encloses the collar 60 and spring 56. A second spring 72 which is relatively weaker than the spring 56 is interposed between the sleeve 62 and the collar 50 and tends to urge the sleeve outwardly.

The damper shaft 68 may be journaled in suitable bearings in the side walls of the duct 18. One end of the shaft is connected to the operating arm 74 of the air cylinder 26, and the damper 22 is mounted to rotate with the shaft 68 when it is rocked by the arm 74, and to rotate relative to the shaft when the power unit 40 is actuated. As shown in Fig. 4, the shaft 68 is provided with a pair of bushings 69, one on each side of the crank portion 66 retained from lateral displacement by collars 80. The damper is formed with alternate upwardly and downwardly pressed semicircular portions 82, 84 forming in effect a cylindrical opening into which the bushings 69 are fitted and frictionally retained. Thus, in operation when the shaft 68 is rocked by the arm 74, with the power unit 40 in a relatively fixed position, for either winter heating or summer cooling operation, the crank portion 66 operating in the groove 64 effects rocking of the damper 22 to open or close the same in response to changes in room temperature.

The thermostatically operated power unit 40 is shown in its contracted position in Fig. 6 with the damper 22 arranged relative to the shaft 68 so as to dispose the damper in a position parallel to the corresponding damper 24 in the duct 20 for summer cooling operation. When the cold air is discontinued in the duct 18 and hot air is supplied therein for winter heating operation, the material in the casing 42 expands at a selected high temperature and forces the plunger 44 outwardly compressing the spring 56 and permitting the spring 72 to urge the sleeve 62 outwardly against the crank portion 66 of the shaft 68. However, since the shaft 68 is held relatively fixed by the arm 74, the damper will be forced to rotate on the shaft 68 in a counterclockwise direction, to the position shown in Figs. 2 and 5, at right angles to the corresponding damper 24 in the duct 20. Conversely, when the hot air is discontinued and cold air is again supplied to the duct 18 for summer cooling operation, the material in the casing will contract at a selected low temperature, permitting the spring 56 to urge the plunger inwardly, the collar 60 engaging the medial portion 70 to move the sleeve 62 to its retracted position against the pressure of the relatively weaker spring 72. Movement of the sleeve inwardly against the relatively fixed crank portion 66 will force the damper to be rotated on its shaft in a clockwise direction to again dispose the damper in a position parallel to its corresponding damper 24 as shown in Figs. 3 and 6.

In order to effect rotation of the damper 22 on its shaft 68 through exactly 90° and to permit continued movement or overthrow of the plunger provision is made for stopping the sleeve 62 at a point corresponding to the 90° rotation. As shown in Fig. 5, when the plunger 44 is extended, the outer end of the sleeve 62 is arranged to engage the inner face of the leg 58 of the frame which serves as a stop in one direction, the plunger being permitted to continue its movement outwardly a short distance to accommodate further expansion of the thermoresponsive material, the spring 56 being further compressed. Conversely, when the plunger 44 is retracted the inner face of the partition 70 will engage the end of the member 46 of the casing to limit the movement of the sleeve in its retracted position.

Referring now to Figs. 7, 8 and 9, a modified form of damper control mechanism embodying a thermoresponsive power unit 100 comprises a structure wherein the power unit 100 is mounted at right angles to the damper 22 and is supported in a frame 102 welded or otherwise secured to the damper. The plunger 104 is provided with an open end slot which fits over and cooperates with the crank portion 66 of the shaft 68. A spring 106 coiled about the power unit and fixed at its upper end in a retaining member 108 is connected at its lower hooked end to the crank portion 66 as shown. A clearance space for the hooked end of the spring is provided by a cross slot in the plunger 104.

The power unit 100 is shown in its retracted position in Fig. 9 with the damper 22 arranged parallel to the corresponding damper 24 for summer cooling operation, and when the air in the duct 18 is changed from cool air to hot air for winter heating operation, the heat of the air passing through the duct will effect expansion of the material in the power unit to extend the plunger 104 against the crank portion 66, and since the shaft 68 is held relatively stationary by the operating arm 74 the damper is forced to rotate on the shaft 68 in a counterclockwise direction to the position shown in Fig. 8, thus disposing the damper 22 in a position at right angles with relation to damper 24 for the winter heating operation. Conversely, when the air in the duct 18 is again changed to cool air for the summer cooling operation the material within the unit 100 will contract, causing the plunger 104 to retract to permit the spring 106 to pull on the relatively stationary crank 66, effecting rotation of the damper on its shaft 68 in a clockwise direction to again arrange the dampers 22, 24 in parallel relation.

From the description thus far it will be observed that the present novel damper control mechanism in a dual duct air conditioning system embodying a thermoresponsive power unit mounted directly on the dampers in one of the ducts is capable of automatically converting the system from winter heating operation to summer cooling operation in response to the temperature of the conditioned air passing through the duct. Summer cooling operation is maintained when the temperature of the conditioned air is below a predetermined low temperature, and winter heating operation is maintained when the temperature of the conditioned air is above a predetermined high temperature.

In practice the commercially available thermoresponsive power unit is provided with a modified or "engineered" wax having fine particles of metal distributed therethrough for uniform heat conduction. The wax is adapted to be fully expanded when it is subjected to a selected high temperature, above 80° F. for example, and is adapted to be fully contracted when it is subjected to a selected low temperature, below 65° F., for example. In practice the power unit is not required to assume any intermediate position at any time since in the operation of the system there would never be any inter-

mediate temperatures of conditioned air in the duct in the range between the predetermined high and low temperatures selected. It will be further observed that the present structure of thermoresponsive power unit is adapted to compensate for the continued expansion of the thermoresponsive medium and further extension of the plunger after the damper blade 22 has been indexed through the selected 90° angle. It will be apparent that other selected angles of indexing of one damper blade relative to the other may be used if found to be of advantage.

In the operation of the dual duct air conditioning system, when the dampers 22, 24 are arranged at right angles to each other for the winter heating season, as shown in Fig. 2, the movement of the hot air damper 22 will be in a closing direction and the movement of the cold air damper 24 will be in an opening direction upon an increase in room temperature, and that the dampers maintain their position at right angles to each other throughout the entire heating cycle so as to modulate the hot and cold air against each other in response to the room thermostat. In effect this serves to vary the proportions of hot and cold air while holding the total delivery substantially constant. During the summer cooling season both of the ducts are supplied with cold air. As shown in Fig. 3, the damper 22 is indexed through 90° to operate in the same plane as damper 24, and instead of holding the total delivery substantially constant and varying the proportionate part of the air from each duct, the proportionate part from each duct is held substantially equal and the total delivery of the air is varied from a completely closed position to a fully open position in each duct with the damper blades operating in unison, thereby substantially doubling the cooling capacity of the system.

While the preferred embodiment of the invention has been herein illustrated and described, it will be understood that the invention may be embodied in other forms within the scope of the following claims.

Having thus described the invention, what is claimed is:

1. In a dual duct air conditioning system, an air distributing outlet box having dual inlet ducts adapted for connection to dual air supply ducts, a damper pivotally mounted in each inlet duct, said dampers being disposed substantially at right angles to each other under one set of conditions, thermostatically controlled means for operating said dampers to effect opening of one damper while the other damper is closing, and thermoresponsive means mounted on one damper responsive to variations in the temperature of air passing through its inlet duct for rotating said damper to a new position substantially parallel with relation to the other damper under a second set of conditions whereby to effect simultaneous opening and closing of the dampers under the influence of said thermostatically controlled means.

2. A dual duct air conditioning system as defined in claim 1 wherein supply manifolds are connected to the dual ducts to supply hot and cold air respectively for heating service under said one set of conditions, and to supply cold air for cooling service under said second set of conditions.

3. A dual duct air conditioning system as defined in claim 2 wherein the thermoresponsive means includes an expansible and contractible medium actuated by the temperature of the air passing through the duct to rotate the damper in one direction at a preselected high air temperature and to rotate the damper in the other direction at a preselected low air temperature.

4. A dual air conditioning system as defined in claim 3 wherein said thermoresponsive damper rotating means includes means for limiting rotation of the damper through a predetermined angle in either direction while permitting unrestricted expansion and contraction of said medium.

5. A dual air conditioning system as defined in claim 4 wherein the thermostatically controlled means actuated by variations in room temperature includes an air motor operatively connected to a supply of compressed air and to said dampers, and a thermostatically controlled valve between said supply and said motor.

6. A dual duct air conditioning system as defined in claim 1 wherein said one damper is mounted on a shaft to rotate therewith when actuated in response to variations in room temperatures, and to rotate relative to the shaft when actuated in response to preselected high and low temperatures of air passing through the duct.

7. A dual duct air conditioning system as defined in claim 1 wherein said one damper is frictionally mounted on a shaft operatively connected to said thermostatically operated means and rotated with the shaft when actuated in response to variations in room temperatures, said thermoresponsive damper rotating means including an expansible medium and a spring pressed plunger cooperating therewith arranged to be extended upon expansion of said medium, said plunger cooperating with said shaft to effect rotation of the damper relative to the shaft in one direction when actuated in response to a preselected high temperature, and in the other direction relative to the shaft when actuated in response to a preselected low temperature of the air passing through the inlet duct.

8. A dual duct air conditioning system as defined in claim 7 which includes stop means for limiting the rotation of said damper relative to the shaft in both directions while permitting overthrow movement of said plunger under the influence of said expansible medium.

9. In a dual duct air conditioning system, an air distributing outlet box having dual inlet ducts adapted for connection to dual air supply ducts, a damper pivotally mounted in each inlet duct, said dampers being disposed at right angles to each other under one set of conditions, thermostatically controlled means for operating said dampers to effect opening of one damper while the other damper is closing, thermoresponsive means mounted on one damper responsive to variations in the temperature of air passing through its inlet duct for rotating said damper through 90° with relation to the other damper under a second set of conditions, and means for controlling the operation of the dampers to effect movement of the dampers while maintaining the openings identical with each other at all times during at least a portion of the second set of conditions.

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