Feb. 6, 1962 R. P. GOEMANN ET AL 3,019,987

AIR DISTRIBUTING APPARATUS AND METHOD

Original Filed Sept. 6, 1955

3 Sheets-Sheet 1

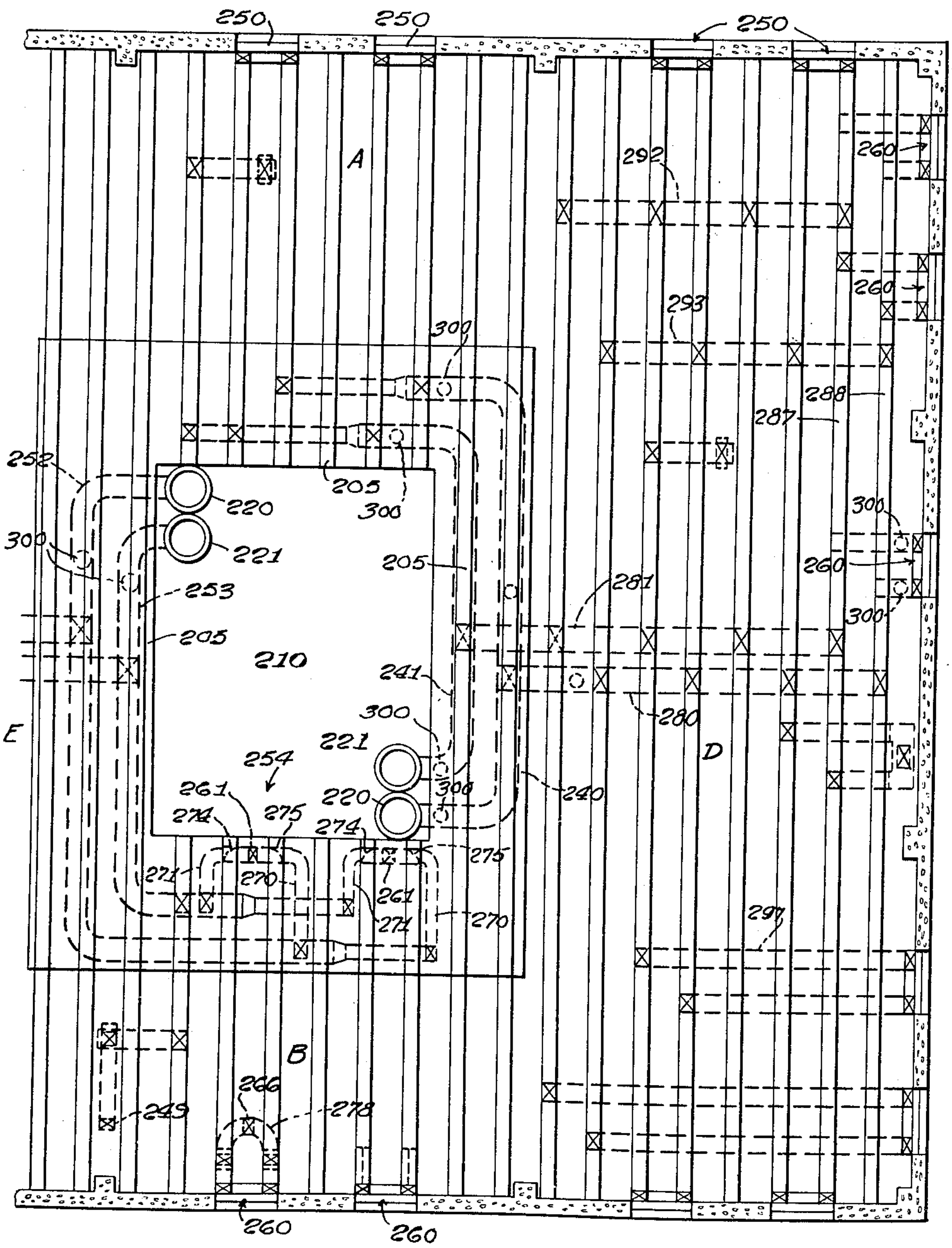

Fig. 1

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Original Filed Sept. 6, 1955 3 Sheets-Sheet 2

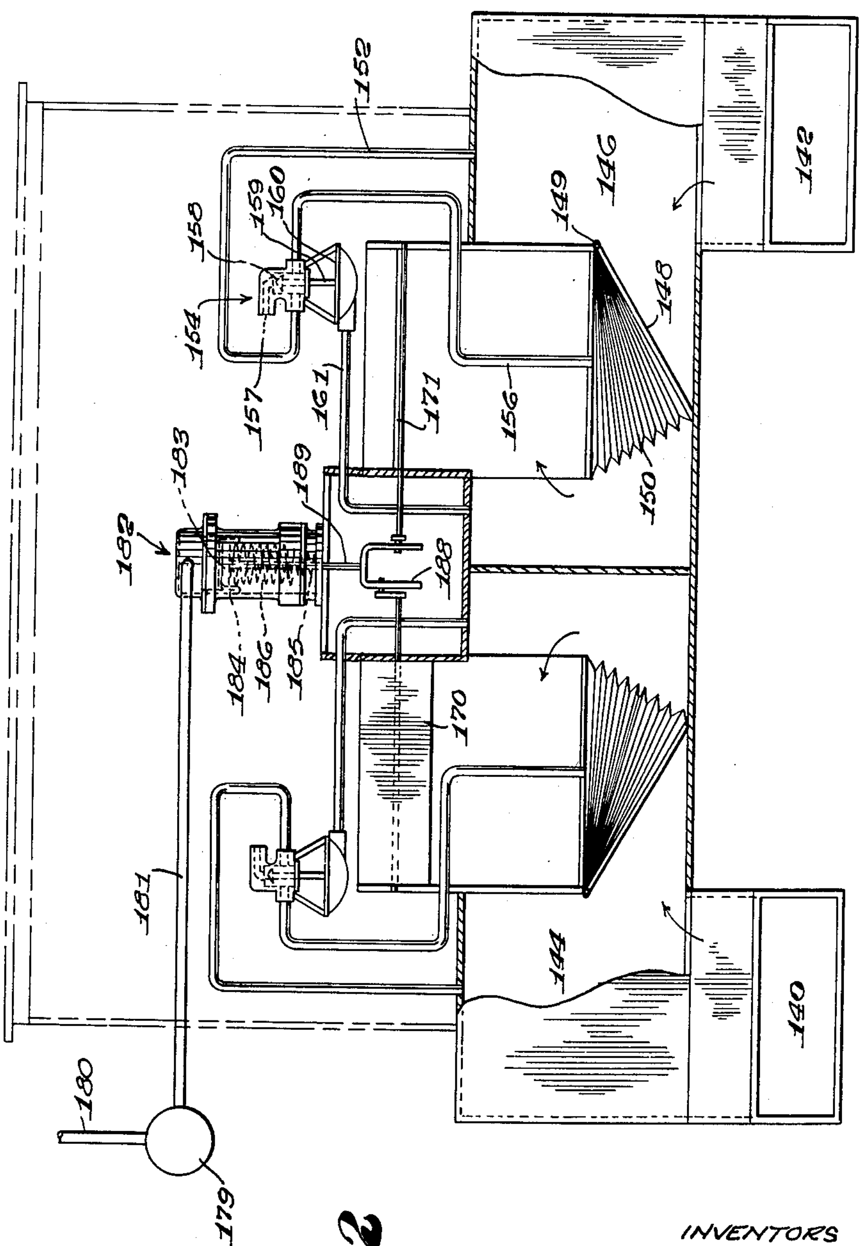

Fig. 2

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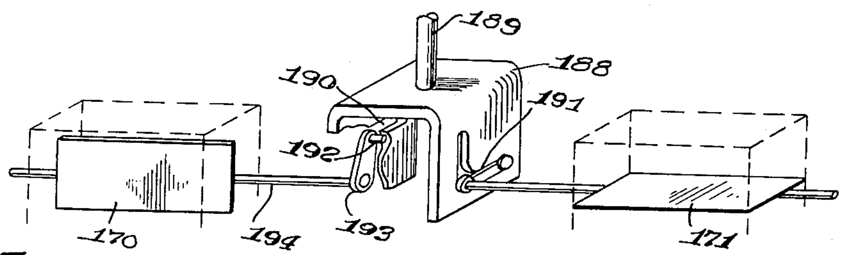

Fig. 3

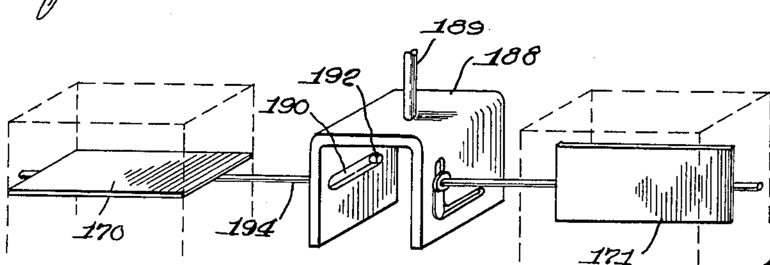

Fig. 4

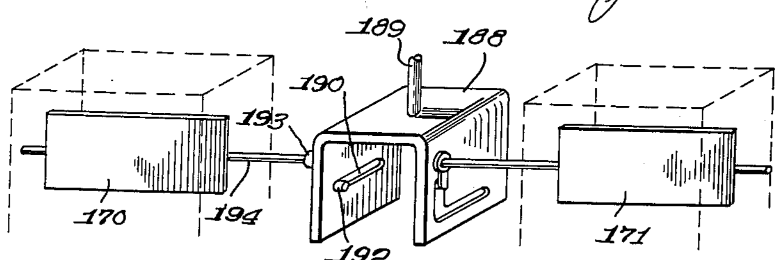

Fig. 5

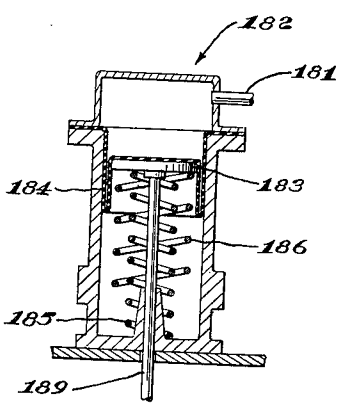

Fig 6

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AIR DISTRIBUTING APPARATUS AND METHOD

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Original application Sept. 6, 1955, Ser. No. 532,436. Divided and this application Sept. 19, 1960, Ser. No. 60,766
6 Claims. (Cl. 236—13)

This invention relates to an air distributing apparatus and to a method and apparatus for regulating the quantity of air flowing through a particular portion of a duct.

This application is a division of our co-pending U.S. patent application Serial Number 532,436, filed September 6, 1955, now abandoned.

The principal object of this invention is to provide a dual duct air conditioning system which includes air mixer means for (1) blending relatively hot air from one duct and relatively cold air from the other duct at certain times and (2) for introducing exclusively the relatively cold air from both ducts at other times. During winter months, hot air is supplied to one duct and cold air to the other duct. During summer months, cold air is supplied to both ducts. In the practice of the present invention, it is possible to provide year-round air conditioning without unduly large cold air supply ducts.

With these general objects in view and such others as may hereinafter appear, the invention consists in the air distributing apparatus, and in the various other structures, arrangements and combinations of parts hereinafter described and particularly defined in the claims at the end of this specification.

In the drawings:

FIG. 1 is a plan view more or less diagrammatically showing a portion of one story of a building embodying the present air distributing structure;

FIG. 2 is an elevation with parts in section of an outlet box embodying the invention;

FIGS. 3, 4 and 5 are schematic views in perspective illustrating dampers and actuating mechanism therefor to be referred to; and

FIGURE 6 is an enlarged detail illustration of an air operated damper motor **182** seen in FIGURE 2.

One of the principal embodiments of certain features of the present invention comprises an air distributing structure of the type forming the subject matter of the application for Letters Patent of the United States, Serial No. 412,217, filed February 24, 1954, now Patent No. 2,729,429 by Richard P. Goemann, one of the present applicants, wherein at least some of the load supporting floors of a building comprise the cellular metal floors illustrated in the United States Patent to Young, No. 1,867,433, and wherein provision is made for distributing air and particularly conditioned air from a source of supply through selected of the cells of the load supporting floors and wherein the air is discharged at selected portions of the building from said cells through sill boxes or outlets of any usual or preferred form.

In FIG. 1 we have illustrated more or less diagrammatically a plan view of a portion of one story of a multistory building embodying the air distributing and air conditioning system forming the subject matter of such Goemann application, Serial No. 412,217. As illustrated in FIG. 1, the building is provided with a cellular metal floor of the type illustrated in the United States Patent to Young, Patent No. 1,867,433, erected upon the usual girders and framework of a building to provide two portions A and B in which the cells **205** of the cellular metal floor extend at right angles to the two end walls of the usual service core **210** through which the elevators, plumbing and other piping run upwardly to the various stories of the building from the basement. Other portions of the floor designated D and E have the floor cells **205** parallel to the remaining sides of the service core. Differently conditioned air streams, which for convenience of description will be referred to as hot and cold air, are conducted through risers **220**, **221** from a source of supply in the basement or other portion of the building and are conducted through headers **252**, **253**, preferably arranged or disposed in a corridor along two sides of the service core and from which the hot and cold air may be introduced into selected floor cells to be conducted through the cells and discharged either above or below the floor through suitable outlets, herein shown as comprising sill boxes **260**, intermediate floor outlets **261** and ceiling outlets **249**. Any preferred connection may be made between the headers and the selected floor cells, as for example through the sets of curved ducts **270**, **271** to the mixing chambers **254** and thence upwardly to branch ducts **274**, **275**. In some instances we may prefer to discharge air through ceiling outlets **266** to the story below connected by branch ducts **278** to the respective cells.

The portion of the floor D in which the cells run parallel to a side of the service core is preferably serviced with air from a second set of hot and cold air risers **220**, **221**, and these risers may be connected by headers **240**, **241** in the corridor and thence through supply ducts **280**, **281** extending transversely across and under the generally parallel floor cells **205** of the portion D of the floor. The different transversely extended supply headers **280**, **281** are each connected to selected floor cells, some of the cells leading directly to sill boxes through which the air may be discharged at the ends of the building. The headers **280**, **281** also may be connected directly to the two floor cells **287**, **288** disposed along the side of the building, and from these cells **287**, **288** the hot and cold air streams may be connected to sill boxes **260** disposed along the side walls of the building under the windows.

As set forth in such Goemann application above referred to, equalizing ducts **292**, **293** may and preferably will be provided for assisting in equalizing the distribution of air from the transverse supply headers **280**, **281** in order to assist in equalizing the volumes of air supplied to the several different outlets.

In the operation of the air distributing system for distributing conditioned air of different conditions, such as hot and cold air, as disclosed in said Goemann application, Serial No. 412,217, above referred to, it is desirable to provide a sill box through which the hot and cold air may be discharged at a predetermined final static pressure at the outlet, and that these pressures should be maintained within predetermined tolerances irrespective of the volume of air of one condition or the other being discharged into the sill box immediately prior to its passage into the room or other portion of the building. For purposes of illustration we have illustrated in FIG. 2 a sill box for accomplishing this purpose. As illustrated in FIG. 1, air of different conditions may be conducted from the risers **220**, **222**, thence through the transversely extended crossover ducts or headers **280**, **281** and thence through the floor cells to supply conduits **297** or **298**. These conduits **297**, **298** are connected to inlets **140**, **142** (see FIG. 2) leading upwardly to the high pressure chambers indicated at **144**, **146**. Each side of the sill box, that is, the cold air side **144** or the hot air side **146**, is provided with an automatic static pressure regulator. For convenience of description the automatic static pressure regulator for the hot air side will be described, it being understood that a duplicate mechanism is provided for the cold air side **144**. As illustrated in FIG. 2, the flow from the inlet **142** in passing upwardly into the upper portion of the sill box comprising a mixing chamber is controlled by a damper 148 pivoted at 149 and backed up by a flexible bellows 150. The upstream side of the conduit is connected by a pipe 152 through a pilot valve 154 and pipe 156 to the interior of the bellows so that the static pressure of the air flowing from the inlet 142 into the chamber 146 prior to its passing under the damper 148 is controlled by the amount of air being bled off through the bleed port 157, the latter being controlled by the valve 158 whose stem 159 rests on the flexible diaphragm 160, and the dome beneath the diaphragm is connected by pipe 161 to the downstream side of the duct system, as shown.

Disposed immediately above the damper 148 are a pair of cam operated modulating dampers 170, 171 arranged to modulate the differently conditioned air streams emerging into the upper portion of the sill box after they have passed the damper 148.

Referring now particularly to FIGS. 2, 3, 4, 5 and 6, as stated, the discharge side of both hot and cold conduits of the sill box are provided with the dampers 170, 171 for controlling the volume of hot and cold air being discharged at the regulated static pressure into the upper portion of the sill box, and preferably the positions of these dampers are controlled from a heat responsive element by any known or preferred apparatus, such as a thermostatic control of the well known pressure or electrically actuated type now being manufactured by several of the leading manufacturers. As shown in FIG. 2, the thermostat 179 is supplied with air pressure from a supply line 180 connected with a compressor or other source of air under pressure. It is also connected by a line with an air operated motor indicated at 182 more fully illustrated in FIG. 6. Essentially the air operated motor may be of any known or preferred type and preferably comprises a cylinder having a piston 183 connected in sealed relation with the cylinder by a rolling rubber sleeve 184 or diaphragm capable of sliding in the cylinder in accordance with variations in air pressure in the head end of the cylinder and to which the line 181 is connected. The second end of the cylinder is provided with two coil springs 185, 186; one spring 185 controls the piston movement for a portion of the travel and, for example, may be of a strength to oppose piston movements corresponding to air pressure variations of from 5 to 10 lbs. per sq. in. assuming a supply of air pressure to the thermostat of 15 lbs. per sq. in., and the second spring 186 is of shorter length and arranged to become operative and control the continued piston movement within a range for example of from 10 to 15 lbs.

In FIGS. 3 and 4 I have diagrammatically illustrated a cam shoe 188 which is attached to the operating piston rod 189 so that the shoe moves downwardly and upwardly in response to the movement of the piston under the influence of the pressure controlled by the thermostatic element. In normal use, as for example in winter, the position of the dampers is as shown in FIG. 3, and when it is desired to decrease the temperature of the hot air due to varying load conditions by the mixture therewith of cold air as the streams are discharged past the operating dampers, the actuating motor springs 185, 186 may be arranged so that under a supply line pressure of say 15 lbs., the thermostat functions between one set of limits, as between 5 and 10 lbs., and as stated, in accordance with the movements of the pistons the dampers may be moved reciprocally from the position shown in FIG. 3 to that shown in FIG. 4, giving maximum cooling during the winter period, and during the course of the movement the dampers may move to increase the proportion of cold air from a position, where in FIG. 6 no cold air is being supplied, to that shown in FIG. 4 where the cold air damper is fully opened and the hot air damper closed. It will be understood that in operation the dampers assume intermediate positions so that the temperature of the resulting air in the upper part of the sill box results from modulation of hot and cold air in re-

sponse to the thermostat, i.e., the total outlet flow of blended air will be relatively constant over the range since any increase in the flow of hot air is accompanied by a decrease in the flow of cold air and vice versa. Over this operating range, the air operated motor 182 has its piston 183 moving against the longer spring 185 as seen in FIG. 6. The cam shoe 188 is provided with two cam slots, one slot 190 for the hot air damper being horizontal and receiving a cam roller 192 from the end of the crank arm 193 attached to the damper operating shaft 194, the latter being pivoted in portions of the duct wall, as illustrated in FIG. 2. The second leg of the U-shaped cam shoe is provided with a right angle slot 191 within which a similar cam roller attached to a similar crank arm is fixed to the end of the cold air damper operating shaft, as shown in FIGS. 2, 3, 4 and 5. In FIG. 3 the relative position of the parts are shown corresponding to a condition where the hot air damper is open and the cold air damper is fully closed, while in FIG. 4 the position of the parts are illustrated with the hot air damper shut and the cold air damper fully open. The operation from FIG. 3 to FIG. 4 is brought about by the movement of the piston downwardly, as shown in FIG. 2, and in which the operation of the piston is under control of the long spring. For some purposes, and particularly during summer operation, it may be desirable that cold air in maximum volume be delivered from both the inlets 140, 142, and accordingly by increasing the operating air pressure in the supply line by adjustment of the pressure or in any other suitable manner, up to for example 30 pounds per square inch, then the piston can be made to effect further movement downwardly viewing FIG. 2, so as to further depress the cam shoe from a position, such as shown in FIG. 4, to that shown in FIG. 5. During this further movement downwardly, the piston 183 of the air operated motor 182 moves against the shorter spring 186 as well as against the longer spring 185 as seen in FIG. 6. In order to move the piston 183 against the shorter spring 186, a greater operating pressure is applied to the air operated motor 182 through the air line 181. Thus during the summer month operation, the pressure within the supply line 180 is maintained at a greater value than during the winter month operation. Accordingly, where the winter month pressure in the supply line 180 may be 15 p.s.i.g., the winter operating pressures in the air operated motor 182 may range from about 5 to 10 p.s.i.g. During summer month operation, however, the pressure in the supply line 180 may be 30 p.s.i.g. and the summer operating range within the air operated motor 182 may range from about 10 to 15 p.s.i.g. This effects the movement of the cam roller to the opposite end of its slot while moving the cam arm through substantially 180° from its original position shown in FIG. 3, resulting in the opening of both dampers and their subsequent nonreciprocal operation. This enables maximum volume of cold air to be discharged into the room through both hot and cold air ducts 140, 142.

It will be observed that during the summer month operation, the damper 171 is fully open while the damper 170 moves over a range from fully open to fully closed. Thus an increase in the flow of air past the damper 170 is not accompanied by any increase or decrease in the flow of air past the damper 171. Accordingly, during the summer month operation, the total flow of blended air is relatively variable in contrast to the conditions which are achieved during the winter month operation wherein the flow of blended air is relatively constant.

Having thus described the invention, what is claimed is:

1. In a dual air distributing system for a building, a first conduit supplying relatively cold air and a second conduit which in a first instance is supplying relatively hot air and in a second instance is supplying relatively cold air, said conduits communicating with an outlet located in association with a room of said building, valve

means in each of said conduits, said valve means operating in said first instance (i.e., when said second conduit supplies relatively hot air) reciprocally whereby movement of one of said valve means in an opening direction is accompanied by movement of the other of said valve means in a closing direction resulting in a relatively constant flow of air through said outlet, said valve means further operating in said second instance (i.e., when the said second conduit supplies relatively cold air) nonreciprocally whereby movement of one said valve means in an opening direction results in a relatively increased flow of air through said outlet, a single drive means associated with said valve means and changeover means associated with the said drive means for changing the relative operation of the said valve means according to the condition of air in the said second conduit.

2. In a dual air distributing system for a building, a source of relatively cold air and a source of relatively hot air, a first conduit connected to said source of relatively cold air and a second conduit which in a first instance is connected to said source of relatively hot air and in a second instance is connected to said source of relatively cold air, said conduits communicating with an air outlet located in a room of said building, valve means in each of said conduits, a single drive means for operating said valve means in response to the thermal conditions within said room, said valve means operating in said first instance (i.e., when said second conduit is connected to said source of relatively hot air) reciprocally whereby movement of one of said valve means in an opening direction is accompanied by movement of one of said valve means in a closing direction resulting in a relatively constant flow of air through said outlet, said valve means further operating in said second instance (i.e., when the said second conduit is connected to the said source of relatively cold air) nonreciprocally whereby movement of one of said valve means in an opening direction results in an increased flow of air through said outlet, and changeover means associated with said drive means for changing the relative operation of said valve means according to the condition of air in said second conduit.

3. In a dual air distributing system for a building, a first conduit supplying relatively cold air and a second conduit which in a first instance is supplying relatively hot air and in a second instance is supplying relatively cold air, said conduits communicating with an outlet located in association with a room of said building, first valve means in said first conduit movable from a closed position to a fully open position, second valve means in said second conduit movable from a closed position to a fully open position, a single drive means for positioning said valve means in response to thermal conditions within said room, said drive means in said first instance (i.e., when the said second conduit supplies relatively hot air), operating said second valve means in a closing direction and said first valve means in an opening direction and vice versa, whereby relatively constant flow of air through said outlets is achieved, said drive means in said second instance (i.e., when the said second conduit supplies relatively cold air) maintaining said second valve means fully open at all times and positioning only said first valve means in response to the thermal conditions within said room whereby a relatively variable flow of air through the said outlet results, and changeover means associated with said drive means for changing the relative operation of said drive means according to the condition of air in said second conduit.

4. An outlet box for use in a dual air distributing system, said box having two air inlets, the first of which receives a supply of relatively cold air and the second of which receives in a first instance a supply of relatively hot air and in a second instance receives a supply of relatively cold air, said box having two air outlets, correlated valve means between each said inlet and said outlet, single drive means for positioning said valve means, said drive means in said first instance (i.e., when said second inlet receives a supply of relatively hot air) operating said valve means reciprocally whereby when one of said valve means moves in an opening direction, the other moves in a closing direction resulting in a relatively constant total flow of air through said outlets, said drive means in said second instance (i.e., when said second inlet receives a supply of relatively cold air) operating at least one of said valve means in an opening direction without accompanying movement of the other of said valve means in a closing direction whereby movement of one of said valve means in an opening direction results in an increased flow of air through said outlets, and changeover means associated with said drive means for changing the operation of said drive means according to the condition of air in said second air inlet.

5. Damper operating mechanism, comprising: a pair of movable dampers each mounted on an operating shaft, means for operating said dampers including a cam shoe, means for moving said cam shoe up and down, said cam shoe being U-shaped and having a straight horizontal cam slot in one leg thereof, a cam roller in the slot, a cam arm to which the roller is attached, said arm being fixed to the operating shaft of the first one of said dampers to effect rotary movement thereof during the first portion of the downward movement of the cam shoe to effect the closing of the first damper and to again effect movement of the first damper into an open position by continued rotary movement of the cam arm in the same direction, said second leg of the cam shoe having a right angular shaped slot including a horizontal and a vertical portion extending upwardly from one end of said horizontal portion, a second cam roller in said right angular slot, a cam arm carrying said second cam roller and being fixed to the operating shaft of the second damper, whereby movement of the second cam roller through the horizontal portion of the angular slot during the first portion of the downward movement of the cam shoe effects movement of the second damper from closed to open position, and whereby continued movement of the shoe permits said second damper to remain in open position while the first damper is being moved from closed to open position.

6. The method of distributing air through a building having dual ducts for supplying air to selected rooms of the said building, comprising in a first instance supplying relatively cold air to the first duct of said dual ducts and supplying relatively hot air to the second duct of said dual ducts, reciprocally blending the air from each duct in response to the thermal conditions within one of said selected rooms by increasing the flow of air from said first duct and decreasing the flow of air from said second duct and vice versa whereby the total flow of blended air is relatively constant in said first instance, and in a second instance supplying relatively cold air to both of said dual ducts and blending the air from each duct in response to the thermal conditions within one of said selected rooms by alternately firstly increasing the flow of air from one of said ducts without an accompanying decrease in the flow of air from the other of said ducts and secondly decreasing the flow of air from one of said ducts without an accompanying increase in the flow of air from the other of said ducts whereby the total flow of blended air is relatively variable in said second instance.

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