Nov. 5, 1940. W. SHURTLEFF 2,220,355

AIR CONDITIONING APPARATUS

Filed Jan. 12, 1938 2 Sheets-Sheet 1

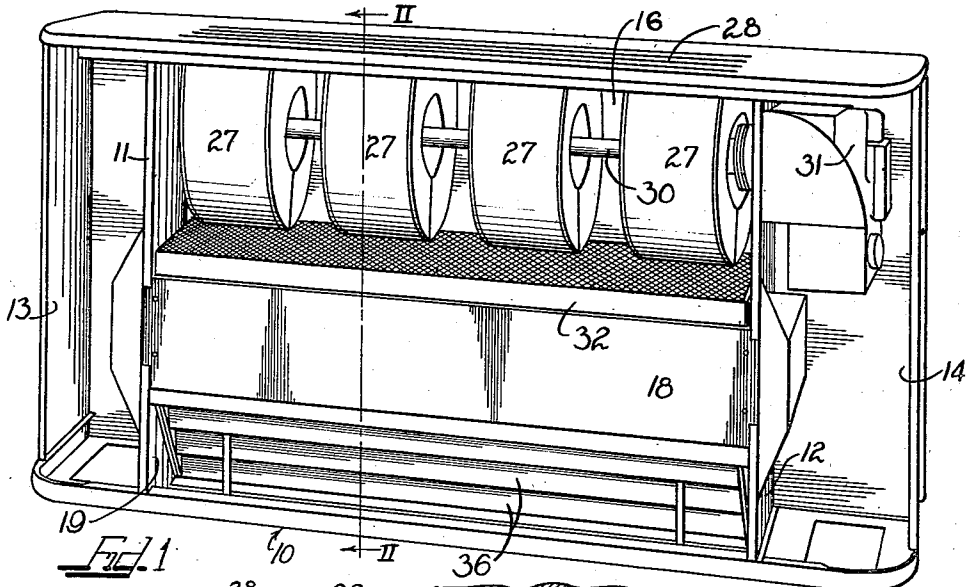

Fig. 1

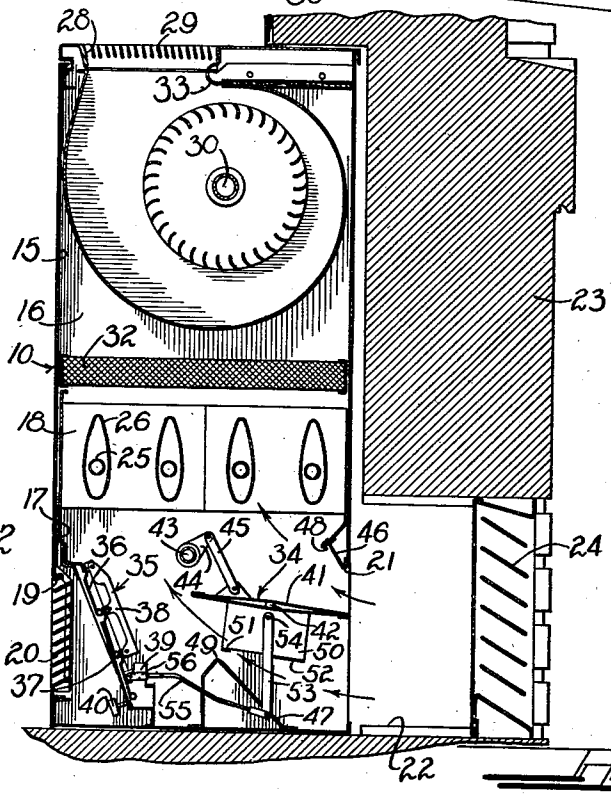

Fig. 2

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Nov. 5, 1940. W. SHURTLEFF 2,220,355

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Filed Jan. 12, 1938 2 Sheets-Sheet 2

Fig. 3

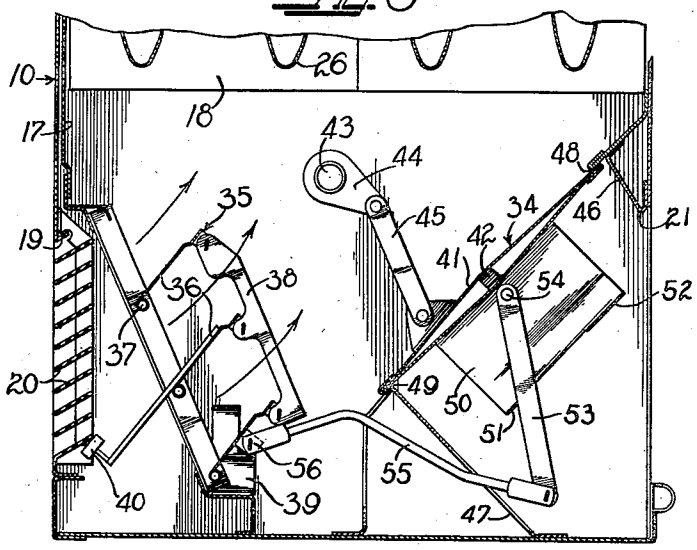
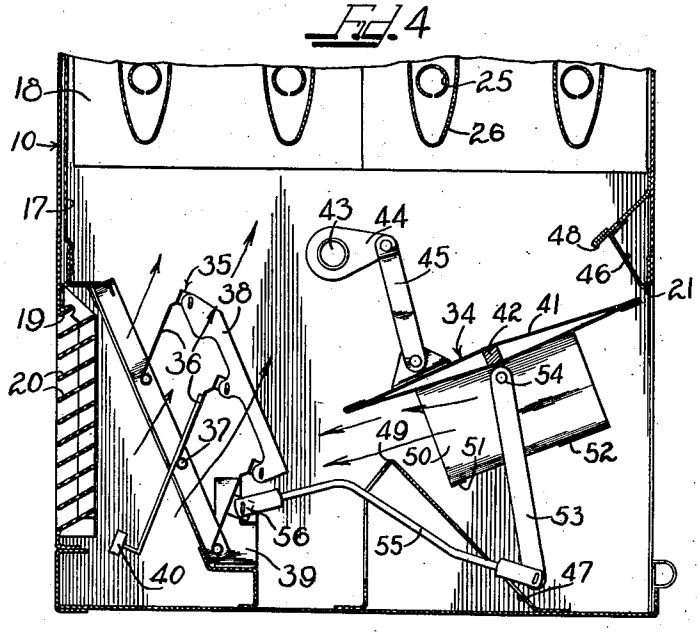


Fig. 4



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AIR CONDITIONING APPARATUS

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13 Claims. (Cl. 98—38)

The present invention relates in general to air conditioning apparatus and is in particular concerned with novel means for controlling the circulation and temperature of air for use in rooms.

A primary object of the invention is to provide apparatus of the herein described type wherein outside air and air from the room in which the apparatus is located may be thoroughly mixed before passing it through a heat exchange element.

A further object of the invention is to provide air conditioning apparatus having an inlet for outdoor air and an inlet for room air, wherein the outdoor air is prevented in a novel manner from passing directly into the room through the room air inlet.

Another object of the invention is to provide air conditioning apparatus wherein inlet air is divided into distinct currents, and, where the inlet air is from different sources, these currents have intersecting paths of movement to insure a thorough mixing thereof.

A still further object of the invention is to provide air conditioning apparatus, wherein air taken from outside the room will be caused to move in one direction when being mixed with air taken from inside the room, and in another shorter direction of less resistance through the apparatus, when all of the air is being taken from the outside.

A still further object is to provide an air conditioning apparatus improved damper control for variably proportioning the amounts of inlet air taken from different sources to meet different conditions of operation.

Other objects and features of the invention will more fully appear from the following detailed description taken in connection with the accompanying drawings which illustrate a single embodiment thereof, and in which:

Figure 1 is a view in elevation of air conditioning apparatus embodying the features of the present invention, the forward wall of the casing being removed to show the cooperative relationship of the instrumentalities therein:

Figure 2 is a vertical section through the apparatus showing the cooperative relationship of the inlet dampers, when all the air is being taken from outdoors, taken substantially on line II—II of Figure 1;

Figure 3 is an enlarged fragmentary sectional view taken through the inlet air mixing compartment to show the cooperative relationship of the dampers when all the inlet air is being taken from indoors; and

Figure 4 is a similar view showing the dampers set for admission of inlet air both from indoors and outdoors, the outdoor damper being set to admit a predetermined minimum amount of air.

As shown on the drawings:

As illustrative of my present invention, air conditioning apparatus is disclosed in the drawings which embodies a casing, generally indicated at 10, this casing being preferably constructed of sheet metal and of generally rectangular configuration.

The interior of the casing is separated by means of partition members 11 and 12 to provide end compartments 13 and 14 which are separated longitudinally of the apparatus by means of a central or intermediate compartment 15.

Vertically, the intermediate compartment 15 is separated into an upper compartment 16 and a lower compartment 17 by heat exchange apparatus 18.

The lower compartment 17 communicates on its forward side with the interior of the room in which the apparatus is located through an inlet opening 19 provided with a plurality of louvers 20. The inlet opening with the louvers therein is preferably located on the forward side of the casing.

At the rear side, the wall of the casing is provided with an inlet opening 21 which establishes communication between the lower or air mixing chamber 17 and an air duct 22 which may be provided in the room wall 23 against which the apparatus may be positioned on its back side.

The duct 22 at the outer surface of the room wall is provided with suitable louvers 24 to permit admission of outdoor air into the duct 22 and thence into the mixing chamber for inlet air.

The heat exchange unit comprises a steam radiator extending entirely across the intermediate compartment 15 so that all inlet air entering the mixing chamber will have to pass through the heat exchange member before reaching the upper chamber 16 of the apparatus.

The radiator comprises a plurality of tubes 25, which are adapted to carry steam. These tubes are perforated on their under side in order to permit expansion of the steam from the tubes into a streamlined surrounding casing 26 which forms heat exchange surfaces that will be engaged by inlet air passing through the radiator. By means of suitable valves, the radiator may be

throttled to increase and decrease its heating effects.

The upper chamber 16 is provided with a plurality of fans 27 which are adapted to draw air from the lower or mixing compartment 17 through the heat exchange means or radiator into the upper compartment from which the fans discharge the conditioned air through an outlet 28 at the top of the casing, this outlet containing a plurality of inclined vanes 29 for controlling the direction in which air will be discharged into the room.

The rotors of the respective fans are mounted on a single shaft 30 which extends longitudinally of the upper chamber and is rotatably supported in any suitable manner. This shaft is connected to a driving motor 31 which is mounted in one of the end compartments, in this instance compartment 14.

Since it is a characteristic of an electric motor to heat up during operation, economy of operation of the air conditioning apparatus is materially increased by mounting the fan motor outside of the air stream which is being conditioned.

It is also preferable that the air which is being circulated through the apparatus be filtered, and for this purpose a filter 32 may be mounted in compartment 16 above the heat exchange means. This filter may be of any desired construction.

Moreover, for controlling the fan discharge, the individual fans are provided with an adjustable slide gate valve 33 at its outlet opening.

For controlling the admission of room air and outdoor air to the mixing chamber and for assuring that the outdoor and indoor air are properly mixed before being circulated through the heat exchange apparatus and thence into the room, the mixing compartment is provided with an outdoor air control damper generally indicated at 34 and an indoor air control damper generally indicated at 35.

These dampers are interconnected for operation to give three distinct results, namely:

(1) During the night, when the room is unoccupied, the indoor air or re-circulation damper 35 is arranged to be held wide open in order to enable aspiration of air heating of the room. Such an arrangement saves fuel and effects heating of the room without the necessity of operating the fans.

(2) For the condition where the occupied room is to be heated and ventilated with one-third outdoor air and two-thirds or any other desired minimum proportion of re-circulated or indoor air. For this condition, the outdoor damper is arranged to be mechanically held one-third open and the re-circulation or inlet room air damper is actuated to two-thirds open position by the suction of the fan. The inlet room air damper is so constructed as to be free to automatically close at any time a strong wind blows an excess of outdoor air into the lower or mixing chamber. During such operation, the radiator steam input may be controlled either manually or by means of thermostatic control in response to temperature changes of the room.

(3) For conditions where the room tends to become overheated either from bodily heat, sun or any source of uncontrolled heat the admission of outdoor air is arranged to be controlled by damper 34 either manually or through suitable thermostatically operated and controlled mechanism to gradually open the outdoor air inlet damper as the re-circulation damper is closed by gravity until the outdoor air inlet damper is wide open to allow full volume of outdoor air to enter the mixing chamber. Under such operation it has been found desirable and preferable to shut off the steam to the radiator before the outdoor air inlet damper is open above the one-third or other minimum setting so as not to waste fuel.

The inlet air damper comprises a plurality of vanes 36 which are disposed in parallel relation and are hinged along similar edges as shown at 37 for swinging movement into open and overlapped closed positions. Simultaneous actuation of the vanes is secured by interconnecting the vanes by means of a bridge member 38. The damper in its fully open position is arranged to abut a suitable stop member 39.

The vanes and connected mechanism are biased by means of a suitable weight 40 which is disposed on the opposite side of the pivots for the vanes, so that this weight tends to actuate the damper toward closed position by the action of gravity thereon.

It will be noted that, if desired, the weight 40 may be so disposed in relation to the vanes that the weight will actuate the damper to fully closed position, or the weight may be placed in such position that instead of the damper being moved to fully closed position it will assume a partially open position depending upon the relationship of the weight 40 thereto. However, regardless of whether the damper 35 is arranged to be fully or partially closed by gravity, the damper may readily be moved to entirely closed position whenever the flow of air therethrough is reversed for any reason, such as a strong wind blowing through the outdoor inlet of the apparatus. Such an arrangement is advantageous in that it prevents cold air from blowing out through the room inlet air opening into the room, whereby undesirable drafts would be set up.

The outdoor air inlet damper 34 comprises an elongated vane 41 which is pivoted as at 42 at its ends on its longitudinal center line for swinging movement.

Swinging movement of the vane 41 is controlled by means of a shaft 43 which extends longitudinally of the mixing compartment and is supported in any suitable manner for rotative movements. Rotation of this shaft may be accomplished either through suitable manual control mechanism or by means of a thermostatically controlled power actuating mechanism (not shown).

The shaft 43 is provided with a crank arm 44 which is connected at its free end to one end of a connecting link 45 having its other end pivotally connected to the vane 41 at a point laterally displaced from its center of rotation.

With this arrangement, it will be observed that movement of the shaft 43 in one direction will actuate the vane or damper 41 toward open position, whereas movement of the shaft in the opposite direction will move the damper toward closed position.

The inlet outdoor air entering opening 21 of the casing is conducted in a generally upward direction by means of an upper baffle plate 46 and a lower baffle plate 47. The damper is arranged to close the channel defined by these abutment plates by having its lateral edges abut the innermost ends of the baffles as at points 48 and 49, in which position the vane 41 is disposed at substantially an angle of 45° relative to the full open position of the vane.

It will be observed that when the edge of the

vane 41 associated with baffle 47 is opened a predetermined amount from its closed position of abutment at point 49 with the baffle, the other edge of the vane is still associated with baffle 46. In other words, for a predetermined open position of the vane 41 inlet air is prevented from passing over the top edge of the vane by the baffle 46, but is free to move past the lowermost edge of the vane. In this position, the entering air will be forced into a downwardly directional path as shown in Figure 4. This direction of entering outdoor air assures that the air will be mixed with air which may be entering through the indoor air inlet damper.

This forced mixing of outdoor and indoor air when a predetermined minimum of outdoor air is being admitted with indoor air is of particular advantage in air conditioning apparatus having a throttling type radiator.

With the usual type of ventilator or air conditioner with the usual damper arrangements, freezing of the radiator often results because the dampers are so arranged as to permit the passage of cold air through the radiator without being properly mixed with warm air. If the radiator is throttled down, there is danger of this cold air, where the outdoor temperature is below freezing, of the radiator becoming frozen in spots. In the novel damper-raised arrangement of my present invention, such danger is eliminated by causing the outdoor air to dive downwardly into the warm air stream from the indoor air inlet, thus causing a thorough mixing of the cold air with a sufficient amount of warm air to raise the resulting mixture to a temperature above freezing before it passes through the radiator.

Although the baffle 46 in the present instance is arranged to cooperate with the vane 41 to direct the cold inlet air downwardly at a predetermined minimum open position of the vane of substantially one-third its total open position, it will be appreciated that the baffle 46 may be arranged to provide such operation at any desired predetermined minimum opening within the limits of the arrangement.

As a practical matter, it has been found that with this method, a thorough mixing of one-third cold air with two-thirds re-circulated air will always insure a final temperature above the freezing point in the air passing through the radiator even down to thirty degrees below zero for outside weather conditions.

If the room should tend to overheat when outdoor temperatures are from 40° to 60° F., it is desirable to automatically gradually increase the amount of outdoor air until a maximum volume is taken from outdoors in order to cool the room. At these temperatures a large volume of outdoor air will not tend to freeze the radiator so that it is not important to insure that the outdoor air be mixed with indoor air before being discharged into the room. Under such conditions, the damper 34 may be actuated so that the vane 41 is moved to fully open position as shown in Figure 2. In this position of the vane 41, it will be observed that the outdoor air is no longer caused to dive downwardly into the bottom of the casing, but is permitted to move in a shorter direct path toward the upper part of the casing. This shorter path has less resistance to the movement of the air than in the case where the cold air is being projected downwardly for mixing with any warm air which might be entering through the indoor air inlet.

A lost motion connection is provided between the outdoor air damper 34 and the indoor air damper 35. Affixed to the underside of vane 41 is a downwardly projecting plate 50 which is provided at its lower edge with spaced lugs 51 and 52 between which an elongate link member 53 is supported for swinging movement. The member 53 is pivoted at one end as shown at 54 to the plate 50, and is pivotally connected at its other end to a link member 55. The other end of link member 55 is pivotally connected as at 56 to one of the vanes 36 of the indoor air inlet damper.

With the foregoing arrangement, it will be observed that when the vane 41 is in fully closed position as shown in Figure 3, the lug 51 is in engagement with link member 53 and will force the vanes 36 of the indoor air inlet damper 35 to fully opened position. This adjustment of the dampers is for night operation of the apparatus, at which time it is desirable to admit full volume of air through the inlet damper 35, whereby the air in the room may aspirate by convection currents through the apparatus.

At the fully opened position of vane 41, the lug 52 engages link member 53 and forces the vanes of damper 35 into fully closed position, whereby full volume of outdoor air may enter the apparatus. This setting of the dampers is utilized where outdoor air is used for cooling an overheated room.

Between these extreme closed and open positions of damper 34 as shown in Figures 2 and 3 respectively, for settings between these extreme positions the dampers 34 and 35 are independent in their operation. This setting which may be when the vane 41 is set for a predetermined minimum supply of outdoor air, for example, one-third volume, is shown in Figure 4. This setting is ordinarily used when the room is occupied, in which case a predetermined minimum supply of outdoor air is specified by law. For such setting, as shown in Figure 4, the damper 35 is not opened to its widest extent, but will be actuated to substantially two-thirds open position by the flow of circulated air therethrough. Moreover, since the damper 35 is of the gravity closing type, this damper is free to move to closing position at any time there is a back draft or the flow of inlet air therethrough is reversed.

From the foregoing description, it will be apparent that the herein described invention provides novel air conditioning apparatus wherein outside air and air from the room in which the apparatus is located may be thoroughly mixed before passing it through a heat exchange element; apparatus in which outdoor air is prevented in a novel manner from passing directly into the room through the room air inlet, thus setting up draft in the room; in which inlet air is divided into distinct currents, and where the inlet air is from different sources these currents of air have intersecting paths of movement to insure a thorough mixing thereof; in which air taken from outside the room will be caused to move in one direction when being mixed with air taken from inside the room, and in another shorter direction of decreased resistance through the apparatus when all the air is being taken from the outside; and in which improved damper control is provided for variably proportioning the amounts of inlet air taken from

different sources to meet different operating conditions.

The invention has been described herein more or less precisely as to details, yet it is to be understood that the invention is not to be limited thereby, as changes may be made in the arrangement and proportion of parts, and equivalents may be substituted, without departing from the spirit and scope of the invention.

I claim as my invention:

1. Air conditioning apparatus comprising a casing, a heat exchange element separating the casing into two chambers, one of said chambers having an outlet opening and the other a plurality of inlet openings adapted to communicate with different air sources, means for circulating the air from the latter chamber through the heat exchange element into the former chamber, dampers respectively associated with said inlet openings, and means connecting said dampers for independent operation at certain relative positions thereof, and dependent operation at other relative positions thereof.

2. Apparatus of the character described comprising a casing defining a mixing chamber having a first air inlet and a second air inlet, said inlets communicating with different air sources, means to discharge air from said chamber, interconnected damper means for controlling the inlet air arranged to admit partial flow through said first inlet when air is being taken in through the second inlet, and admit full flow through said first inlet when no air is being taken in through the second inlet, and means including the damper associated with the first inlet for directing said partial flow of air in its movement to said discharge means through a relatively long path in mixing relation with the air entering the second inlet, and through a relatively shorter path when full flow is admitted through the first inlet.

3. Apparatus of the character described comprising an air conditioning element, a casing for said element defining a mixing chamber on the inlet side of said element, said chamber having an inlet for air to be re-circulated and an inlet for outdoor air, means for circulating air from the mixing chamber through said element, an outdoor inlet damper, baffle means associated with said damper and cooperative therewith to direct a proportioned stream of outdoor air in a direction to form an intimate mixture with re-circulated air before any air from either source is circulated through said elements, and means for altering the direction of outdoor air flow into a direct flow path of reduced resistance when the outdoor damper is wide open and all the inlet air is from outdoors.

4. In apparatus of the character described including a steam radiator of the throttling type, a casing for said radiator defining a mixing chamber below said radiator, means for circulating air from the mixing chamber through said radiator, and means including interdependent dampers in said chamber for controlling the admission of inlet air thereto from two sources, one the room in which the casing is located and the other outdoors, said means being arranged to deflect outdoor air downwardly within said chamber and room air upwardly when air enters from both sources, and direct the inlet air upwardly when all the air entering the chamber is from one of said sources.

5. In a ventilator unit to deliver a predetermined minimum of outdoor air into a room while occupied and up to one hundred per cent of outdoor air in order to cool the room when overheated, and including a steam radiator adapted to be throttled; a casing for the radiator defining a mixing chamber, means for circulating air from said chamber through the radiator, means in said chamber for intimately mixing outdoor air and room air of wide temperature differences before it is circulated through the radiator, whereby cold streaks which might freeze the condensate in said radiator when the outdoor air is below freezing are eliminated, said means including a room air damper and an outdoor air damper, the room air damper being normally automatically responsive to the operation of said circulating means at partially open positions of the outside air damper, and a lost motion connection between said dampers for forcing the room air damper to closed position, when the outdoor air damper is fully opened.

6. In an air conditioning unit, means for circulating room air through the unit, means for controlling the inlet of room air to said unit, said means comprising a damper arranged to normally open and close in response to the operation and non-operation of said first means, and means for restraining the damper against closing movement when said first means is not in operation.

7. In an air conditioning unit, means for circulating room air through the unit, means for controlling the inlet of room air to said unit, said means comprising a gravity closing damper normally maintained open a predetermined amount by the flow of air therethrough when said first means is operating, and means for actuating the damper to a greater opening than said predetermined amount and latching it against closure by gravity.

8. In an air conditioning unit, means for circulating room air through the unit, means for controlling the inlet of room air to said unit, said means comprising a damper, means for selectively locking the damper in fully open and fully closed positions, said damper between said extreme positions being free to open in response to the movement of inlet air therethrough when said first means is operating, and closed by gravity when said first means is stopped.

9. In an air conditioning unit, means for circulating outdoor air through the unit, means for controlling the inlet of outdoor air to said unit, said means comprising a damper vane pivoted intermediate its lateral edges for swinging movement, a baffle associated with one of said lateral edges of said vane operative for a predetermined movement thereof from closed toward open position to force the inlet air to pass around the other lateral edge, but for further opening movement of the vane to enable inlet air to pass around both lateral edges.

10. In an air conditioning unit, means for circulating air through the unit, radiator means in said unit for heating air passing through the unit, means for controlling the inlet of outdoor air to said unit, said means comprising a damper vane pivoted for swinging movement, a baffle associated with said vane and operative therewith to direct a predetermined minimum volume of the entering outdoor air downwardly relative to the radiator, and a maximum volume of the air in an upward direction toward the radiator.

11. An air conditioning unit having a pair of air inlet openings, adjustable dampers for proportioning the flow of inlet air through said openings, one of said dampers being free to open in

response to flow of inlet air therethrough and move toward closing position by gravity as the flow of air is decreased, the other of said dampers being adjustable to a position wherein a predetermined minimum of air is admitted, but operable to the extreme positions of fully closed and fully opened positions, and a lost motion connection between said dampers arranged to force the former damper to fully closed and fully opened positions when the latter damper is at its extreme positions.

12. Air conditioning apparatus comprising a casing, a heat exchange element separating the casing into two chambers, one of said chambers having an outlet opening and the other a plurality of inlet openings adapted to communicate with different air sources, means for circulating the air from the latter chamber through the heat exchange element into the former chamber, first and second dampers respectively associated with said inlet openings, and means for dependently actuating the first of said dampers in response to the movement of the second damper to certain positions, said latter means including a lost motion connection enabling independent actuation of said dampers at certain other positions of said second damper.

13. Air conditioning apparatus comprising a casing, a heat exchange element separating the casing into two chambers, one of said chambers having an outlet opening and the other a plurality of inlet openings adapted to communicate with different air sources, means for circulating air from the latter chamber through the heat exchange element into the former chamber, a first damper and a second damper respectively associated with said inlet openings, said first damper being normally responsive to the operation of said means, and common actuating means for said dampers operative to actuate the first damper to full open position when the second damper is fully closed, and actuate the first damper to fully closed position when the second damper is fully opened, said actuating means including a lost motion connection releasing said first damper for normal operation at intermediate positions of the second damper.

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