Jan. 4, 1938. S. E. LYMAN 2,104,088

TIME CONTROLLED MEANS FOR DISTRIBUTING AIR

Filed Oct. 3, 1933 2 Sheets-Sheet 1

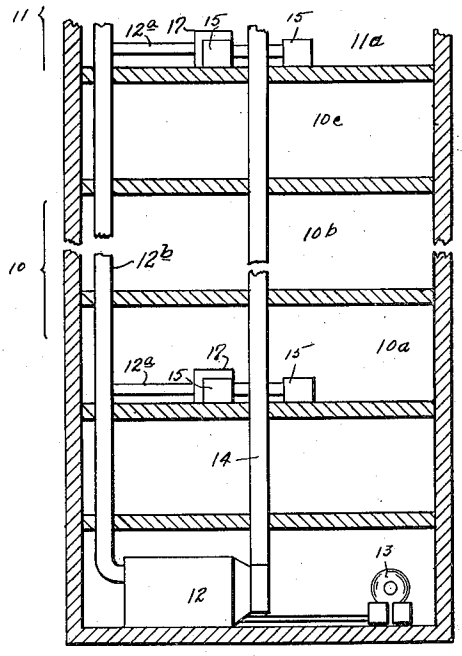


Fig. 1.

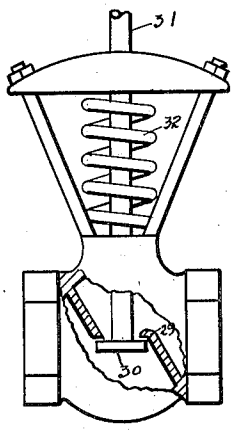


Fig. 3.

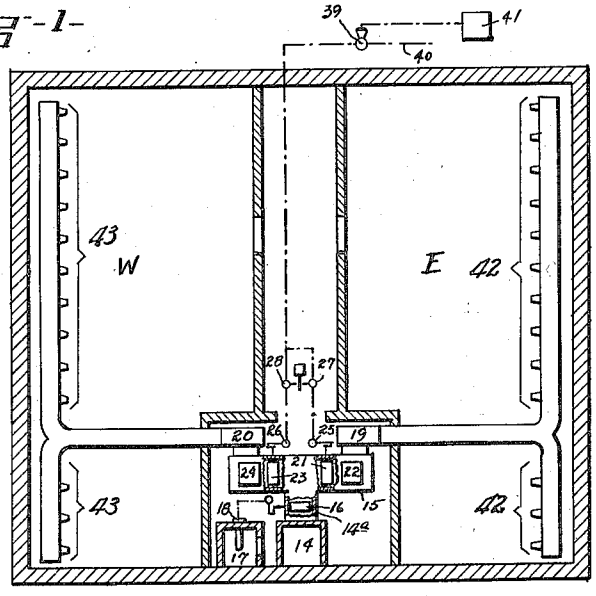


Fig. 2.

INVENTOR.
Samuel E. Lyman
BY Herman Seid
ATTORNEY

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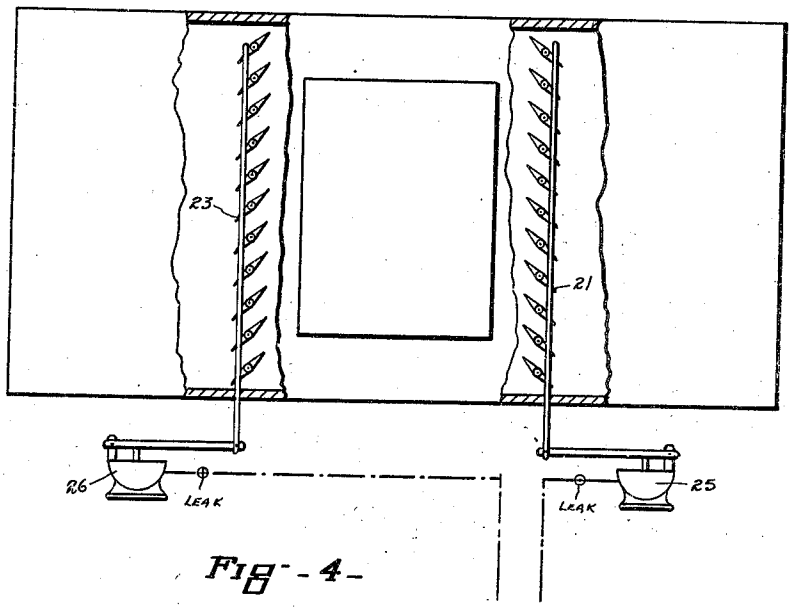


FIG. 4.

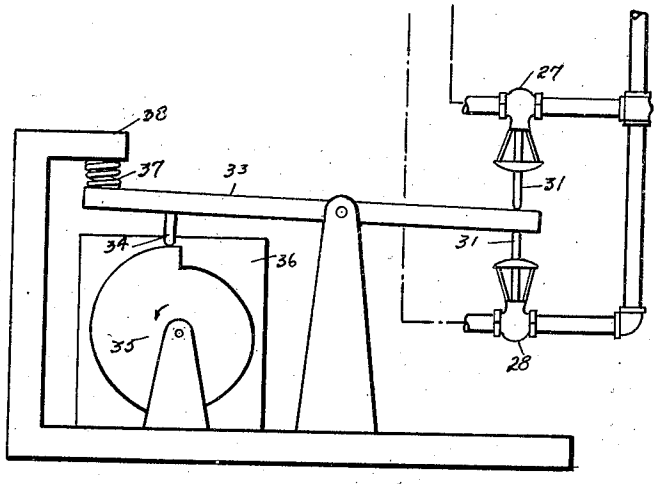


FIG. 5.

INVENTOR.
Samuel E. Lyman
BY Herman Seid
ATTORNEY

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TIME CONTROLLED MEANS FOR DISTRIBUTING AIR

Samuel E. Lyman, Elizabeth, N. J., assignor, by mesne assignments, to Carrier Corporation, Newark, N. J., a corporation of Delaware

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12 Claims. (Cl. 98—39)

This invention relates to methods of and means for controlling atmospheric conditions within an enclosure and more particularly, to the distribution of air throughout an enclosure.

In general, the problems confronting an air conditioning engineer fall into two classes: (1) Those involving the treatment of air, and (2) The problems relating to distribution of the treated air within the enclosure. This invention relates to a problem of the second class.

More particularly, this invention relates to a method of air distribution to vary the amount of conditioned air supplied in accordance with changes in the heat load due to sunlight gain. In prior practice, the air conditioning expert has estimated the heat load on a building and has provided conditioning equipment of sufficient capacity to take care of peak loads. As a result, the sunny side of a building is comfortably cooled, whereas the shady side is overcooled. If, on the other hand, the capacity of air conditioning equipment is figured for an average condition, then no part of the enclosure is comfortable, since the temperature and humidity are average rather than specific for maximum comfort. An object of the invention, therefore, is to provide a distributing means whereby all portions of an enclosure are maintained at substantially the same temperature, regardless of the varying sunlight gain on the different portions of a building.

Another object is to provide means for shifting from one portion of a building to another that amount of conditioned air which is just sufficient to overcome the heat gain due to sunlight.

Still another object of the invention is to provide a means for supplying relatively equal volumes of air to all portions of the building whenever there is no sunlight gain.

A further object of the invention is to reduce the amount of conditioning equipment required, consequently reducing the operating and maintenance cost.

A feature of the invention resides in dividing an enclosure into zones corresponding to different relative positions of the sun, supplying conditioned air to the separate zones and shifting from one zone to another that quantity of air necessary to overcome sun effects.

Another feature of the invention resides in the provision of a central conditioner for supplying air to local attemperators throughout the enclosure.

Another feature resides in the provision of a time-control device for shifting the position of dampers, thereby to vary the amount of conditioned air supplied to different zones.

A further feature of the invention resides in the provision of a photo-electric cell adapted to cause the dampers to assume a predetermned normal position whenever the sun is not shining.

Other objects and features will be in part obvious and will in part appear hereinafter.

Fig. 1 is an elevational view of a building showing the central air conditioner supplying air to the local attemperators the figure being largely diagrammatic.

Fig. 2 is a plan view, on an enlarged scale, of an operating floor of the building of Fig. 1.

Fig. 3 is an elevation of one of the control valves, a portion of the valve casing being broken away to show the interior thereof.

Fig. 4 is a fragmentary elevational view of one of the attemperator units, a portion of the casing being broken away to show the damper arrangement.

Fig. 5 is an elevational view of one form of time-operated control device which may be used in connection with the invention.

In this invention, among other things, applicant contemplates dividing a building into sections, each of which comprises one or more floors. Thus, the partially shaded lower floors might constitute one section, and the upper unshaded floors constitute another section. Air is delivered from a central source to one floor of each section and is, from that floor, circulated throughout the several floors of that section. As illustrated in Fig. 1, for example, the building is divided into section 10, including floors 10*a*, 10*b* and 10*c*, and section 11, including floor 11*a* and floors thereabove (not shown). An air conditioner 12 located in the basement and supplied with cold water from a refrigerating machine 13 for conditioning air delivered to the conditioner from any desired source or sources through duct 12*b* delivers conditioned air through riser 14 to the attemperators, or mixing boxes, 15, on floors 10*a* and 11*a* of sections 10 and 11, respectively. Fig. 2 illustrates the division of an operating floor into zones. Assuming that the building faces north and south, the main sunlight gain will occur on the eastern and western walls. The floor plan is, therefore, divided into two principal zones, an eastern zone E, and a western zone W. The quantity of conditioned air sufficient to take care of the heat load in an entire floor is supplied to the respective mixing boxes 15 from riser 14 through conditioned air inlet 14*a* under the control of damper 16. The position of damper 16

is determined by the temperature of air returned both from the zone E and zone W to conduit 17, as indicated by thermostat 18. The air from conduits 17 discharges into ducts 12a feeding into duct 12b leading to conditioner 12. As can readily be understood, the temperature of returned air indicates the average temperature in both zones. Therefore, damper 16 passes just sufficient air to overcome the total heat load on the entire floor. If the temperature of return air rises, the damper 16 will be opened to supply more conditioned air, and conversely, if the temperature falls, the supply of conditioned air is reduced. Assuming that the sun is on the east side, it is apparent that if this air were divided equally between the two zones, the east zone would be undercooled, while the western zone would be overcooled. As a result, people in either zone would be uncomfortable. Therefore, applicant divides the quantity of air between the two ones in accordance with the sunlight gain affecting the particular zone. To this end, each zone is provided with a fan, to wit, 19, for supplying air to a distributing means 42 in zone E and 20 for supplying air to a distributing means 43 located within zone W. The distributing means 42 and 43, as herein shown, comprise a plurality of tapered nozzles for discharging air directly into the enclosure. Since such distribution means is well known in the art, and, per se, form no part of this invention, it is believed that further description is unnecessary. Fan 19 draws a quantity of conditioned air determined by the position of damper 21, plus a quantity of unconditioned air through the bypass opening 22, and supplies this mixture to zone E. Similarly, fan 20 supplies a mixture of conditioned air through damper 23, plus unconditioned air through bypass opening 24 to zone W. Therefore, the position of dampers 21 and 23 determine the temperature in zones E and W respectively. As is shown in Fig. 4, both sets of dampers have a normal partially opened position, and are further opened by an increase in air pressure on their respective damper motors 25 and 26. The initial, or normal, position of dampers 21 and 23 is designed to pass a quantity of conditioned air just sufficient to overcome the heat load due to all factors other than sunlight gain, or more precisely, to supply relatively equal amounts of conditioned air to both zones. Thus if there is no sunlight gain affecting the building, or if the heat gain due to sunlight is substantially uniform over the entire building, then these normal positions of dampers 21 and 23 supply relatively equal amounts of air to both zones. The difference between the total heat load on the building when there is no sunlight gain, and when there is sunlight gain is, of course, reflected by changes in the temperature of return air in conduit 17. Such changes are corrected by the action of thermostat 18 to decrease or to increase the amount of conditioned air supplied from conduit 14. However, if the sun is shining, on the east wall in the morning, for example, it is desirable that damper 21 be further opened to increase the conditioned air supplied to the east zone. As the sun changes its position relative to the building and begins to affect the west wall, as in the afternoon, it is desirable that the amount of conditioned air supplied to the eastern zone be decreased, while the amount supplied to the western zone be increased. To accomplish this, applicant provides two valves 27 and 28 in the main air supply for varying the air pressure on damper motors 25 and 26 respectively. Each valve, see Fig. 3, comprises a casing, a valve seat 29, closure member 30, a valve stem 31 attached to the closure member, and a spring 32 for holding the closure member in normally closed position. The valves are mounted opposing each other, with the ends of their respective stems 31 resting against one end of a pivoted bar 33 (Fig. 5). A pin 34 rests against the face of a cam 35 which cam is rotated by suitable clock works 36. Clock 36 is set to move in timed relation to relative movements of the sun and earth. Spring 37, held in compression between bar 33 and bracket 38, maintains pin 34 in constant engagement with cam 35, thereby causing the bar to follow movements of cam 35. Movement of the bar necessarily affects the setting of valves 27 and 28. Thus, when pin 34 is resting on the highest point of cam 35, as illustrated in Fig. 5, valve 28 is in fully opened position, while valve 27 is fully closed. Rotation of cam 35, in the direction indicated by the arrow, will cause pin 34 to fall abruptly to the lowest point of cam 35, and as a consequence, valve 27 will be fully opened and valve 28 fully closed. Continued rotation of the cam will cause a graduated movement of both valves, that is, valve 27 will slowly close, while valve 28 will slowly open. The total effect on the dampers will be as follows: Assuming that the position of the cam is as shown in Fig. 5, with valve 28 fully open, air pressure on air motor 26 will open dampers 23 a maximum amount, whereas with valve 27 fully closed, air pressure on air motor 25 will be entirely cut off and dampers 21 will be open a minimum amount. This is the position which the dampers will have in the late afternoon when the sun is affecting the western zone a maximum amount. Rotation of cam 35 will exactly reverse this procedure and dampers 21 will be opened a maximum amount, whereas dampers 23 will be opened a minimum amount. These latter positions of the dampers correspond to the morning operation, i. e., when the eastern zone is most affected by sunlight gain. It is apparent that continued rotation of the cam will slowly close dampers 21; at high noon, both sets of dampers will be in normal position; and during the afternoon, dampers 23 will slowly open. In other words, by the timed operation of dampers 21 and 23, that quantity of conditioned air necessary to overcome sunlight gain, is slowly shifted from one zone to the other, in timed relation to relative movements of the sun.

From the foregoing, it is apparent that changes in the total heat load on the building are reflected by changes in the return air temperature, and that such changes affect thermostat 18 to increase, or decrease, the amount of conditioned air supplied by conduit 14, thus to compensate for the increased, or decreased, heat load. Dampers 21 and 23, serve merely to divide this conditioned air supply between the zones in accordance with the relative position of the sun. Such operation would be adequate to take care of the varying sunlight gain provided the sun were always shining. However, this latter condition does not prevail and some means must be provided to shift the dampers back to normal position whenever the sun is under a cloud. To this end, applicant provides a valve 39 in the main air supply line 40 controlled by a photo-electric cell indicated generally at 41. The cell 41 will be placed upon the roof of the building, or at any other point at which it will constantly be subject to changes in sunlight intensity. The photo-electric cell is subject to sunlight

variations and operates to cut off the valve 39, hence the air supply, whenever the sun is not shining. As a result, dampers 21 and 23 assume their normal position and supply relatively equal quantities of air to both zones. Applicant has described the operation of dampers 21 and 23 with respect to one floor. However, one apparatus such as shown in Fig. 2 can be utilized to supply and control the distribution of conditioned air throughout one section comprising several floors.

Since certain changes in carrying out the above process and in the constructions set forth, which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a combination of apparatus for controlling atmospheric conditions within a zoned enclosure, a mixing box for each zone of said enclosure, means for supplying conditioned air to said mixing boxes, means for supplying return air to said mixing boxes, means for supplying air from said mixing boxes to the zones of said enclosure, means for varying the total amount of conditioned air supplied to said mixing boxes in accordance with variations of the average air temperature in the entire enclosure, and clock-operated means for proportioning the conditioned air between said mixing boxes in accordance with the time of day.

2. A combination of apparatus for controlling atmospheric conditions within a zoned enclosure including a source of conditioned air, a mixing box for each zone of said enclosure, means for supplying a single stream of conditioned air to said mixing boxes, means for supplying return air to said mixing boxes, means for varying the total amount of conditioned air supplied to said mixing boxes in accordance with the average heat load affecting said enclosure, means for proportioning the conditioned air supply between said mixing boxes in accordance with the time of day, and means for cutting out said proportioning means whenever the sun is not shining.

3. In an air conditioning system, a plurality of mixing boxes, an enclosure served by said mixing boxes, means for supplying a volume of conditioned air to said mixing boxes, means for varying the total volume of conditioned air supplied in accordance with the heat load on said enclosure, dampers for proportioning the conditioned air between said mixing boxes, a clock device for shifting the position of said dampers in accordance with changes in the time of day, and photo-electric means for causing said dampers to return to a normal position whenever the sun is not shining.

4. In an air conditioning system, a plurality of mixing boxes, means for supplying a volume of conditioned air to said mixing boxes, means for varying the total volume of conditioned air, dampers for proportioning the conditioned air between said mixing boxes, a clock operated device for effecting a movement of said dampers, and photo-electric means for causing said dampers to return to a predetermined normal position whenever the sun is not shining.

5. In an air conditioning system, an area to be conditioned, means for conditioning air, means for supplying said conditioned air to said area, a damper, for controlling the supply of conditioned air to said area and means including a clock mechanism for causing said damper to admit a relatively small amount of conditioned air to said area when the sun is not in position to shine upon said area, and for causing said damper to admit a greater quantity of conditioned air to said area when the sun is in position to shine upon said area.

6. In an air conditioning system, a damper, means for causing a graduated movement of said damper in timed relation to relative positions of the sun, and means for causing said damper to return to a predetermined normal position in response to a predetermined variation in sunlight intensity.

7. In an air conditioning system, a plurality of mixing boxes, a plurality of areas adapted to be served by said mixing boxes, means for supplying a volume of conditioned air to said mixing boxes, means for controlling the total volume of conditioned air supplied to said mixing boxes, dampers for proportioning the controlled volume of conditioned air between said mixing boxes, and a clock device for shifting the position of said dampers in accordance with changes in the position of the sun, said clock device being arranged to supply a greater amount of conditioned air to one of said mixing boxes when an area served by said mixing box is subjected to the heating action of the sun, and to supply a lesser amount of conditioned air to said mixing box when said area is not subjected to the heating action of the sun.

8. In an air conditioning system, a plurality of outlets serving different areas of an enclosure, means for supplying a volume of conditioned air to said outlets, means for varying the total volume of air supplied to said outlets, other means for proportioning the air between said outlets, and clock operated means in combination with said proportioning means for supplying relatively greater amounts of conditioned air to areas subjected to sun effect and relatively lesser quantities of conditioned air to areas not subjected to sun effect, the clock operated means varying the proportioning of the conditioned air between the various areas in accordance with changes in the position of the sun.

9. In an air conditioning system, a plurality of outlets serving different areas of a conditioned enclosure, means for supplying conditioned air to said outlets, dampers for proportioning the conditioned air between said outlets, and clock operated means in combination with said dampers for supplying relatively greater amounts of conditioned air to those outlets serving areas upon which the sun shines and for supplying relatively lesser amounts of conditioned air to those outlets serving areas upon which the sun does not shine, the clock operated means varying the proportioning of the conditioned air between the various areas in accordance with changes in the position of the sun.

10. In an air conditioning system, a plurality of outlets serving different areas to be conditioned, means for supplying conditioned air to said outlets, dampers for proportioning the conditioned air between said outlets, and time-controlled means in combination with said dampers for supplying relatively greater amounts of conditioned air to those outlets serving areas upon which the sun shines and for supplying relatively lesser amounts of conditioned air to those outlets serving areas upon which the sun does not shine, the

time-controlled means varying the proportioning of the conditioned air between the various areas in accordance with changes in the position of the sun.

11. In an air conditioning system, a plurality of outlets serving different areas to be conditioned, means for supplying conditioned air to said outlets, means for proportioning the conditioned air between said outlets, and time-controlled means in combination with said proportioning means for supplying relatively greater amounts of conditioned air to those outlets serving areas upon which the sun shines and for supplying relatively lesser amounts of conditioned air to those outlets serving areas upon which the sun does not shine, the time-controlled means varying the proportioning of the conditioned air between the various areas in accordance with changes in the position of the sun.

12. In a system for air conditioning a plurality of areas which are subject to heat loads which vary predeterminately, a plurality of outlets, different of said outlets serving different areas to be conditioned, a source of conditioned air, means constantly supplying conditioned air at all times from said source to said areas through said outlets, means for distributing the said conditioned air between said outlets to said areas, and time-controlled means including a clock mechanism for governing said distribution means to gradually decrease the supply of conditioned air to one area and to gradually increase the supply of conditioned air to another area.

SAMUEL E. LYMAN.