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DUAL DUCT AIR CONDITIONING SYSTEM

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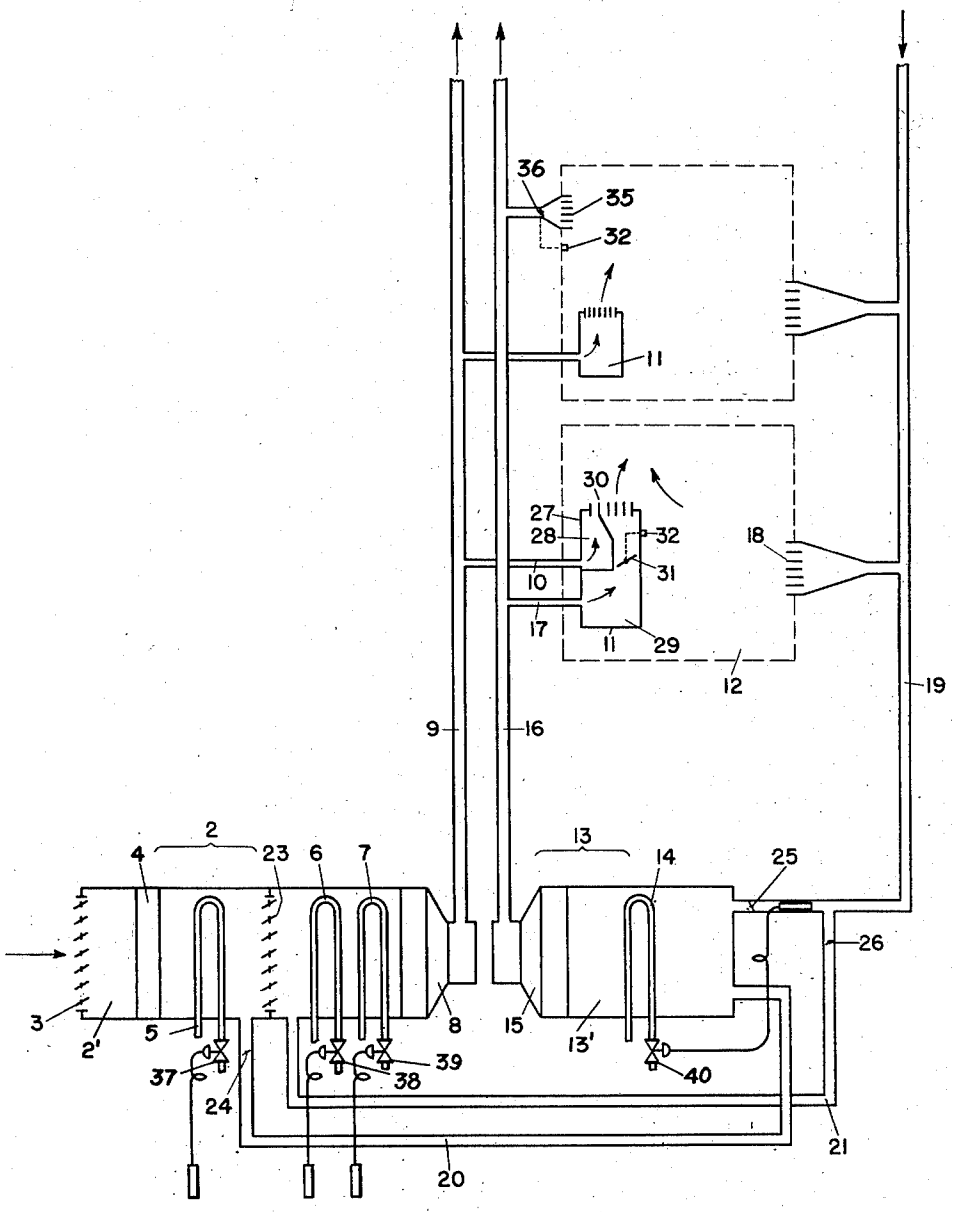

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DUAL DUCT AIR CONDITIONING SYSTEM

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14 Claims. (Cl. 98—33)

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This invention relates to air conditioning, and more particularly to a method and system of the so-called dual-duct type for conditioning a building structure containing a plurality of enclosed areas.

The chief object of the present invention is to provide a method of operation of an air conditioning system in which ventilation and humidity requirements, room air movement, and transmission gains or losses are compensated for or maintained by the supply of a substantially constant volume of primary air in each area and in which internal heat loads arising from occupants, lights, sun load, and the like, are compensated for by the supply of a variable volume of secondary air at a substantially constant predetermined temperature.

An object of the present invention is to provide an air conditioning system in which primary air for supply to the areas being conditioned may be treated to compensate for transmission gains or losses and supplied to a plurality of areas being conditioned while return air from the areas being conditioned may be cooled to pre-determined temperature and again supplied to each area in a volume varied to compensate for internal heat factors present therein.

A further object is to provide an air conditioning system including control means which may be adjusted to permit return air to be used as a source of supply of primary air and in which outside air may be utilized as secondary air with or without some proportion of return air from the areas being conditioned.

A still further object is to provide an air conditioning system including separate supply members for primary and secondary air, so arranged that, under peak load conditions, both primary air and secondary air supplied to the areas being conditioned are at a minimum temperature. The heat load present under peak load conditions is absorbed by the combined streams of primary and secondary air thereby eliminating the necessity for large ducts which would be required if one stream of air were heated and the other were cooled under peak load conditions.

This invention relates to a method of air conditioning a building structure containing a plurality of enclosed areas in which the steps consist in supplying a constant volume of primary air to each area being conditioned to compensate for transmission gains or losses, the temperature and humidity of the primary air being adjusted in accordance with conditions of temperature existing exteriorly of the structure and the humidity being adjusted to maintain a desired degree of humidity in the areas being conditioned, supplying a volume of secondary air at a predetermined temperature to the areas being conditioned, and varying the volume of secondary air supplied to each area in accordance with the internal and solar heat factors present therein.

This invention further relates to an air conditioning system which comprises in combination means for treating primary air to desired conditions of temperature and humidity, means for supplying a substantially constant volume of primary air at the desired temperature to each of a plurality of areas to be conditioned to compensate for transmission gains or losses, means for conditioning secondary air to a predetermined temperature, means for supplying such secondary air at the predetermined temperature to a plurality of areas being conditioned, and means for varying the volume of secondary air supplied to each area in accordance with internal and solar heat factors present in the area.

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The attached drawing illustrates diagrammatically an air conditioning system adapted for use in practicing the method of the present invention.

Referring to the drawing, there is shown an air conditioning system which includes a central station 2 to condition primary air. The equipment provided at central station 2 includes a casing 2', dampers 3 to adjust the volume of outside air drawn into station 2, a filter 4, a preheating coil 5, a dehumidifying coil 6, a reheating coil 7, and a fan 8. The central station system so described is well-known in the industry. Fan 8 draws air through dampers 3 and through the various elements of the station, supplying the treated air through duct 9 and run-outs 10 to distributing units 11, disposed in areas 12 to be conditioned. Units 11 are more fully described hereafter.

A second central station 13 is provided to treat secondary air for supply to the areas being conditioned. Station 13 includes a casing 13' a cooling coil 14 and a fan 15, which serves to supply cooled secondary air through duct 16 and run-out 17 to units 11. The dry bulb temperature of the secondary air supplied to the areas being conditioned does not exceed 65°. Air is withdrawn from the areas being conditioned through grilles 18 and duct 19, being drawn within the second central station 13 by fan 15.

Cooling coil 14 may be operated by separate refrigeration equipment or, if desired, it may be operated by the same equipment designed to operate dehumidifying coil 6 of station 2. Suitable controls 37, 38, and 39 as indicated diagrammatically are provided to assure that the temperature and humidity of primary air are adjusted in accordance with conditions exterior of the building to maintain design conditions. A suitable control 40 is provided to regulate the temperature of the secondary air in accordance with design conditions.

A duct 20 connects central stations 2 and 13. A second duct 21 connects central station 2 and duct 19; dampers 23 are disposed in central station 2 between preheating coil 5 and dehumidifying coil 6. Duct 20 is connected to central station 2 at a point between dampers 23 and coil 5. Damper 24 is provided in duct 20. Closing of dampers 23 and opening of damper 24 permits

outside air to be supplied through duct 20 to the second central station 13.

A damper 25 is placed in duct 19 at a point between the second central station and the juncture of duct 21 with duct 19. A damper 26 is placed in duct 21; closing of damper 25 and opening of damper 26 permits return air from the areas being conditioned to bypass the second central station 13 and to be supplied to central station 2. It will be understood the position of such dampers may be varied as desired to permit suitable proportions of outside air and return air to be supplied to either central station 2 or central station 13.

Unit 11 may consist of a casing 27 separated into chambers 28 and 29. Primary air discharged through run-out 10 enters chamber 28, while secondary air discharged through run-out 17 enters chamber 29. A grille 30 is placed in unit 11 to permit the streams of primary and secondary air to be discharged into the area being conditioned. A damper 31 is placed in chamber 29 to vary the volume of secondary air supplied to the area. Damper 31 may be actuated by any suitable means 32. Such means may be manually or automatically operable to vary the volume of secondary air supplied to the area in accordance with or in response to the internal heat factors present therein.

If desired as indicated in the drawing, the primary and secondary air supplies may be separated, primary air being discharged in unit 11 while secondary air is discharged into any or all of the areas being conditioned at an outlet 35 remote from the place of discharge of primary air. Of course, in such case, suitable members 36 are provided to permit the volume of secondary air to be varied as described above.

Preferably, in the present invention, primary air is supplied to the units at a static pressure of within the range of about .2'' to about .5'' and at a velocity of about 1500 feet to about three thousand feet per minute. Secondary air may be supplied at a velocity barely sufficient to assure that it enters the area being conditioned. The discharge of primary air at high velocity into the room being conditioned induces a flow of secondary air and room air into the primary air stream. The induced air will be made up of secondary air and air drawn from the room, the respective proportions thereof depending upon the volume of secondary air supplied to the area. The total amount of primary air and induced air remains substantially constant, thereby maintaining a pre-determined constant air movement within each area being conditioned.

Assume the system as described is in operation under summer conditions. Primary air is drawn into station 2 by means of fan 8 and is treated to attain desired conditions of temperature to offset transmission gains or losses in the areas being conditioned. In other words, the temperature of the primary air is adjusted in accordance with conditions of temperature existing exteriorly of the structure, while the humidity of the air is adjusted if necessary to maintain the desired humidity in the areas being conditioned. If desired, the primary air may be treated in addition to compensate for some fixed portion of the internal heat load; it will be understood the expression "to compensate for heat gains or losses" as used herein contemplates that some minor portion of the internal heat load may be taken care of if desired by the primary air supply in addition to strict transmission gains or losses and such operation is within the purview of my invention.

The treated primary air is then supplied in a substantially constant volume sufficient for ventilation purposes of each area through ducts 9 and run-outs 10 to the various units 11 disposed in areas 12 being conditioned. The primary air is discharged from units 11 at high velocity, thereby inducing streams of air from the area and secondary air to mix with the primary air stream to maintain a substantially constant air movement within the area being conditioned.

Return air is withdrawn from the areas being conditioned through duct 19, passed through cooling coil 14 of central station 13 to adjust its temperature to a predetermined point, say 55° F., and is again supplied to the areas being conditioned through duct 16 and run-outs 17. The volume of secondary air supplied to each area is adjusted in accordance with the internal heat load and direct solar load present in each area by means of damper 31 which may be actuated manually or automatically in response to the temperature of the area being conditioned as indicated by control 32.

Under peak load conditions, both primary air and secondary air supplied to the areas is cooled, permitting both primary and secondary ducts to be used to offset the maximum heat loads imposed upon the system. Such procedure permits a reduction in duct capacity required for peak loads, thereby reducing the initial cost of the system. The cooled secondary air, supplied at a substantially constant temperature to the areas being conditioned, may be throttled freely, if required, without affecting the ventilation, humidity control, or air movement within the areas being conditioned.

Under conditions of winter operation, secondary air, preferably, is still supplied as cold air at a substantially constant predetermined temperature to compensate for internal heat factors present in the areas being conditioned.

If desired, under winter conditions, to decrease the cost of operation of the system, dampers 23 to 26 inclusive may be adjusted to permit outside air, in a volume at least sufficient for ventilation requirements in the areas being conditioned, to be supplied to central station 13, cooled, if required, and supplied to the areas being conditioned as secondary air. Return air may be directed through duct 21 to central station 2; the return air may be heated, as required, at central station 2 and supplied in a substantially constant volume as primary air to the areas being conditioned. Under the conditions described, any suitable proportions of return and outside air may be supplied as primary or secondary air to the areas being conditioned. It is essential, however, that a sufficient volume of outside air be supplied to the areas for ventilation purposes.

It will be understood that under all conditions, the stream of primary air, whether composed of outside air or return air or any mixture thereof, is treated to compensate for humidity requirements and transmission gains or losses in each area and is supplied in a substantially constant volume to each area. The secondary air is cooled to a predetermined temperature, if required, and is supplied to each area in a volume varied to compensate for internal and direct solar heat loads present in each separate area.

We have described a system in which primary air is supplied at a high velocity. It will be understood primary air may be supplied at a relatively low velocity, say 800 to 1000 feet per min-

ute, if desired. Under such conditions, the secondary air is supplied at a greater velocity than the velocity described in order that the combined velocities of discharged primary and secondary air induce and maintain a desired air movement within each area being conditioned. Under such circumstances, velocity of the secondary air may vary inversely as the volume of the secondary air thereby maintaining substantially constant air movement in each area being conditioned.

The present invention provides a simple and inexpensive air conditioning system in which sufficient outside air is provided to compensate for the ventilation requirements of each area being conditioned. Such air may be treated to compensate for conditions of humidity and transmission gains or losses in each separate area; preferably, such air is supplied in a substantially constant volume and at a velocity sufficienty great to maintain substantially constant movement of air within each area being conditioned. The costs of operation of this system are greatly decreased since a large volume of return air may be utilized under summer operating conditions while under winter operating conditions a large volume of outside air may be utilized to decrease the refrigeration required.

The secondary air is cooled to a substantially constant temperature to compensate for internal heat factors and sun load present in each separate area. The system is highly flexible permitting full advantage to be taken of changes in temperature and humidity exteriorly of the structure to decrease the quantity of refrigeration required thereby decreasing operating costs.

Under conditions of peak load during summer operation, for example, both sources of supply may provide cold air for use in the areas being conditioned, thus eliminating to a large extent the expense involved in the provision of separate ducts, each large enough to compensate for demand under peak load conditions. To decrease the cost of operation of the system, depending upon the conditions of operation, outside air may be employed as a source of secondary air while return air may be employed as a source of primary air.

A modification of the present invention is described in copending application of Carlyle M. Ashley, Serial No. 722,321, filed January 16, 1947.

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

We claim:

1. In the method of air conditioning a building structure containing a plurality of enclosed areas, the steps which consist in under summer operating conditions cooling fresh air to a desired temperature to form a source of primary air, supplying a substantially constant volume of the primary air from said source to each area to be conditioned to compensate for transmission gains and ventilation requirements in that area, providing a supply of cooled, secondary air at a central station, connecting the supply of cooled secondary air to the areas to be conditioned to supply a volume of cooled secondary air to said areas, and varying the volume of cooled secondary air supplied in each area in accordance with the internal and solar heat factors present therein.

2. In the method of air conditioning a building structure containing a plurality of enclosed areas, the steps which consist in under summer operating conditions treating fresh air to adjust the temperature thereof in accordance with conditions existing exteriorly of the structure and the humidity to maintain a desired degree of humidity in the areas being conditioned, supplying a substantially constant volume of the treated fresh air to each area being conditioned to compensate for transmission gains and ventilation requirements in that area, providing a supply of cooled secondary air at a central station, connecting the supply of cooled secondary air to the areas to be conditioned to supply a volume of cooled secondary air to the areas being conditioned, and varying the volume of cooled secondary air supplied in each area in accordance with the internal and solar heat factors present therein.

3. In the method of air conditioning a building structure containing a plurality of enclosed areas, the steps which consist under summer operating conditions in treating fresh primary air to adjust the temperature thereof in accordance with conditions existing exteriorly of the building structure and the humidity to maintain a desired degree of humidity in the areas being conditioned, supplying a substantially constant volume of treated primary air in each area to be conditioned to provide for ventilation requirements and to compensate for transmission gains or losses, returning air from the areas being conditioned to a central station, treating the return air at the central station to pre-determined temperature to form a source of secondary air for the areas being conditioned, supplying secondary air to the areas to be conditioned, and varying the volume of secondary air supplied in each area in accordance with the internal and solar heat factors present therein.

4. In the method of air conditioning a building structure containing a plurality of enclosed areas, the steps which consist in withdrawing air from the areas being conditioned, treating such air to a desired temperature at a central station to form a source of supply of primary air, supplying a substantially constant volume of primary air in each area being conditioned to compensate for transmission gains or losses, supplying outside air as secondary air to each area to be conditioned in a volume at least sufficient to compensate for ventilation requirements of the area, and varying the volume of secondary air supplied in each area in accordance with the internal and solar heat factors present therein.

5. In the method of air conditioning a building structure containing a plurality of enclosed areas, the steps which consist in treating a primary mixture of outside and return air to desired conditions of temperature and humidity in accordance with conditions exteriorly of the structure, supplying a substantially constant volume of the primary air in each area being conditioned to compensate for transmission gains or losses in the area, treating a secondary mixture of outside air and return air at a central station to predetermined temperature, supplying the secondary air to each area being conditioned, and varying the volume of secondary air supplied in each area in accordance with the internal and solar heat factors present therein.

6. A method of air conditioning according to claim 1 in which the dry bulb temperature of the

secondary air supplied to the areas being conditioned does not exceed 65° F.

7. A method according to claim 1 in which the duct velocity of the primary air supplied to each area being conditioned is at least 1500 F. P. M., discharge of primary air into each area being conditioned inducing a substantially constant total volume of secondary air and room air into the primary air stream to attain a predetermined air movement within each area.

8. A method according to claim 2 in which the duct velocity of the fresh air discharged in each area being conditioned is at least 1500 F. P. M., the stream of fresh air discharged into each area being conditioned inducing streams of secondary air and room air in a substantially constant total volume thereby maintaining a predetermined air movement within each area.

9. In an air conditioning system, the combination of means for cooling fresh air to a desired temperature to form a source of primary air, means for supplying a substantially constant volume of cooled primary air from said source to each of a plurality of areas to be conditioned to compensate for transmission gains and ventilation requirements in each area, a central station for providing a supply of cooled secondary air, means for connecting the supply of cooled secondary air to said areas to supply a volume of cooled secondary air to each area to be conditioned, and means for varying the volume of secondary air supplied in each area in accordance with internal and solar heat factors present in the area.

10. In an air conditioning system, the combination of means for treating primary air to desired conditions of temperature and humidity, means for supplying a substantially constant volume of primary air to each of a plurality of areas to be conditioned to compensate for transmission gains or losses a central station for conditioning return air to a desired temperature, means for withdrawing air from the areas being conditioned, and for returning such air to the central station, means for supplying the conditioned return air to each area to be conditioned, and means for varying the volume of conditioned return air supplied in each area in accordance with the internal and solar heat factors present in the area.

11. In an air conditioning system, the combination of a central station for conditioning primary air to desired conditions of temperature and humidity, a duct for supplying a substantially constant volume of treated primary air to each of a plurality of areas to be conditioned to compensate for transmission gains or losses, units disposed in said areas adapted to receive primary air, means to discharge primary air from each unit into the area to induce flow of air within the area thereby maintaining a substantially constant air movement within the area being conditioned, a second central station for treating return air from the areas being conditioned to a desired temperature, a duct through which return air is withdrawn from at least some of said areas and returned to the second central station, a duct for supplying conditioned return air to said units, and means in each unit for regulating the volume of return air discharged in accordance with internal and solar heat factors present in the area.

12. In an air conditioning system, the combination of a central station for conditioning primary air to desired conditions of temperature and humidity, a duct for supplying a substantially constant volume of treated primary air to each of a plurality of areas to be conditioned to compensate for transmission gains or losses, units disposed in said areas adapted to receive primary air, means to discharge primary air from each unit into the area to induce flow of air within the area thereby maintaining a substantially constant air movement within the area being conditioned, a second central station for treating return air from the areas being conditioned to a desired temperature, a second duct through which return air is withdrawn from at least some of said areas and returned to the second central station, a third duct for supplying conditioned return air to said units, means in each unit for regulating the volume of return air discharged in accordance with internal and solar heat factors present in the area, a fourth duct connecting the first central station and the second central station, dampers to discontinue the flow of outside air through the first central station and to direct such outside air to the second central station, a fifth duct connecting the second duct and the first central station, and dampers disposed in the fifth duct and the second duct to discontinue supply of return air to the second central station whereby return air may be supplied to the areas being conditioned as primary air and outside air may be supplied as secondary air in a varied volume in accordance with the internal and solar load factors present in the area.

13. In the method of air conditioning a building structure containing a plurality of enclosed areas, the steps which consist under summer operating conditions in supplying a substantially constant volume of fresh primary air to each area of the structure to provide for ventilation requirements, returning air from the areas being conditioned to a central station, treating the return air to pre-determined temperature, supplying the treated return air to the areas to be conditioned, and varying the volume of treated return air supplied in each area to compensate for the internal and solar heat factors present therein.

14. In the method of air conditioning a building structure containing a plurality of enclosed areas, the steps which consist in supplying a constant volume of fresh primary air to each area being conditioned to provide for ventilation requirements and to compensate for transmission gains or losses, returning air from the areas being conditioned to a central station, cooling the return air to pre-determined temperature, supplying the cooled air to the areas being conditioned, and varying in each area the volume of cooled air supplied thereto to compensate for the internal and solar heat factors present therein without substantial interference with the volume of cooled air supplied to the remaining areas.

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