July 6, 1937. B. P. FONDA 2,085,964

AIR CONDITIONING SYSTEM

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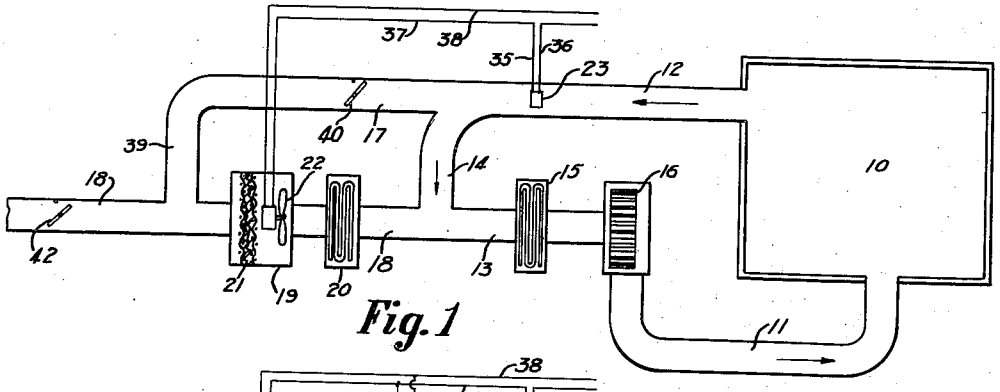

Fig. 1

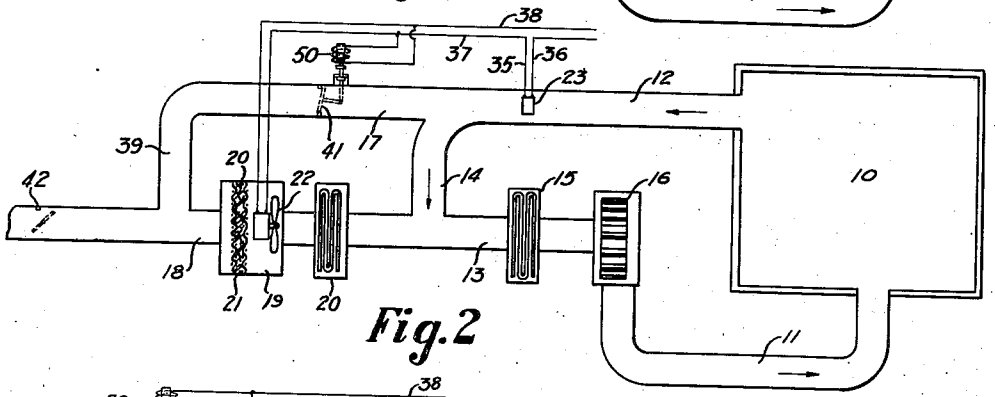

Fig. 2

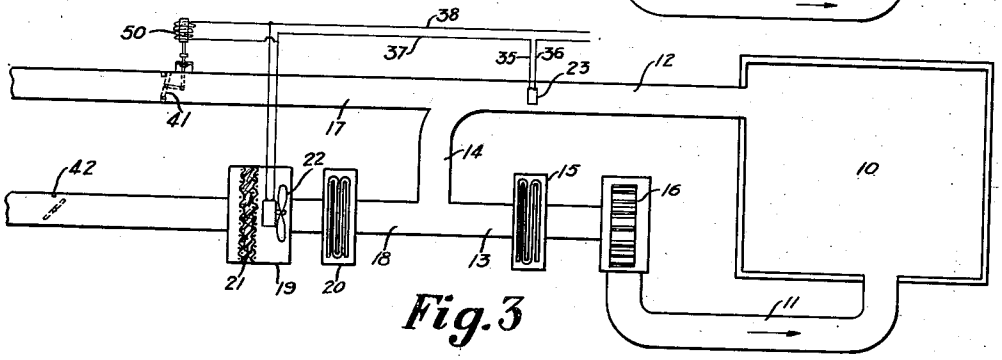

Fig. 3

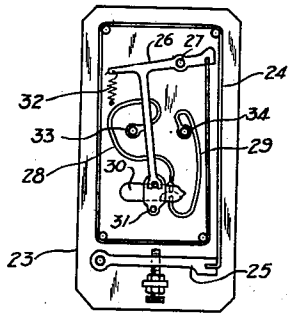

Fig. 4

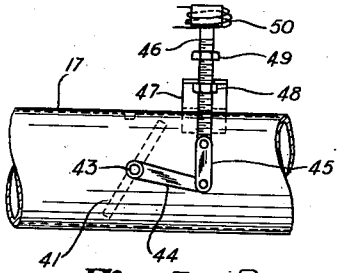

Fig. 5

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AIR CONDITIONING SYSTEM

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12 Claims. (Cl. 257—2)

This invention relates to improvements in air conditioning systems, and has reference particularly to systems in which provision is made for the dehumidification of air admitted to the system, especially where the control of the system is automatic.

One of the objects of the invention is the provision of means for insuring a substantially constant supply of fresh air, whether or not the dehumidifying means is in operation.

Another object is the provision in connection with such a system of means for conducting some predetermined proportion of the recirculated air through the dehumidifying means.

Still another object is the provision of a separate supply of fresh air to the system with automatic control of this supply as well as of the supply of dehumidified air.

Other objects and features of novelty will appear as I proceed with the description of those embodiments of the invention which for the purposes of the present application, I have illustrated in the accompanying drawing, in which

Figs. 1, 2 and 3 are diagrammatic views illustrating different modifications of the system which is the subject of the invention, that of Fig. 2 being the preferred form.

Fig. 4 is a detail elevational view showing one form of humidostat which may be employed in connection with the invention.

Fig. 5 is a sectional detail view illustrating a damper construction which may be employed.

In the drawing a compartment in which air is to be conditioned is indicated at 10. An air duct 11 carries the air into compartment 10, while air leaves compartment 10 through a duct 12. The recirculating line for the compartment 10 includes besides the ducts 11 and 12 a duct 13 and a short connecting duct 14. In duct 13 there is an air cooler 15, which may consist of a coil of pipe through which cool water is circulated. At the junction of duct 13 with duct 11 I have shown a blower 16, by means of which the circulation of air throughout the recirculating line 10, 12, 14, 13, 11, is effected. The above parts are identical in all of the three forms of the invention here illustrated.

Into this recirculating line at points which are spaced from each other to some extent at least, I connect a conductor 17 and a conduit 18. In the latter there is a dehumidifying means 19 and an air cooler 20, similar to the cooler 15. The dehumidifying means 19 comprises a body of solid adsorbent 21, such as silica gel, activated alumina, or the like. Such an adsorbent has the property of removing moisture from the air, its action being to transform the latent heat from the moisture removed into sensible heat, which makes itself evident through an increase in the temperature of the air passing through the material. The adsorbent may be confined between spaced walls of foraminous material, as indicated in the drawing. The dehumidifying means includes an electric fan 22, by means of which the air is drawn through the adsorbent 21 and induced to flow through cooler 20 into the air recirculating line.

In order to control the periods of operation of the dehumidifying means I use a humidostat 23, which may be placed at an appropriate point in the line, that is in the duct 12, or in the compartment 10. The present invention is not concerned with the detail construction of the humidostat, but an example of a well known type is illustrated in Fig. 4, wherein a tape 24, which expands and contracts as the humidity of the air in contact with it increases or decreases, is secured at one end in an adjustable anchoring means 25 and at the other end in a lever 26 pivotally mounted at 27. 28 and 29 are flexible electric conductors which have terminals in a mercury tube switch 30, which is tiltably mounted at 31 and is adapted to be swung to circuit closing position by the action of a spring 32 when the tape 24 expands to a predetermined extent due to a rise in humidity, and to circuit opening position by the contraction of tape 24 when the humidity falls sufficiently.

The terminals 33 and 34 of the humidostat are connected by electric conductors 35 and 36 into one side of a line circuit comprising conductors 37 and 38 which lead to the motor of fan 22. Hence, when the humidity in the recirculating line rises above a predetermined level, the humidostat closes the circuit through conductors 37 and 38 and the electric fan 22 operates to induce flow of dehumidified air into the recirculating line.

In the systems illustrated in Figs. 1 and 2 I have connected the air conductor 17 and the air conduit 18 by a shunt 39, which connects with the conduit 18 on the rear side of the dehumidifier 19. This shunt connection has for one of its purposes permitting or causing a portion of the recirculating air to flow from the recirculating line through the conductor 17 to the left, through the dehumidifier 19, and back to the recirculating line. In order that the extent to which this occurs may be regulated to suit different conditions or requirements, I provide a manually operated damper 40 in the conductor 17 in the case of the system illustrated in Fig. 1, and an automatically operated damper 41 in the case of the system illustrated in Fig. 2. A further damper 42 in the conduit 18 to the left of the shunt 39 may also be provided, and may be used to cut off more or less of the fresh air entering the conduit 18, thereby increasing the suction effect of fan 22 acting through shunt 39. I prefer however to set damper 42 to admit a given quantity of fresh air

at all times and to use only the damper 40 or 41 for regulating the proportion of fresh and recirculated air entering the dehumidifier 19.

One of the functions of conductor 17 is to provide a path of flow for fresh air to the recirculating line through ducts 14, 13 and 11 when the dehumidifying means 19 is at rest, in other words when the fan 22 is not running. The resistance of the adsorbent 21 to the passage of air therethrough is sufficiently great so that the blower 16 does not induce any appreciable flow of air through the dehumidifier. Hence, when the fan 22 was not running there would be no admission of fresh air to the recirculating line were it not for the conductor 17. At such times the suction of blower 16 is free to act upon conductor 17 through duct 14 in the same way that it acts upon duct 12 through duct 14, that is if the dampers 40 or 41 are not closed.

If in the case of Fig. 1 the damper 40 is open part-way, then fresh air will enter the dehumidifier through conduit 18, at the same time that recirculating air is being delivered to the dehumidifier from shunt 39 and conduit 17. On the other hand when the fan 22 is not running fresh air will be by-passed around the dehumidifier, that is from conduit 18 through shunt 39 and conductor 17 to ducts 14, 13 and 11.

In Figs. 2 and 3 the control of the damper 41 in conductor 17 is automatic, the damper being moved automatically toward closed position when the fan 22 is started, and being moved automatically toward open position when the fan 22 stops, all of these operations being under the control of the humidostat 23. The apparatus illustrated in the drawing is merely illustrative of one particular means for accomplishing this purpose. In this case, as shown particularly in Fig. 5, the damper 41 is pivotally mounted upon a shaft 43, which extends through the conductor 17. To one end of the shaft exteriorly of the conductor there is attached a crank 44 to which is pivotally connected a link 45 that is pivoted to the lower end of a rod 46 that extends through a notch or hole in a bracket 47 which is secured to the conductor 17. The rod 46 is threaded, and upon it are mounted two nuts 48 and 49, each of which may be adjusted to any desired position. The rod 46 is mounted in or fastened to the solenoid of an electromagnet 50, which is bridged across the electric line 37, 38. Obviously, when a circuit is set up through the line 37, 38 by the humidostat, the electromagnet 50 is energized and the damper 41 is closed to whatever extent the nut 48 will permit. On the other hand, when the electric circuit is broken, gravity will cause the rod 46 to descend until the nut 49 engages the top of bracket 47, and the damper 41 will be opened to a corresponding extent.

Fig. 3 differs from Fig. 2 by the omission of the shunt 39, and is the system employed when it is not desired to dehumidify any of the recirculated air, as would be the case when the ventilation requirement of the compartment 10 was substantially equal to the amount of fresh air that was dehumidified.

It will be understood that the cooler 20 acts only upon the dehumidified fresh air introduced into the system. It could be eliminated, and the cooler 15 depended upon exclusively for maintaining the desired temperature in the compartment 10, but the addition of cooler 20 is regarded as quite desirable because of the temperature rise imparted to the air in the dehumidifying operation.

In practice the amount of fresh air introduced into the system by the dehumidifying means may be sufficient, while that means is operating, to meet the ventilating requirements of compartment 10. The ventilating requirements remain the same, whether or not the dehumidifier is required to be in operation. The apparatus employed in my system may be so adjusted, that when the dehumidifier is not in operation, a similar quantity of fresh air will be by-passed around the dehumidifier, as in Figs. 1 and 2, or drawn into the system independently of the dehumidifier. Hence, the supply of fresh air delivered to the compartment 10 may be made to be substantially constant regardless of the operation of the dehumidifier.

Having thus described my invention, I claim:

1. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, means for introducing dehumidified fresh air into said line at a fixed rate, a humidostat in said line, means actuated by the humidostat for starting and stopping said first named means, and a conductor for by-passing fresh air around said dehumidifying means into said line at a fixed rate when said dehumidifying means is stopped.

2. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, means for introducing dehumidified fresh air at a fixed rate into said line at a given point, a humidostat in said line, means actuated by the humidostat for starting and stopping said first named means, and a conductor connecting the said line at a point spaced from said first named point with the intake side of said dehumidifying means, whereby a portion of the recirculating air may be dehumidified or whereby fresh air may be introduced into the line independently of said dehumidifying means.

3. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, means for introducing dehumidified fresh air at a fixed rate into said line at a given point, a humidostat in said line, means actuated by the humidostat for starting and stopping said first named means, a conductor connecting the said line at a point spaced from said first named point with the intake side of said dehumidifying means, whereby a portion of the recirculating air may be dehumidified or whereby fresh air may be introduced into the line independently of said dehumidifying means, and means for varying the effective size of said conductor.

4. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, means for introducing dehumidified fresh air into said line at a fixed rate, a humidostat in said line, means actuated by the humidostat for starting and stopping said first named means, a conductor for fresh air connected with said line at a point spaced from its connection with said dehumidifying means and being connected at its opposite end with the intake of said dehumidifying means, and means for varying the effective size of said conductor.

5. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, means for introducing dehumidified fresh air into said line at a fixed rate, a humidostat in said line, means actuated by the humidostat for starting and stop-

ping said first named means, a conductor for fresh air connected with said line at a point spaced from its connection with said dehumidifying means, said conductor being connected also with the intake side of said dehumidifying means, a damper in said conductor, and means also controlled by said humidostat for causing said damper to assume either open or closed position.

6. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, means for introducing dehumidified fresh air into said line at a fixed rate, means for starting and stopping said introducing means, a conductor for fresh air also connected with said line, a damper in said conductor, means for moving said damper from one setting to a different setting and vice versa, and a humidostat in said line, said humidostat being arranged to control the said damper and the said means for introducing dehumidified air.

7. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, means for introducing dehumidified fresh air into said line at a fixed rate, means for starting and stopping said introducing means, a conductor for fresh air also connected with said line, a damper in said conductor, means for moving said damper from one setting to a different setting and vice versa, and a humidostat in said line, said humidostat acting when the humidity content is high to start said means for introducing dehumidified air and to move said damper to its closed setting, and when the humidity content has decreased to a predetermined level to stop the means for introducing dehumidified air and to move the damper to its open setting.

8. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, a fresh air conduit having dehumidifying means therein connected with said line arranged to supply dehumidified air at a fixed rate, a fresh air conductor having a damper therein also connected with said line, a humidostat in said line, and means controlled by said humidostat for starting the dehumidifying means and closing the damper to a predetermined extent when the moisture content in the line rises above a predetermined level, and for stopping the dehumidifying means and opening the damper to a predetermined extent when the moisture content falls below said predetermined level.

9. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, a fresh air conduit having dehumidifying means therein connected with said line at a given point arranged to supply dehumidified air at a fixed rate, an air conductor having a damper therein connected with said line at a different point, a humidostat in said line, means controlled by said humidostat for starting the dehumidifying means when the moisture content in the line rises above a predetermined level, and for stopping the dehumidifying means when the moisture content in the line falls below said predetermined level, said dehumidifying means including a fan for positively moving air toward the said recirculating line, said conduit and conductor being connected together upon the intake side of said dehumidifying means, whereby when said damper is moved to open position and said fan is not running the movement of air in said conductor is reversed.

10. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, a fresh air conduit having dehumidifying means therein connected with said line at a given point arranged to supply dehumidified air at a fixed rate, a fresh air conductor connected with said line at a different point, a humidostat in said line, means controlled by said humidostat for starting the dehumidifying means when the moisture content in the line rises above a predetermined level, and for stopping the dehumidifying means when the moisture content falls below said predetermined level, said dehumidifying means including a fan for positively moving air toward the said recirculating line, a shunt between said conductor and conduit on the intake side of said dehumidifying means, and a damper in said conduit on the side of said shunt which is remote from said recirculating line, whereby the proportion of fresh air and recirculated air passing through the dehumidifying means may be varied.

11. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, a fresh air conduit having a dehumidifying means therein connected with said line at a given point arranged to supply dehumidified air at a fixed rate, a fresh air conductor having a damper therein connected with said line at a different point, a humidostat in said line, means controlled by said humidostat for starting the dehumidifying means and moving the damper in the direction of closed position to a predetermined setting when the moisture content in the line rises above a predetermined level, and for stopping the dehumidifying means and moving the damper toward open position to a predetermined setting when the moisture content in the line falls below said predetermined level, said dehumidifying means including a fan for positively moving air toward the said recirculating line, and a shunt connecting said conduit and conductor on the intake side of said dehumidifying means.

12. In an air conditioning system, an air recirculating line including a compartment in which the air is to be conditioned, a fresh air conduit having a dehumidifying means therein connected with said line at a given point arranged to supply dehumidified air at a fixed rate, a fresh air conductor having a damper therein connected with said line at a different point, a humidostat in said line, means controlled by said humidostat for starting the dehumidifying means and moving the damper in the direction of closed position to a predetermined setting when the moisture content in the line rises above a predetermined level, and for stopping the dehumidifying means and moving the damper toward open position to a predetermined setting when the moisture content in the line falls below said predetermined level, said dehumidifying means including a fan for positively moving air toward the said recirculating line, a shunt connecting said conduit and conductor on the intake side of said dehumidifying means, and a damper in said conduit on the side of said shunt which is remote from said recirculating line.

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