

Sept. 5, 1933.

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DOMESTIC AIR CONDITIONING
Filed June 7, 1930

1,925,812

FIG. 1.

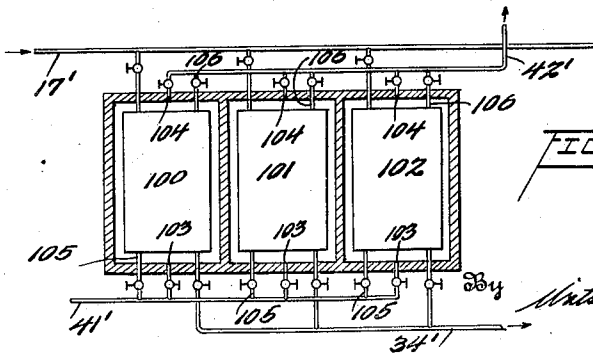
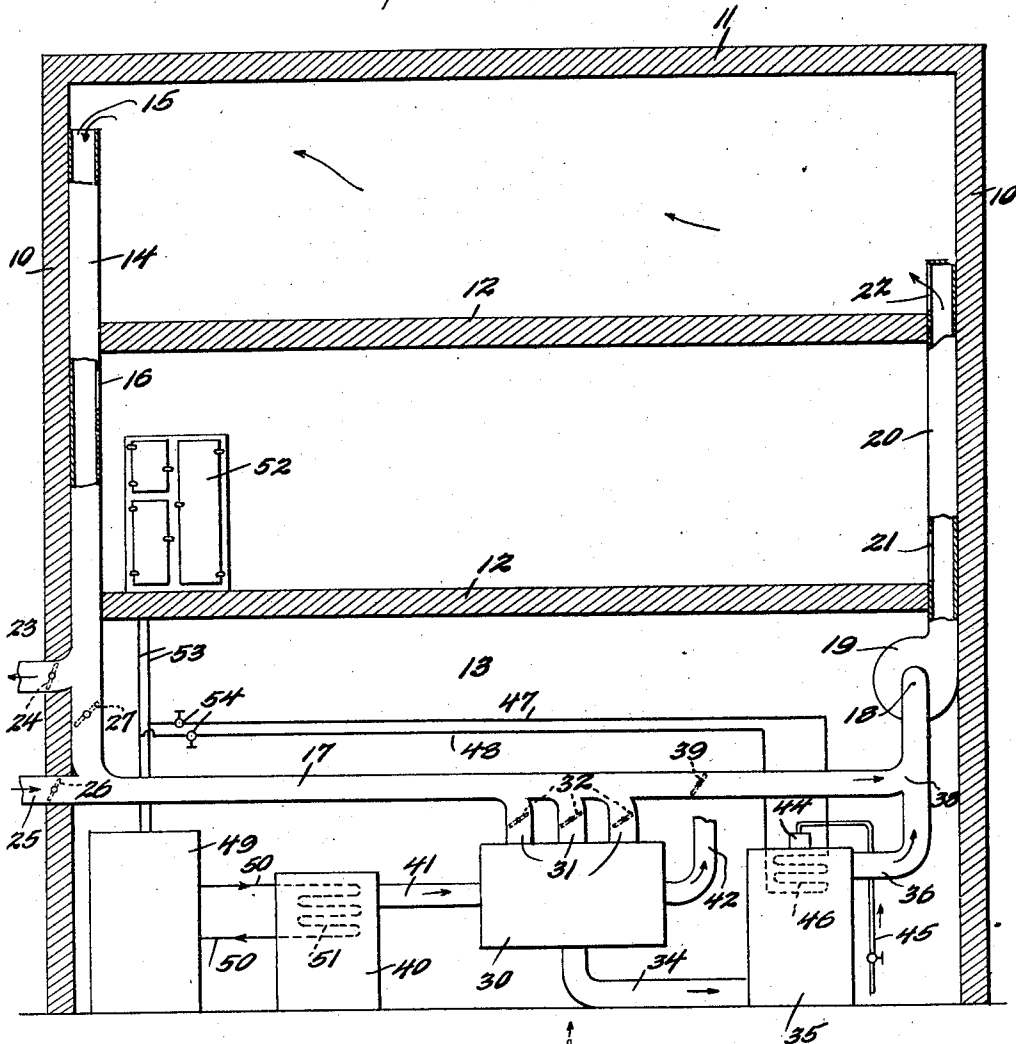


FIG. 2.

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1,925,812

DOMESTIC AIR CONDITIONING

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Application June 7, 1930. Serial No. 459,806

17 Claims. (Cl. 62—176)

This invention relates to air conditioning systems and particularly to systems for providing air of suitable temperature and humidity for ventilating small buildings, such as residences or the like, during all seasons.

It is a general object of the present invention to provide a novel process of and apparatus for conditioning air and providing refrigeration.

One of the important features of the invention consists in a conditioning method which may either dry the air with moderate temperature change, dry it with a great rise in temperature, increase its temperature only, and change the humidity with any of the temperature and condition changes.

Another feature of the invention resides in the provision of a single fuel burning device adapted to both revivify the dehumidifying agent and operate the refrigerating apparatus used for cooling the air after drying or other treatment.

Still another feature of the invention resides in the use of adsorbent material which may be heated indirectly at the same time that air is passing through it for the purpose of heating the air and which may be heated either directly or indirectly for the purpose of activating it when it has become saturated with moisture removed from air.

Other and important features and objects of the invention will be more apparent to those skilled in the art upon a consideration of the accompanying drawing and following specification, wherein are disclosed two embodiments of the invention, with the understanding, however, that various changes and modifications may be made therein without departing from the spirit of the invention so long as they fall within the scope of the appended claims.

In said drawing:

Figure 1 is a diagrammatic and schematic representation of a building in vertical section showing apparatus of the present invention applied thereto; and

Figure 2 is a section through a modified form of adsorber bank.

Conditioning air for auditoriums and large buildings where numbers of people gather has become a common practice, but the apparatus required for this purpose is quite extensive and necessitates considerable attention for satisfactory operation. In dwellings either for a single or a number of families, the conditions required are not so exacting, and the control need not be so fine since there is not much moisture gain

and but little heat gain, in warm weather, where there is not a great quantity of people massed in a small space. It is well known that if the humidity is reduced sufficiently, little attention need be paid to the dry-bulb temperature of the air as long as it is within reasonable ranges, in order to provide comfort. The present invention contemplates the provision of simple apparatus and a simple method of conditioning air for domestic use.

Referring to the drawing, there is illustrated a simple form of building having side walls 10, roof 11, and floors 12 which divide it into several stories. Preferably, the roof and side walls are adequately insulated against heat leakage and are tight to prevent air leakage. The apparatus for producing the conditioned air is preferably located in the basement 13 of the building. An eduction duct is shown at 14, open at 15 for the removal of air from the top story and at 16 for the removal of air from the first story of the building. It leads into the basement and connects with the header 17, connected at 18 to the intake of a suitable fan 19 which returns the air to a delivery duct 20, vented at 21 and 22, respectively, on the first and second floors. Preferably the eduction vents 15 and 16 are near the ceilings, and the discharge vents 21 and 22 are near the floors, but this arrangement can be reversed or adjusted in any way desired, since it forms no particular part of the present invention.

The eduction duct 14 has a discharge vent 23 to the atmosphere controlled by a damper 24, and the header 17 has an inlet 25 from the atmosphere controlled by a suitable damper 26. There is a damper 27 in that portion of the eduction duct between the discharge vent 23 and the inlet 25, as shown at 27, so that a certain desired proportion of used air can be discharged to the atmosphere at 23 and replaced by fresh air from the inlet 25. By suitable manipulation of the three dampers all fresh air can be used or any desired proportion of used air returned for reconditioning.

To remove excess humidity from the air there is provided a bank of dehydrators 30, here shown as three in number, and each supplied with a suitable dehydrating agent, preferably an adsorbent, such as silica gel. Each of the individual adsorbers is connected by a branch pipe 31 to the header 17, and each of the branch pipes is controlled by a suitable damper 32. In the form shown in Figure 1 the outlets from the three adsorbers are connected into a single main

34 which discharges into the lower portion of the compartment 35 having an outlet 36 at the upper part thereof which joins with the header 17 at 38. Between the branching of the pipes 5 31 and the junction of the pipe 36 with the header 17 is a damper 39 which will determine the proportion of air flowing in the header 17 which passes through the adsorber and that which flows directly to the fan without treatment.

10 In operation one or more of the dampers 32 is open and the damper 39 partially closed so that air passes over the adsorbent in one or more of the adsorbers and has more or less of its moisture removed before it is returned to the rooms for use. It is desirable to use but one or two of the adsorbers at a time, since after a period of use the material therein becomes saturated and must be revived or activated to drive off the excess moisture therein in order that the material may be conditioned for reuse. This can be effected in one adsorber while the others are adsorbing.

25 For activating the adsorbent, there is provided a furnace 40 in which any suitable form of fuel may be burned, but it is preferred to burn certain hydrocarbon fuels, such as gas or oil. The products of combustion pass through the flue 41 and into suitable heat exchanging relationship with the saturated adsorbent so that the moisture is driven off and may be discharged into a stack through the pipe 42 along with the waste products of combustion. The exact manner of activating the adsorbent is of secondary importance in the operation of the system.

35 In the chamber 35 is arranged a water discharge nozzle 44 supplied with water through a pipe 45 from a suitable source, and this water is intended to be sprayed through the air rising in the chamber 35 to return it to a certain proportion of moisture to give it the desired humidity. This may be regulated by adjusting the quantity of water discharged into the chamber. The process of absorbing moisture from the air raises its temperature, since the latent heat of the moisture extracted is changed into sensible heat. This heat may be removed by suitable after coolers, not shown, or can be partially or totally removed by the water spray if the spray water has a suitable low temperature. Part of the heat will be extracted by the evaporation of the water which really changes the sensible heat back to latent heat, and the other part may be given up as sensible heat to the water. However, in order not to raise the humidity too greatly, it is desired that the water be sprayed into the air at a low temperature, and, if the temperature of the water is not low enough, this may be effected by having it flow over refrigeration coils 46 before it sprays into the chamber.

65 The refrigerant is circulated into these coils by pipes 47 and 48 from suitable refrigeration apparatus 49. This may be any approved form of refrigeration apparatus, but for the purposes of this invention it is preferred to use an adsorption system wherein the vapor evaporated from the liquid refrigerant in the coils 46 is adsorbed in a suitable adsorbent which is from time to time revived or activated by heat. One type of apparatus for performing this operation is shown in my copending application Serial No. 415,548, filed December 20, 1929.

75 In that application a fluid such as oil is used for heating the adsorbent to activate it, and such an arrangement is particularly valuable in the

present construction, since it permits of heating the adsorbent in the refrigeration apparatus by the same fuel combustion as used for activating the adsorbent in the air conditioning means. For this purpose the refrigeration apparatus 49 is shown as connected by pipes 50 to a coil 51 in the furnace 40, which coil and pipes carry heated oil or other fluid into the refrigeration apparatus for suitably activating the adsorbent therein. Where the apparatus is used in dwellings, refrigeration may also be provided by the apparatus 49 for a suitable food storage compartment 52 shown on the first floor and connected by means of pipes 53 to the refrigeration apparatus 49.

When operating the apparatus for ventilating the building, air is circulated by means of the fan 19, and that delivered into the room is preferably partially composed of air returned from the eduction duct 14 and by-passed around the adsorbers and partially of that which passes through the adsorbers, both diluted with the desired quantity of fresh air entering through the inlet 25. The air after passing through the adsorbers is suitably cooled and humidified and mixed with the untreated air in such proportions, by manipulation of the dampers, as to provide the proper temperature and humidity in the rooms.

105 In the winter it will be appreciated that heat as well as moisture will probably have to be added to the air, and for this purpose it is possible to use the adsorbent material as a heat transfer means by passing the air through it at the same time as it is being heated. In this way the air is heated without having moisture extracted therefrom, since the adsorbent material is not effective to remove moisture while in a highly heated condition. However, as in summer operation, one or more of the adsorbers may be used for the adsorption operation while the others are being heated. Of course, in the summer those being heated have no air passing through them, since they are being activated. By closing the valves 54, refrigeration of the sprayed water may be stopped in the winter time while yet permitting operation of the refrigeration compartment 52.

125 In Figure 2 is shown a form of adsorption apparatus which is particularly suitable for the present invention. The air header is shown at 17', the pipe from the furnace at 41', the pipe to the stack at 42', and the pipe to the washing chamber 35 at 34'. Three adsorbers are shown at 100, 101, and 102, respectively, each arranged in a separate insulated compartment and spaced from the walls thereof. Products of combustion may be delivered through the pipes 103 into the space between the adsorber casings and the outer insulated walls to heat the adsorbent material indirectly, and the products of combustion are exhausted then through the pipes 104 into the header leading to the stack. This permits air to be delivered through the adsorbers without being contaminated by products of combustion and to be heated if desired for winter use. It will be seen that by proper manipulation of the valves air can be passed through one, two, or three of the adsorbers at the same time, and any number of these may be heated. For summer use, to get the most effective benefit of the products of combustion for activation, they may be delivered, to the adsorber to be activated, through the pipes 105 which deliver them directly into contact with

the adsorbent material within its casing. The used products of combustion are discharged through the pipes 106 into the header leading to the stack. Each of the pipes leading into the adsorber or its housing is provided with a suitable valve, and by manipulation of these any desired combination of air flow and combustion products flow may be obtained.

It will be understood that where the term "adsorbent" has been used to refer to the material for dehumidifying the air or taking up a refrigerant vapor, it also includes absorbents which would be suitable for the purpose, such as calcium chloride or the like. In some of the claims the term "sorbent" has been used to include both of these materials.

The various valves used on the adsorption apparatus are subject to automatic control, such, for instance, as shown in my copending application Serial No. 425,883, filed February 4, 1930. After the air dampers are set, they need but little attention except upon unusual changes in the weather, so that the device needs but little attention.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. The method of cooling and conditioning a building or the like comprising contacting air and a moisture sorbent, spraying water through said air, delivering the air to the building, evaporating a refrigerant to cool the spray water, adsorbing the vapor of the refrigerant in a porous adsorbent, burning a fuel, and using the heat to restore the adsorbent and sorbent.

2. The method of cooling and conditioning a building or the like comprising contacting air and a moisture sorbent, partially restoring moisture to the air by evaporation of cooled water therein, delivering the air to the building for use, evaporating a refrigerant liquid by heat transfer from said water, sorbing the vapor in a sorbent, burning fuel, and activating said sorbents, when saturated, with heat from said fuel.

3. The method of cooling and conditioning a building or the like comprising contacting air and a moisture sorbent, partially restoring moisture to the air by evaporation of cooled water, delivering the air to the building for use, evaporating a refrigerant liquid by heat transfer from said water, evaporating more of said refrigerant liquid to cool a storage compartment, sorbing the refrigerant vapor from said cooling processes in a sorbent, burning fuel, and activating said sorbents, when saturated, with heat from said fuel.

4. The method of cooling and conditioning a building or the like comprising contacting air and a moisture sorbent, partially restoring moisture to the air by evaporation of water, delivering the air to the building for use, cooling the water by evaporating a refrigerant liquid, evaporating more of the refrigerant to cool a storage compartment, sorbing the vapor of said refrigerant in a sorbent, burning fuel, transferring heat of said burning to a liquid and then to said refrigerant sorbent to activate the same when saturated, and heating said moisture sorbent, when saturated, with products of combustion from said fuel to restore the same.

5. Apparatus for conditioning air comprising means for adsorbing moisture from air, means for returning water to the air by evaporation to cool it, refrigeration means to cool the water and air, a single source of heat, and means to

apply said heat to restore saturated adsorbing means and to actuate said refrigeration means.

6. Apparatus for conditioning air comprising adsorbent means for dehydrating air, means to return water to the air by evaporation, refrigeration apparatus including an adsorbent and a refrigerant in heat transferring relation to said water and a single source of heat to activate said adsorbents when saturated.

7. Apparatus for conditioning air for buildings comprising an adsorber, means to pass air through said adsorber to dehumidify it, means for adding water to said dehumidified air to moisten and cool it; refrigeration apparatus including an adsorber and an evaporator for cooling said water; apparatus for burning fuel and means to apply the heat of combustion to said adsorbents to activate them.

8. Apparatus for conditioning air for buildings comprising an adsorber, means to pass air through said adsorber to dehumidify it, means for adding water to said dehumidified air to moisten and cool it; refrigeration apparatus including an adsorber and an evaporator for cooling said water; apparatus for burning fuel, means to apply the heat of combustion to said adsorbents to activate them and means to return a portion of said conditioned air after use to the first adsorber for reuse.

9. Apparatus for conditioning air for buildings comprising a plurality of adsorbents, means to pass air through at least one of said adsorbents at a time to dehumidify the air, means to then add water to the air to bring it to the desired humidity, means to cool said water when necessary to produce the desired air temperature, means to deliver the conditioned air to the building, means to burn fuel, means to transfer the heat of combustion to a saturated adsorber to activate it, and means to pass air through an adsorber being heated to heat the air when required, before delivery to the building.

10. Apparatus for conditioning air for buildings comprising means to deliver air to the building, a plurality of adsorbents at least one of which is always in circuit with said delivery means when dehumidification is required, means to burn fuel, means to transfer the heat of combustion to a saturated adsorber to activate the same and means to at times pass some of the air through an adsorber being heated to raise the temperature of the delivered air.

11. Apparatus for conditioning air for buildings comprising a plurality of adsorbents containing adsorbent, means to pass air through one or more of said adsorbents, means to heat said adsorbent including a fuel burner and means to pass the products of combustion around or through each adsorber, means to combine air emerging from a cool and a heated adsorber to regulate the temperature of the mixture and means to deliver the mixture to a building for use.

12. Apparatus for conditioning air for buildings comprising a plurality of adsorbents containing adsorbent, means to pass air through one or more of said adsorbents, means to heat said adsorbent including a fuel burner and means to pass the products of combustion around or through each adsorber, means to combine air emerging from a cool and a heated adsorber to regulate the temperature of the mixture, means to humidify the mixture when desired and means to deliver the mixture for use.

13. Apparatus for conditioning air for build-

- ings comprising a plurality of adsorbers containing adsorbent, means to pass air through one or more of said adsorbers, means to heat said adsorbent including a fuel burner and means to
- 5 pass the products of combustion around or through each adsorber, means to combine air emerging from a cool and a heated adsorber to regulate the temperature of the mixture, means to humidify the mixture when desired, refrigeration apparatus to cool the water used for humidification and means whereby heat from said fuel burner actuates said apparatus.
- 10 14. Apparatus for conditioning air for buildings comprising a plurality of adsorbers containing adsorbent, means to pass air through at least one of said adsorbers at a time, a fuel burner, means to pass the products of combustion around at least one of the adsorbers at a time to heat the adsorbent therein, means to deliver
- 15 air from the adsorbers to a chamber, means to spray water into said chamber to humidify the air and means energized by heat from said products of combustion to cool said water.
- 20 15. Apparatus for conditioning air for buildings comprising a plurality of adsorbers containing adsorbent, means to pass air through at least one of said adsorbers at a time, a fuel burner, means to pass the products of combustion through at least one of the adsorbers at a
- 25 time to heat the adsorbent therein, means to deliver air from the adsorbers to a chamber, means to spray water into said chamber to humidify the air and means energized by heat from said products of combustion to cool said water.
- 30 16. Apparatus for conditioning air for buildings comprising a plurality of adsorbers containing adsorbent, means to pass air through at least one of said adsorbers at a time, a fuel burner, means to pass the products of combustion around at least one of the adsorbers at a time to heat the adsorbent therein, means to deliver air from the adsorbers to a chamber, means to spray water into said chamber to humidify the air, means energized by heat from said products of combustion to cool said water, a separate compartment within said building and means associated with said water cooling means to directly cool said compartment to a lower temperature than the building.
- 35 17. Apparatus for cooling rooms comprising dehydration apparatus including a mass of moisture adsorbent, means to pass air therethrough and to the rooms, means to partially rehumidify the air before delivery to the rooms, means to refrigerate the liquid used for humidifying and a storage compartment including a second mass of adsorbent material, and a single means to revivify both masses.
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