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2,807,258

AIR-CONDITIONER, INCLUDING FURNACE

Original Filed June 29 1951

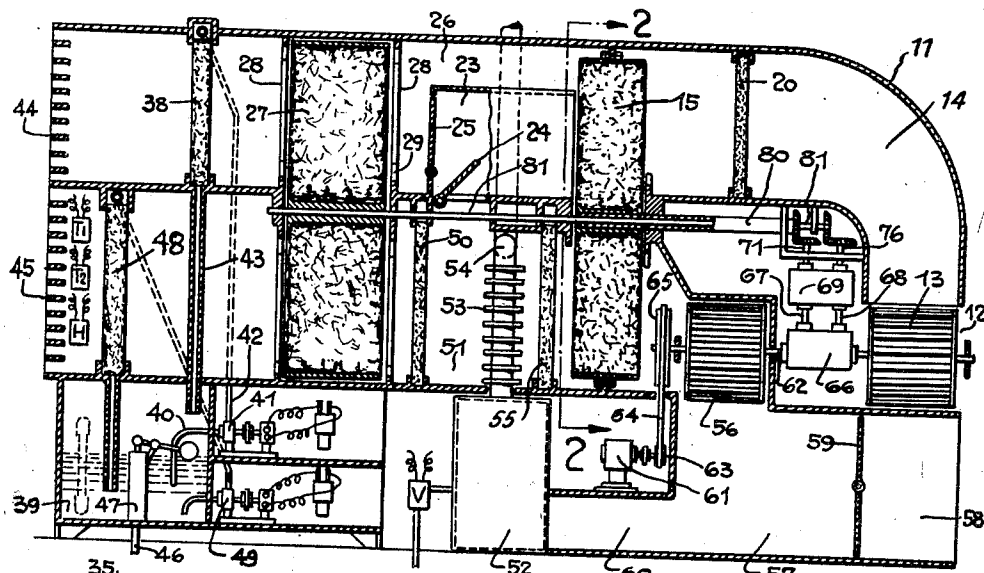


FIG. 1.

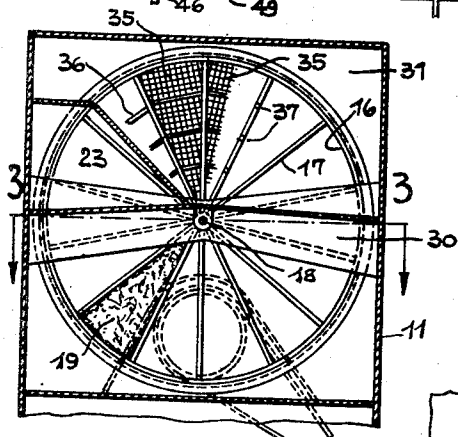


FIG. 2.

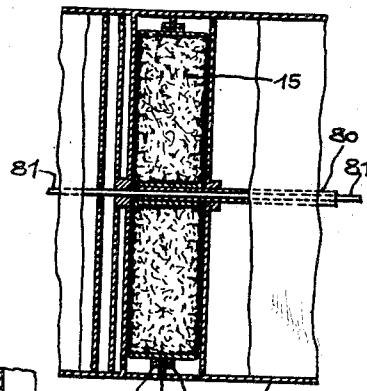


FIG. 3.

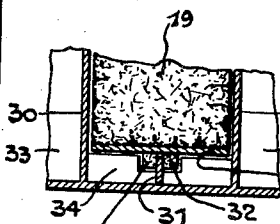


FIG. 4.

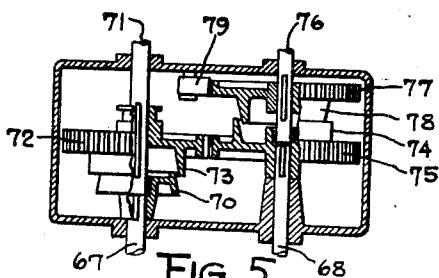


FIG. 5.

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1

2,807,258

AIR-CONDITIONER, INCLUDING FURNACE

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Original application June 29, 1951, Serial No. 234,301, now Patent No. 2,700,537, dated January 25, 1955. Divided and this application December 7, 1954, Serial No. 473,508

3 Claims. (Cl. 126—113)

This invention relates to a new and useful air-conditioner, including a furnace, and more particularly to the utilization for furnace draft of exhaust air (specially treated) from the enclosure being conditioned.

This present application is a division of applicant's copending patent for humidity-changer for air-conditioning, No. 2,700,537, which in turn was a continuation-in-part of applicant's application (copending therewith) for Universal Air-Conditioner, Serial No. 765,554, filed August 1, 1947, now abandoned without prejudice to said patent No. 2,700,537, and without prejudice to one other continuation-in-part, Patent No. 2,723,837.

It is the principal object of the present invention to devise a novel and useful interrelation (within an air-conditioning apparatus) between humidity-changing means and an air-heating furnace, for the purpose of increasing the efficiency of said furnace.

In addition to the objects above stated, the present invention includes a number of novel and useful details, which will be readily evident as the description progresses.

The invention consists in the novel parts and in the combination and arrangement thereof, which are defined in the appended claims, and of which one embodiment is exemplified in the accompanying drawings, which are hereinafter particularly described and explained.

Throughout the description the same reference number is applied to the same member or to similar members. Figure 1 is a longitudinal vertical central section of my apparatus.

Figure 2 is a transverse vertical section of my apparatus, taken along the line 2—2 of Figure 1.

Figure 3 is a horizontal section of the rotary moisture-transferer, and adjacent parts, of my apparatus, taken along the line 3—3 of Figure 2.

Figure 4 is an enlargement of a portion of Figure 3, to illustrate my means for preventing the leakage of air past my rotary moisture-transferer in either air-passage, and for preventing the leakage of air from one air-passage to the other at the periphery of said transferer.

Figure 5 is a diagrammatic detailed showing of the gear-shift for changing the rotation speed of my heat-exchanger and my moisture-transferer, this gear-shift being merely indicated in Figure 1.

Referring now to Figure 1, we see that 11 is the main container of the invention, in which 12 is an air-inlet from outdoors. Centrifugal fan 13 impels this air into passage 14, thence through filter-pad 20, and thence through the upper portion of rotating wheel-like moisture-transferer 15.

The rim 16, ribs 17, and hub 18 of the moisture-transferer are of substantially the same width in an axial direction. Each of the sectors between successive ribs is fully and rigidly but loosely stuffed with some air-pervious liquid-absorbing non-heat-conducting packing 19, which may be excelsior or other similar filamentous material, or corrugated asbestos paper or the like with the corrugations extending axially.

2

The packing should be impregnated with some appropriate solution of a hygroscopic liquid or salt.

Moisture-transferer 15 rotates clockwise in Figure 2. It has two alternative speeds of rotation, as will be explained later herein.

That sectoral portion of the incoming air first treated by this moisture-transferer passes therefrom into by-pass 23, and thence into the outgoing air-stream, for purposes which have no bearing on the present invention. If damper 24 be closed and damper 25 be opened, this air, instead of being thus discarded, will pass with the rest of the incoming stream. If there be no damper 25, and damper 24 be closed, all the incoming air will by-pass the by-pass.

In any event, the main stream of incoming air continues on in passage 26, until it encounters heat-transferer 27, rotating at a speed of about 30 R. P. M.

This heat-transferer 27 is preferably of the sort of the "aluminum wool pad" of applicant's Patent No. 2,464,766.

Heat-transferer 27 rotates in a casing 28, spanned by bridges 29, with sectoral openings between each face of the casing and the corresponding bridge, all as shown and described in applicant's Patent No. 2,464,766.

But moisture-transferer 15, although having very similar bridges 30, has a single shroud 31, which projects inwardly from the main container 11, nearly touching the center line of the periphery of rim 16 of the moisture-transferer. The rim carries two annular pieces of felt 32, one being on each side of, and touching or nearly touching the sides of, the inwardly projecting edge of the shroud. In the horizontal section portrayed by Figure 4, it is seen that, in addition to partition 33, which separates the two air-passages, there are between the two bridges 30, in extension of the partition, two small plates 34 attached to the two bridges 30, the shroud 31, and the wall 11 of the container, and almost touching the rim 16 of the rotating moisture-transferer and the two felts 32. See Figure 4.

These expedients could equally well be substituted in connection with the heat-transferer. They serve to prevent appreciable leakage of air past the moisture-transferer, or from passage to passage.

In both types of transferer, it is desirable to hold the packing in place in some convenient manner, as for example by metal screening secured to each face of the transferer in any convenient manner, as for example (see Figure 2) by being cut into sectors 35 inserted between successive ribs 17, and in turn held in place by wires 36, strung in spider-web formation through transverse holes 37 through the ribs close to the edges thereof.

The incoming air, after having been cooled by heat-transferer 27, is further cooled by passing through evaporative pad 38, which is called the "secondary" pad. Water from tank 39 is sucked through pipe 40 by electric pump 41, by which this water is impelled through feed pipe 42 to the top of pad 38, whence it trickles down through this pad, so much of the water as is not evaporated therein, being returned to the tank through pipe 32.

The tank is supplied with water from any convenient source through supply pipe 46 and ball-cock 47.

The air then enters the room or other enclosure through louvres 44.

Exhaust air leaves the room or other enclosures through louvres 45, and is cooled by passing through evaporative pad 48, which I call my "primary pad," and which is supplied with water from tank 39 by pump 49 in exactly the same manner as secondary pad 38, already described.

Adiabatically cooled by primary pad 48, the outgoing air in turn cools heat-transferer 27, being itself warmed in the process, and then passes through radiation-shield 50 into chamber 51, where it is joined by the by-passed

portion of incoming air entering the chamber through by-pass 23.

In this chamber there is a heat exchange portion of a furnace (preferably gas) 52, which heats the air by means of fins 53 on its flue 54. This furnace, and its flue and fins, are represented here merely conventionally.

The furnace could be located in an adjoining chamber, with heat-exchange means (such as heat-transferer 27) transferring heat from that chamber to chamber 51.

The outgoing air, greatly heated by the furnace, then passes through radiation-shield 55.

Chamber 51 should be lined with some highly heat-reflecting material, backed by heat-insulating material.

Radiation-shield 50 may be of any convenient construction which will shield heat-transferer 27 from the direct rays emanating from air-heater 52, while permitting the free passage of air. In other words, it should be substantially impervious to heat-radiations, and yet pervious to air. Preferably it should be a stationary pad of much the same sort of aluminum-wool as employed as a filler for heat-transferer 27. Radiation-shield 55 is similar, and similarly protects moisture-transferer 15 from the rays of air-heater 52.

The outgoing air, having been raised in temperature by passing through heat-transferer 27 and through radiation-screens 50 and 55, and by the addition of by-passed incoming air, and by air-heater 52, then passes through moisture-transferer 15, where it dries and heats the hygroscopic packing thereof.

Thence it is sucked through centrifugal fan 56 into passage 57, whence it passes outdoors through exit opening 58. In this opening is butterfly valve 59.

From passage 57, in the opposite direction, there extends a draft-passage 60, which connects with furnace 52 in such manner as to furnish draft-air thereto. The amount of this draft can be regulated by butterfly-valve 59.

This draft arrangement is the essence of the present invention.

By thus utilizing a portion of the exhaust air as draft-air for the furnace, there is not only avoided the expense of an additional draft fan, and preheated draft-air is obtained, but also there is utilized the principle that somewhat damp air is better than dry air for draft purposes. It has been found that this simple expedient of utilizing hot damp exhaust air for draft purposes results in a fuel-saving of about 15%.

Motor 61 drives shaft 62 through pulley 63, belt 64, and pulley 65. Fans 13 and 56 are keyed to, and driven by, this shaft 62.

This shaft 62, through gear-reduction 66, drives shaft 67 at a very slow speed (about 3 R. P. M., or considerably less), and drives shaft 68 at a relatively-faster speed (about 25 to 30 R. P. M.). On these speeds, see later herein. Shafts 67 and 68 enter speed-changer 69, the details of which are shown enlarged and somewhat symbolically in Figure 5.

In that figure, slow shaft 67 terminates in male clutch-member 70. Aligned with shaft 67, there is a driven shaft 71, on which and keyed thereto there slides gear 72 and female clutch member 73 integral with this gear.

Fast shaft 68 terminates in female clutch-member 74 and gear 75 integral therewith. Aligned with shaft 68, there is a driven shaft 76, on which and keyed thereto there slides gear 77 and male clutch-member 78 integral with this gear. A fixed dog 79 engages and locks this gear when in its upper position.

Driven shaft 71 drives sleeve 80 which is keyed to rotary moisture-transferer 15. Driven shaft 76 drives shaft 81 which is keyed to rotary heat-transferer 27.

The operation and object of this whole speed-change system, just described, is as follows.

Gear 72 and its female clutch member 73, and gear 77 and its male clutch member 78, are raised or lowered simultaneously. When they are both in their lowered position, gears 72 and 75 are disengaged, and both

clutches are set. The slow speed of shaft 67 is transmitted, through shaft 71 and sleeve 80 to moisture-transferer 15; and the fast speed of shaft 68 is transmitted, through shaft 76 and shaft 81, to heat-transferer 27.

When they are both in their raised position, the situation shown in Figure 5, both clutches are released, gear 72 engages gear 75, and gear 77 engages dog 79. The fast speed of shaft 68 is transmitted through gears 75 and 72 to shaft 71, and thence through sleeve 80 to moisture-transferer 15; and the engagement of gear 77 with dog 79 locks shaft 76 and thence shaft 81 and heat-transferer 27 against rotation. In place of gear 77 and dog 79, any convenient form of brake could be used.

The optimum rotations-speeds differ somewhat for various materials, but can easily be experimentally determined for each. The optimum fast speed for both exchangers is of the order of 25 to 30 R. P. M.

The optimum slow speed for a fully-impregnated moisture-exchanger is of the order of 3 R. P. M. or considerably less. For example, for excelsior fully impregnated with triethylene glycol, it is 2 to 3 R. P. M. For excelsior fully impregnated with the best hygroscopic salts, it is $\frac{1}{8}$ to $\frac{1}{2}$ R. P. M. For corrugated asbestos board impregnated with the best hygroscopic salts, it is of the order of $\frac{1}{8}$ R. P. M.; less if fully impregnated. Various variables enter into the determination of the optimum slow speed.

The object of the two speeds for the moisture-transferer is fully explained in the parent case, Patent No. 2,700,537. It may be summarized as follows:

The moisture-transferer always transfers sensible heat from the air-stream of higher temperature to the air-stream of lower temperature, but more so at high rotation-speed than at low.

At low speed the moisture-transferer transfers moisture from the air-stream of lower temperature to the air-stream of higher temperature, regardless of the relative vapor-pressure of the two streams.

At high speed the moisture-transferer transfers moisture from the air-stream of higher vapor-pressure to the air-stream of lower vapor-pressure, regardless of the relative temperatures of the two streams. Of course, these principles presuppose that the controlling differential is substantial.

Condensation of moisture on the moisture-transferer from either air-stream, adds sensible-heat to that stream, by increasing the temperature of the moisture-transferer, and thence increasing the temperature of the air. Evaporation of moisture into either air-stream, subtracts sensible heat from that stream.

The net effect of the above principles results in the following three operations, as more fully explained in the parent case:

(1) On a warm humid day, with the moisture-exchanger rotating slowly, the by-pass open, and the furnace on, the incoming air will be dehumidified and somewhat warmed. Other means, described earlier herein, are employed to then cool the incoming air.

(2) On a warm dry day, with the moisture-exchanger rotating slowly, the by-pass open, and the furnace off, the incoming air will be humidified and somewhat cooled. The other means, above mentioned, are then employed to further cool the incoming air.

(3) On a cold day, with the moisture-exchanger rotating rapidly, the by-pass closed, and the furnace on, the incoming air will be humidified and considerably warmed.

T₁ and T₂ are two thermostats (but might as well represent one double-stage thermostat), and H is a humidistat. See Figure 1. These could be placed at any strategic location in the room or other enclosure which is being air-conditioned, or equivalently in the outgoing-air passage just inside the louvres 45. These three stats control the turning on and off of pumps 41 and 49, and valve V which supplies fuel to furnace 52, all in a manner

5

described in the second continuation-in-part of parent application Serial No. 765,554, which second continuation-in-part is identified earlier herein as Patent No. 2,723,837.

Now that one embodiment of the invention has been described, it is to be understood that the invention is not limited to the specific form of arrangement of parts herein described and shown.

What is claimed is:

1. An air-conditioner, including: means forming an outgoing-air passage, for conveying exhaust air away from the enclosure which is being serviced; means forming an incoming-air passage for conveying conditioned air to the enclosure which is being serviced; means for impelling air through the two passages in countercurrent relationship; a rotary moisture-transferer, mounted for rotating across both passages; means for rotating the moisture-transferer; and means, including a furnace, for heating the exhaust air in the outgoing-air passage prior to said air reaching the moisture-transferer; said air-conditioner being characterized by having conduit means for routing

6

at least a portion of said exhaust air to the combustion-chamber of the furnace to serve as a forced draft therefor.

2. An air-conditioner according to claim 1, further characterized by having, in the outgoing-air passage in-doorward of where the air is heated by the furnace, means for evaporating water into the air.

3. An air-conditioner according to claim 2, still further characterized by having means for heat-exchange between the air in the two passages, said means treating the air in the outgoing passage at a point between the water-evaporating means and the point where the air is heated by the furnace.

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