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GAS TREATING APPARATUS AND METHOD

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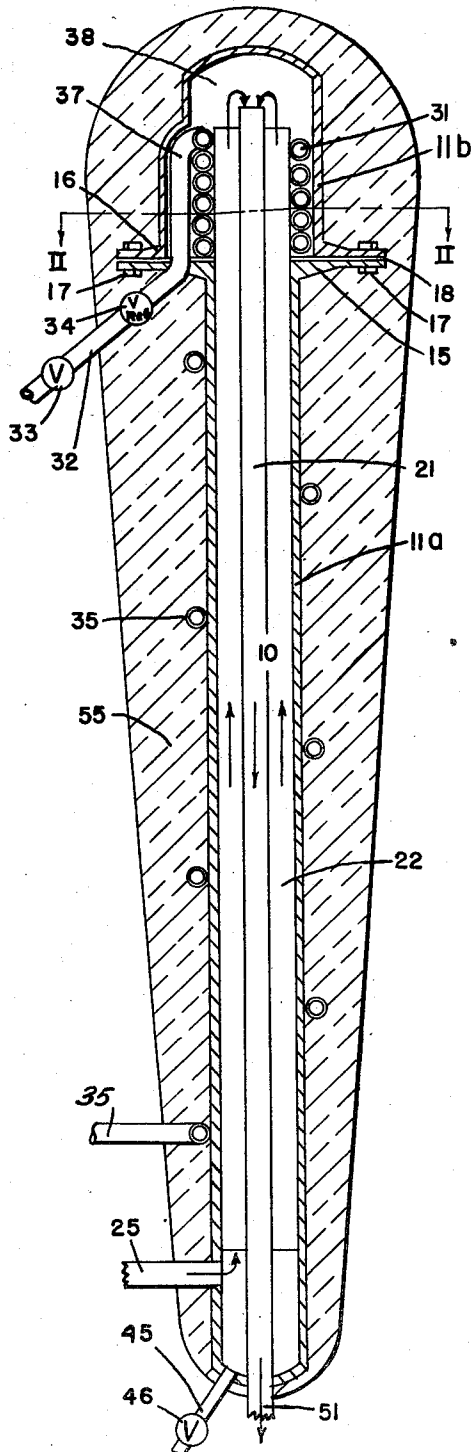


Fig 1

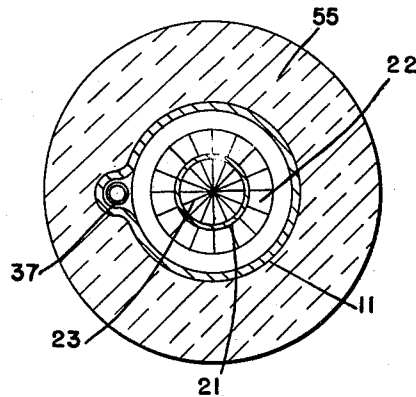


Fig 2

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GAS TREATING APPARATUS AND METHOD

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This invention relates to gas driers and more particularly to a counterflow-heat-exchanger gas drier and to novel gas drying methods.

It is an object of this invention to provide a gas drier and method of gas drying which requires only a small amount of externally-supplied refrigeration to dry gas to a very low dew point.

It is a further object to provide a gas drier which dries gas to a very low temperature dew point, yet requires no artificial or external heater for raising the outlet temperature of the dried gas to its desired temperature for use, which may be slightly lower than inlet temperature.

A further object is to provide a counterflow gas drier in which icing occurs at a point substantially removed from the moisture discharge and wet-gas inlet points.

Still a further object is the provision of a compact, efficient gas drier having no physically separate chambers requiring connecting lines with consequent high refrigeration losses.

It is still a further object to provide a gas drier utilizing a counterflow-heat-exchange arrangement wherein the outgoing cooled and dried air absorbs heat from the incoming warm moist air over substantially the entire length of travel of the warm moist air in the drier, and vice versa.

It is a further object to provide a gas drier having a concentric-tube counterflow heat exchanger with gas inlet and outlet points at or near its lower end, whereby the lower end is maintained above freezing point and does not clog up with ice.

Still another object is the provision of a counterflow-heat-exchanger gas drier in which the gas inlet and outlet points and the condensate discharge point are each at or near the bottom of the drier.

A still further object is to provide a gas drier which utilizes concentric gas counterflow with the moist inlet gas moving upwardly and with the dried gas moving downwardly adjacent thereto.

A still further object is to provide a refrigeration-counterflow-heat exchanger gas drier wherein most of the moisture extracted from the dried gas collects by gravity as liquid water in normal continuous operation at the bottom of the drier for discharge therefrom.

Still another object is to provide a refrigeration gas drier and method of gas drying wherein unplugging or deicing of ice formation in the system can be performed so quickly as not to substantially interfere with continuous operation.

Still a further object is to provide a refrigeration gas drier requiring no artificial or externally supplied heating for regeneration of the unit.

Still further objects and many attendant advantages will become apparent from a reading of a detailed description of a physical embodiment of my invention, taken in conjunction with the accompanying figure of the drawing, wherein:

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Figure 1 illustrates in diametrical vertical cross section a gas drier embodying my invention,

Figure 2 is an enlarged view in horizontal cross section taken on the line II—II of Figure 1.

5 In the preferred embodiment of my invention, as shown in Figures 1 and 2, a counterflow heat exchanger, generally indicated at 10, is mounted in a suitable casing, with an inlet line and an outlet line for gas to be passed through the heat exchanger and dried.

10 The heat exchanger 10 embodies a concentric-counterflow arrangement, and has a tube 21 to whose external surface are secured a plurality of uniformly-spaced radial fins or panels 22. The interior of tube 21 also has a plurality of uniformly-spaced radial or diametral panels 23 extending over substantially the same length of tube 21 as the outer panels or fins 22.

20 Tube 21 with its panels or fins 22, 23 is mounted concentrically within casing 11, the inner surface of the lower casing section 11a thereof conforming substantially to the outer diameter of the radial fins or panels 22 for secure radial support of the tube 21 and fins 22, 23 relative to casing 11. The panels or fins 22, which extend down to a point just above the gas inlet, thus form heat exchanger passages for the gas to be dried and greatly increase the heat exchanger effective surface, as well as serving the dual secondary function of supporting the inner tube 21 in its concentric position within casing 11. It will be understood that while I have shown in my preferred embodiment a heat exchanger utilizing a radial fin construction, other suitable arrangements of panels, baffles, etc., might be employed, as desired, without departing from the overall scope of my invention; however, as pointed out above, this particular arrangement is highly advantageous from several standpoints and is a preferred construction.

35 Wet gas to be dried flows (under any desired pressure) into the casing 11 through gas inlet line 25 which is suitably connected to the lower end of lower casing 11a. At the upper end of the heat exchanger 10, refrigeration from an external source is applied to the rising gas in the heat exchange passages. In the present embodiment of the invention this refrigeration is applied through the medium of a refrigeration coil 31, into which refrigerant is supplied through inlet line 32. 40 It is an important aspect of my invention that this refrigeration source is applied at the upper end of the counterflow heat exchanger 10, as will become apparent during the following discussion. It is a further important aspect that this refrigeration is applied at the opposite end of the heat exchanger 10 from the gas inlet and outlet points, as will be later discussed in more detail. The refrigerant coil 31 is preferably bonded to the fins 22 as by soldering, or other suitable means, in order to provide a highly conductive connection between the refrigerant coil 31 and the fins 22. This is of considerable importance in order to provide maximum efficient utilization of the refrigerant in the zone of super cooling coil 31. The super cooling coil 31 is fed with a suitable refrigerant, such as Freon, through an inlet line 32 which has therein a suitable shutoff valve 33 and expansion valve 34 to maintain predetermined outlet pressure and thus maintain the desired temperature in coil 31. The closely spaced super cooling coils 31 may have a direct refrigerant outlet closely adjacent thereto, if desired, for returning the heated and expanded refrigerant to the compressor (not shown) in the closed refrigerant system. However, I prefer to continue the outlet end of closely-spaced-supercooling coil 31 in a loose or widely spaced apart helix, forming an auxiliary coil 35 having an outlet 36 and extending downwardly and closely surrounding the outside of the lower 45 50 55 60 65 70

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casing section 11a in order to precool the warm moist gas prior to its coming into the super cooling zone adjacent coil 31, thus affording increased efficiency with the refrigerant used and effectively lowering the amount of refrigerant required to be supplied for a given degree of drying (i.e. cooling). The provision of auxiliary coil 35 also effectively lowers the height of the zone in which icing occurs, and permits the use of a shorter length heat exchanger 10 than otherwise without heavy icing occurring in the vicinity of the super cold region of upper coil 31. It is to be emphasized, however, that the lower coil 35, when used, is not so arranged or operated with sufficient latent heat of vaporization remaining to be absorbed throughout the zone of coil 35 as to alone freeze the moisture in the air to be dried. This would defeat the purpose of the invention as will become more apparent as the description proceeds, as the icing would thereby occur substantially at the bottom of lower casing section 11a near the gas inlet and thus cause quick clogging of the tube, as substantially all moisture would form as ice. The refrigerant may be pumped through the coils 31, 35 by any suitable refrigeration compressor and condensing mechanism (not shown) it being only necessary that liquid refrigerant be supplied at the refrigerant inlet 32 to the coils and circulated therethrough. In typical operation the refrigerant evaporates with high heat transfer resulting between coil 31, fins 22 and the gas, due to the absorbed heat of evaporation taken up by the refrigerant and the close physical arrangement of coil 31, fins 21 and the gas in the heat exchange passages between the fins 21; whereas in auxiliary coil 35 a low rate of heat exchange occurs due to the physical arrangement of the coil 35.

The heat exchanger 10 is shown in the preferred embodiment as being mounted vertically, with the gas inlet line 25 and condensate discharge line 45 being suitably connected thereto at the lower end of lower casing section 11a. This is an important aspect of my invention, as it will be seen that moisture which is condensed out in the passages between fins 22 will thus flow down the heat exchanger passages to the closed bottom of casing 11a for periodic discharge through line 45 and condensate discharge valve 46 as may be necessary. Except for the opening into the discharge line 45 (which is normally closed through valve 46) the lower end of casing 11a is closed in order to prevent leakage of wet gas or condensate. While I have shown the heat exchanger 10 in a vertical position, and such is to be preferred, it might also be mounted in an inclined position at other suitable angle to the horizontal, so long as the gas inlet, condensate discharge, and gas outlet are below the upper refrigeration source (coil 31). By employing this vertical or inclined mounting of the heat exchanger 10 with the major (or sole) refrigeration source (coil 31) as has been described supra, at the upper end of heat exchanger 10, and with gas inlet 25 and outlet 51 at or near the lower end of the heat exchanger, I provide a dryer construction which does not ice up at the gas inlet nor to any substantial degree in the zone of the major external source of refrigeration (coil 31). This is also an important aspect of my invention, as a large amount of the original moisture in the warm entrant gas is condensed out as water in the zone below the icing region and drops down to the bottom of casing 11a, with resultant lesser and slower formation of ice in the icing region, which region in a preferred operation of the dryer, as will be later described, lies at some intermediate location between the gas inlet 25 and coil 31.

In order to provide easy access to the coil 31 and upper end of the heat exchanger 10, the casing 11 is formed in two parts, having a lower section 11a, described supra, and an upper closed dome section 11b. Suitable means, such as complementary flanges 15 and 16 formed at the junction ends of casing sections 11a and 11b, with gasket 18 and bolts 17, are provided for

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securing the two sections 11a and 11b together in substantially gastight relation. The upper dome section 11b forms a chamber within which lies coil 31, together with a segment 37 of refrigerant inlet line 32 which extends up through flanges 15 and 16 and connects the coil 31 with the external portion of the refrigerant inlet line. The refrigerant inlet line enters dome section 11b through an opening in flanges 15 and 16 in order to eliminate having to have an opening therefor in the side of the dome section, and thus permits easy removal of the dome section 11b. It will be noted that by providing the inlet into coil 31 at the upper end thereof, the coldest portion of the coil 31 will be adjacent to the coldest gas, and more efficient heat exchange will be effected through the more uniform temperature gradient existing between the coil 31 and the gas adjacent thereto.

The upper ends of the inner and outer passages of the heat exchanger 10 are open and the upper portion of chamber 38 forms a fluid connection for these inner and outer passages. Thus there is provided a continuous path for the gas from inlet line 25 up through the outer passages within casing 11a, past coil 31, into chamber 38, and counterflow down through the passages within inner tube 21 and out through the lower-outlet end 51 of tube 21.

Suitable insulation 55 may be provided around the casing 11 to provide for maximum heat exchange efficiency. The insulation may completely surround the casing 11; however, if desired, the lower end of the lower casing section 11a below the lower end of fins 22, 23 may be uninsulated, since there is very little refrigeration heat exchange in this area and the gas in this area is normally at or comparatively near normal room temperature.

In a typical operation of my refrigeration gas dryer, gas to be dried enters through gas inlet line 25 at the bottom of the heat exchanger 10. The gas as it enters may be assumed to be saturated with water vapor and there is at least sufficient pressure differential between the inlet and outlet points to force the same through the heat exchange passages. The gas thus passes upwardly through the passages formed by the outer surface of tube 21, the inner surface of the lower casing 11a, and the panels or fins 22. As the gas rises, it is cooled by dried gas which is passing downward through the inner heat exchange passages within tube 21, and which dried gas is in turn being warmed through heat exchange from the entrant gas.

As the gas in the outer passages is cooled, water condenses out and forms on the surfaces of the heat exchanger 10. As soon as moisture condensation forms drops of sufficient size that they do not support themselves by sticking to the heat exchanger surfaces, the drops of water will flow to the bottom of the chamber formed at the lower end of the lower casing portion 11a, and the collected water may be periodically removed by opening condensate discharge valve 46 in the condensate discharge line 45 for a short time; or other suitable means for discharge of the condensate from casing 11 may be provided as desired, as for example, an external drain reservoir (not shown) might be provided in the discharge line to prevent the necessity for frequent opening of the condensate valve 46.

Water will continue to condense out as the gas rises in the passages and continues to be cooled by the exhausting dry gas in the inner heat exchanger passages. When the gas reaches a temperature of 32° F., moisture will condense out as ice. Water removed from the gas from this point onward will form as ice on the surfaces of the heat exchanger passageways within the outer casing 11.

As the gas proceeds upward, ice will form on the heat exchanger surfaces. Most of this ice will be formed in the temperature range from 32° F. to 0° F., and thus by operating the drier with this major icing region lying

below the region adjacent coil 31, substantially all moisture will be removed from the gas before the gas reaches the open coil 31. Thus the coil 31 will be relatively free of ice.

It is to be emphasized that with this system of gas drying the minimum amount of moisture in the gas condenses out as ice. If all moisture condensed as ice about eight times as much ice would be formed and clogging would thus occur in approximately one-eighth the time.

During the passage of the gas through the region of coil 31 the temperature of the gas will be lowered a small amount, as for example 10° F., depending on the temperature to which it is desired to lower the gas and the efficiency of the heat exchanger 10. At the upper end of the heat exchanger in the chamber where the gas reverses direction the temperature of the gas will be at the dew point temperature to which it is desired to dry the gas. The refrigerant in the coil 31 during normal operation after initial starting, thus only lowers the temperature of the gas a small percentage of the overall temperature reduction, and for this purpose very little refrigerant is required. After passing into the top of the chamber 38, the gas flow is directed downwardly through the inner-heat-exchange passages within inner tube 21, and the cooled gas thus supplies the refrigeration to the entrant gas flowing upwardly through the passages between tube 21 and casing 11.

Thus, as previously stated, it is important that the drier be provided with its major (or sole, as the case may be) externally supplied source of refrigeration (coil 31) located at or near its upper end, and that the major portion of the overall refrigeration be supplied, after initial starting, by the heat exchange absorption of the heat from the entrant wet gas in the passages within casing 11 by the constantly, comparatively, colder-dried counterflowing gas in the inner tube 21. It will be apparent, therefore, that by so using the concentric-counterflow heat exchanger 10, the drier may be operated, if desired, with the icing region occurring well below the coil 31 (yet well above the gas inlet point), with the addition of only a very small amount of externally-supplied refrigeration through the coil 31, and that such may be accomplished either with or without auxiliary coil 35.

By the time that the gas reaches the bottom of the inner-heat-exchange passages it will have been reheated by absorbing heat from the entrant-rising wet gas to a temperature that is only slightly below the gas inlet temperature. The temperature difference represents the heat loss through the inefficiency of the heat exchanger and that heat which is lost through the insulation 55. It will be noted that this temperature differential is a necessity to achieve heat exchange along the entire length of travel of the gas within the heat exchanger 10.

After an extended period of operation, sufficient ice will have formed in the icing region in the passages inside lower casing section 11a to seriously restrict gas flow. This ice may be removed quickly and easily simply by stopping refrigerant flow for a very short period through the closing of valve 33. Since no external refrigeration is being supplied, the cold regions will start slowly to warm up relatively. In a very short time, on the order of 10 to 15 minutes, the ice, previously formed, will melt and run down to the bottom of lower casing section 11a where it may be discharged through condensate discharge line 45. This deicing operation thus takes place naturally due to heat supplied by the gas which continues to flow through the heat exchanger passages. During this short interval some gas will pass through with slightly higher moisture content but still relatively dry as it is not necessary to permit raising the temperature of cooling coil 31 more than 20° to 40° F. through this operation. If such a moisture-content increase cannot be tolerated for the particular application, this gas may be suitably diverted after it leaves gas outlet 51, during this short period. Also, at this time, a minute amount of ic-

ing will take place in a new icing zone above the initial or normal icing zone. Typical operation might require one day to form sufficient ice to require removal from the normal icing zone. Thus it will be apparent that the ice formed during deicing operation is very small in view of the short time required, and deicing of this secondary icing zone will be required very rarely.

For a typical operation of the illustrated embodiment of my invention, with a wet entrant gas inlet temperature of 100° F. and gas flow of 1500 cubic feet per hour at a pressure of 300 p.s.i., externally-supplied refrigeration of approximately 400 B.t.u. per hour will dry the gas in a 6-foot-high drier to a dew point of -40° F., with the icing region occurring approximately half-way up the heat exchanger 10.

While I have illustrated only one physical embodiment of my invention, it will be apparent to one skilled in the art that many modifications may be made within the scope of my invention, and the invention is thus to be limited only by the scope of the appended claims.

I claim:

1. A gas drier comprising an upwardly extending first tube disposed at an angle to the horizontal, a second tube smaller in cross section than said first tube and mounted concentrically therein, whereby a passageway is formed between said tubes, said first tube being closed at its upper end, a gas inlet at the lower end of one of said tubes, a gas outlet at the lower end of the other of said tubes, condensate discharge means for said first tube, and a refrigerating coil, said refrigerating coil surrounding said tubes in open spaced relation about the greater length of the lower end of said outer tube, and being contiguous to and surrounding the upper end of said outer tube in relatively close spaced relation compared to said lower coil spacing.

2. A self-reheating gas drier comprising two concentrically arranged heat exchange tubes having a gas passage formed therebetween and connecting at one end of said tube with the interior of the inner of said tubes, outer of said tubes having one end closed, thereby forming a continuous counterflow gas passageway, a gas opening in the wall of said outer tube at its other end, a wall separating the interior of said inner tube from the interior of said outer tube at said other end of said tubes, cooling means about said tubes, and means for discharging condensate, said cooling means being a refrigeration coil extending in a closely spaced tight helix about said tubes at the upper end of said tubes, said tight helix extending over a relatively short length of said tubes, the remaining portion of said cooling coil extending down around said tubes substantially to the bottom thereof in a widely spaced helix relative to the spacing of said tight upper helix.

3. A gas drier comprising a casing having a longitudinally extending chamber formed therein, a tube in said chamber, said tube being spaced from the side wall and one end of said chamber, said casing being closed at said one end and having a tube-receiving aperture formed in said other end, the interior of said tube and said chamber being in fluid connection at said one end, said tube extending in substantially gas-tight enclosed relation through said aperture in the lower end of said casing, a gas inlet in said casing near said other end for entry of wet gas to be treated within said casing and tube, and major cooling means concentrated near said one end of said chamber, said other end of said casing chamber and said tube being lower than said one end thereof.

4. A gas drier comprising a casing having a longitudinally extending chamber formed therein, a tube in said chamber, said tube being spaced from the walls and one end of said chamber and being concentric with the chamber walls, said casing being closed at said one end, the interior of said tube and said chamber being in fluid connection at said one end, said tube extending through the other end of said casing, said casing having a lower

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end wall enclosing said tube in substantially fluid tight junctive relationship, a gas inlet in said casing near said other end for entry of gas to be treated within said casing and tube, and major cooling means concentrated near said one end of said chamber, said tube and chamber being substantially vertical, said other end of said chamber being the lower end thereof.

5. A gas drier comprising a casing having a longitudinally extending chamber formed therein, a tube in said chamber, said tube being spaced from the walls and one end of said chamber, said casing being closed at said one end and having an aperture formed in said other end, the interior of said tube and said chamber being in fluid connection at said one end, said tube extending in substantially gas tight relationship through said aperture in the other end of said casing, said other end being disposed lower than said one end, a gas inlet in said casing near said other end for entry of gas to be treated, major cooling means concentrated near said one end of said chamber, the outer surface of said tube being substantially unbroken therealong to permit downward passage of condensate therealong to the bottom end of said casing, and water condensate discharge means at the bottom of said chamber, said casing being closed at its bottom end about said tube, said condensate discharge means including a discharge line connecting with the interior of said chamber through an opening in said casing bottom and adjacent said gas inlet, and a shut-off valve for opening and closing said discharge line.

6. A self-reheating gas drier comprising two tubes one within the other, said tubes being disposed at a substantial angle to the horizontal, said tubes having a gas treating passageway formed therebetween and connecting at the upper end of said tubes with the interior of the inner of said tubes, the outer of said tubes having said upper end closed, thereby forming a continuous counterflow gas treatment passageway, a gas inlet in the wall of said outer tube near its lower other end, the interior of said inner tube being in fluid disconnection from the interior of said outer tube at said lower other end, cooling means disposed about the outer of said tubes, and means for the removal of condensate.

7. A counterflow gas drying and reheating device comprising two tubes one within the other and in fluid connection at one end thereof to form a counterflow gas treating path therein and therebetween, said tubes being disposed at a substantial angle to the horizontal and being in fluid connection at their upper end only, and in fluid disconnection at their lower end, the outer wall surface of said inner tube having a configuration to permit free downward passage of condensate therealong from the top thereof to the bottom end of said outer tube, cooling means concentrated near said upper end, a gas inlet and a gas outlet near said lower end for gas to be treated while passing along said counterflow gas path, and condensate discharge means near said lower end.

8. The method of drying a gas comprising sequentially passing a continuously changing stream of wet gas first upwardly in a first path, reversing the direction of gas flow and then passing said gas downwardly in a counterflowing second path in heat exchange relation with said first path, one of said paths being substantially within the other of said paths, refrigerating and drying said gas with externally supplied and circulated heat-removing refrigerant to a temperature below the freezing point of water in an area along said first path, the major portion of said refrigerating being applied adjacent the upper reverse flow end of said first path to effect the formation of liquid condensate and ice along said first path, interrupting the circulation of said externally supplied refrigerant for a period after formation of ice along said first path, and passing relatively wet gas along said first and second paths during said interruption, whereby said gas is refrigerated and dried by said ice and also melts said ice.

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9. The method according to claim 8, further including the step of ceasing the interruption of said circulation of said refrigerant after a period of said interruption to restore normal operation, and intermittently repeating the aforementioned cycle.

10. The method of drying gases, comprising passing a wet gas in reverse concentric flow first upwardly in a first path and then downwardly in a second path concentric with and in heat exchange relationship to said first path, subjecting said gas to the action of an externally supplied refrigerant in a concentrated area adjacent the upper reverse flow end of travel of said gas and to an extent of heat exchange such that the temperature of said gas is lowered to substantially below the freezing point of water adjacent said concentrated area, whereby liquid condensate and ice are formed along said first path, interrupting the supply of said externally supplied refrigerant for a period after formation of ice along said first path, and passing said gas along said first and second paths during said interruption whereby said gas is refrigerated and dried by said ice and also simultaneously melts said ice.

11. The period of drying a gas comprising passing a gas upwardly in a first path and then downwardly in a counterflowing second path and in heat exchange relation with said first path, one of said paths being substantially within the other of said paths, refrigerating said gas adjacent said first path to a temperature below the freezing point of water through the medium of externally supplied and circulated heat removing refrigerant, whereby liquid condensate and ice are formed from said gas along said first path, and reducing the circulation of said externally supplied refrigerant after formation of ice along said first path to a degree whereby said gas melts said ice and is refrigerated and dried by the heat absorbed by the melting of said ice.

12. The method according to claim 11 further including the steps of restoring said circulation of refrigerant to again effect a build-up of ice along said first path, and intermittently repeating the aforementioned cycle.

13. A gas drier comprising a casing having a longitudinally extending chamber formed therein, a tube in said chamber, said tube being spaced from the side wall and the upper end of said chamber, said casing being closed at said one end and having a tube-receiving opening formed in said other end, the interior of said tube and chamber being in fluid connection at said one end, said tube extending through said opening in said other end of said casing in substantially gas-tight relationship to said casing, a gas inlet opening in said casing near said other end, cooling means concentrated near said upper end of said chamber, said casing including an upper dome section and a lower section each having adjoining connecting flanges, said cooling means comprising a refrigerant conveyor disposed within said dome section and having an inlet and an outlet portion extending through said lower section flange respectively into and out of the interior of said dome section whereby said dome and the interior of said drier may be readily removed for servicing of said refrigerant conveyor without necessitating the disturbing of said inlet and outlet portions thereof.

14. A gas drier comprising a casing having a longitudinally extending chamber formed therein, a tube in said chamber, said tube being spaced from the side wall and the upper end of said chamber, said casing being closed at said one end and having an opening formed in said other end, the interior of said tube and chamber being in fluid connection at said one end, said tube extending through said opening in said other end of said casing in substantially gas-tight relationship with said casing, a gas inlet opening in said casing near said other end, cooling means concentrated near said upper end of said chamber, said casing including an upper dome section and a lower section, said cooling means comprising a refriger-

ant conveyor disposed within said dome section and having an inlet and an outlet portion extending through a portion of said lower section for passage of refrigerant into and out of the portion of said refrigerant conveyor within said dome section, whereby said dome and the interior of said drier may be readily removed for servicing of said refrigerant conveyor without necessitating the disturbing of said inlet and outlet portion of said refrigerant conveyor.

15. The method of drying a relatively wet gas comprising passing an above-freezing entrant gas first upwardly in a first path and then downwardly in a counterflowing second path in heat exchange relation with said first path, one of said paths being substantially within the other of said paths, passing a refrigerant at a below-freezing temperature in heat exchange relation to said gas in an area of application extending along the upper end of travel of said gas along said first path, effecting transfer of heat energy from the instant portion of said gas passing along said first path to the instant portion of said gas passing along said counterflowing second path and effecting the condensation formation of ice in said first path, and maintaining the major portion of said formation of ice in said first path below the area of appli-

cation of said below-freezing refrigerant to said gas and above the entry point of said gas into said first path.

16. The method of drying a gas comprising passing a gas first upwardly in a first path and then downwardly in a counterflowing second path in heat exchange relation with said first path, one of said paths being substantially within the other of said paths, passing a refrigerant in heat exchange relation to said gas while said gas is traveling along said first path, and maintaining said refrigerant progressively colder in an upwardly extending direction along said first path.

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