

Jan. 17, 1933.

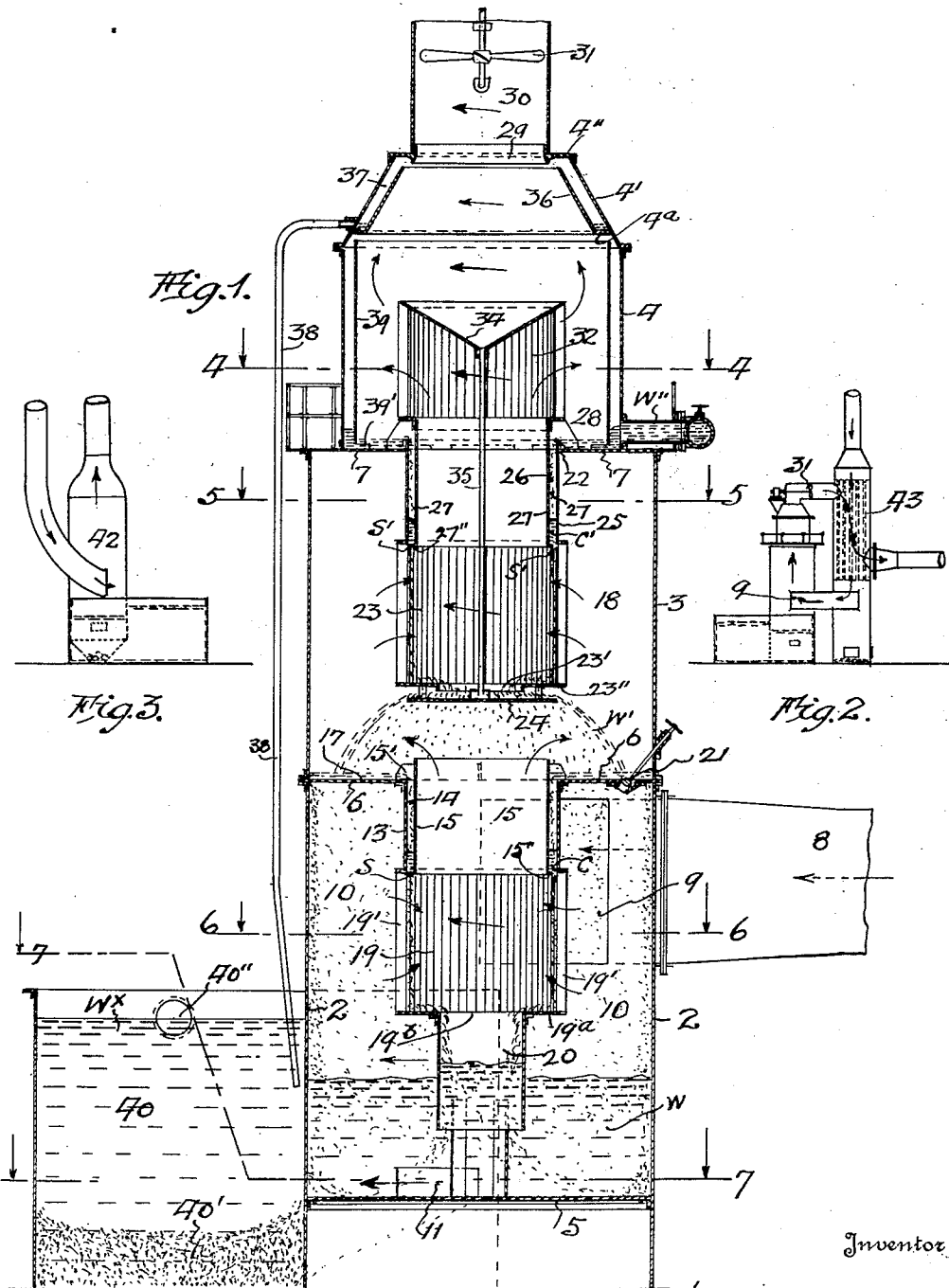
C. G. HAWLEY

1,894,744

GAS CONDITIONER

Filed Dec. 6, 1927

3 Sheets-Sheet 1



Inventor

Charles G. Hawley.

By

C. A. Mason Attorney

Jan. 17, 1933.

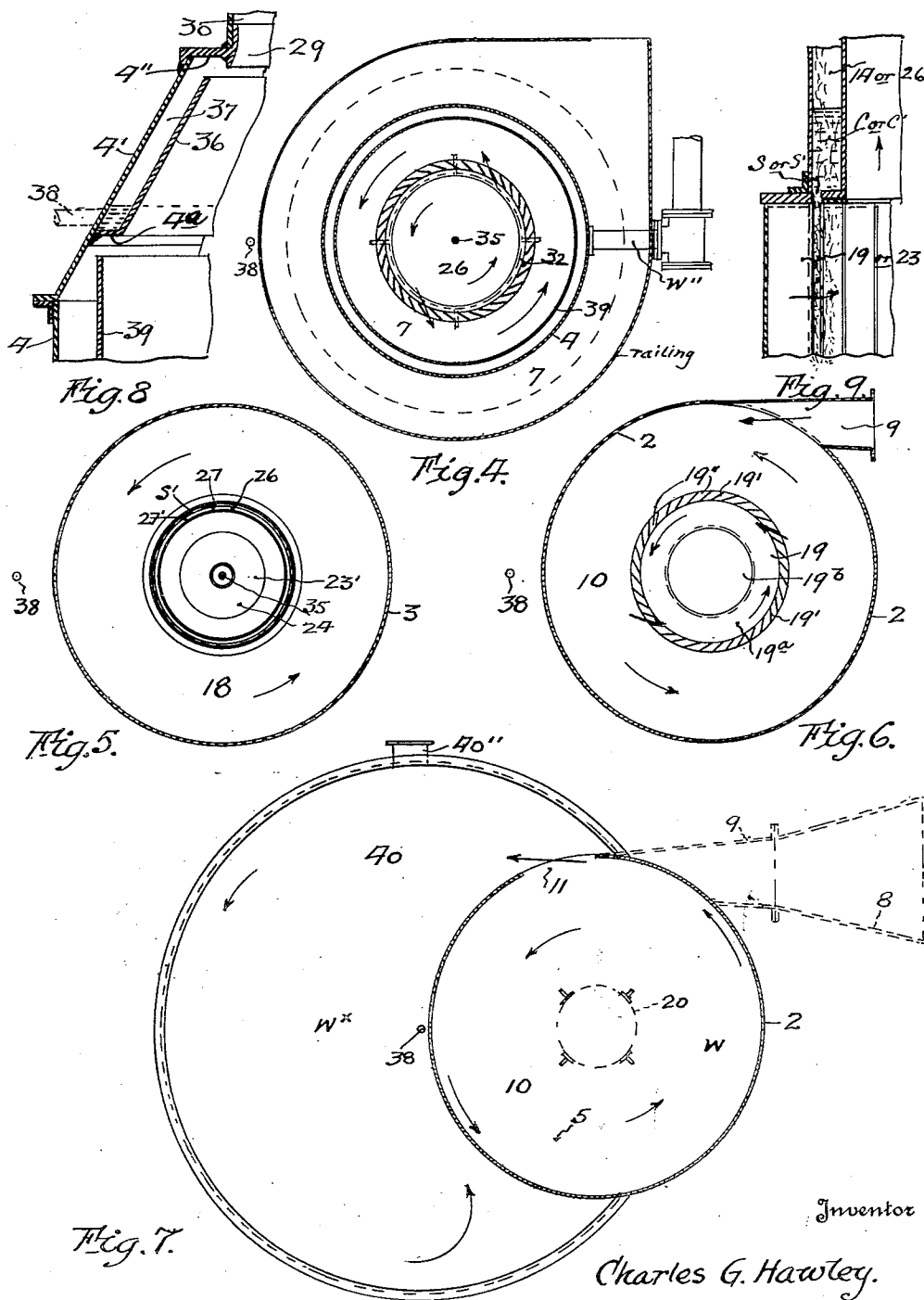
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

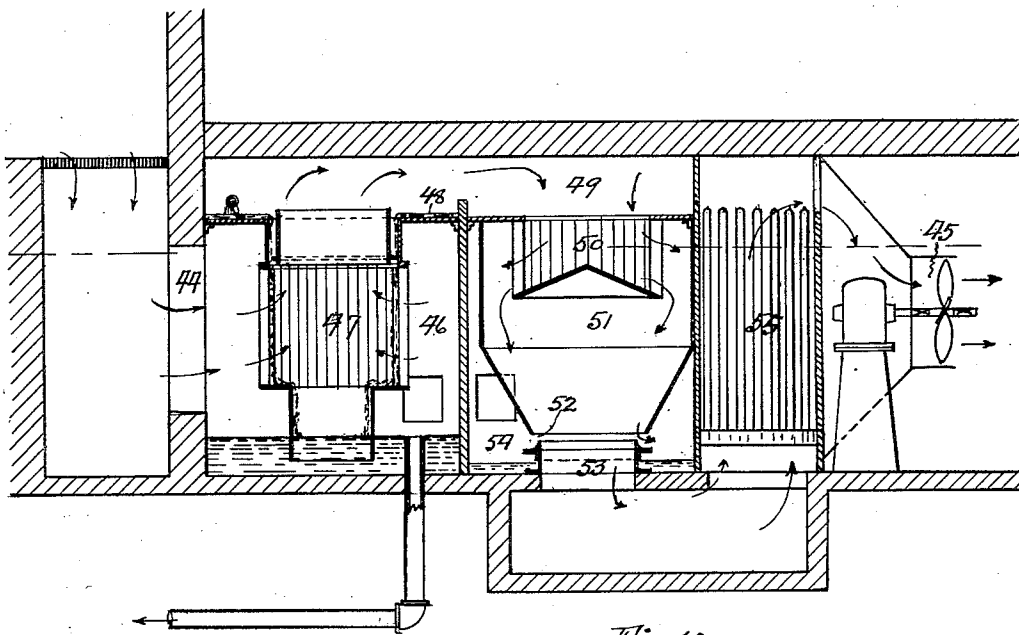


Fig. 10.

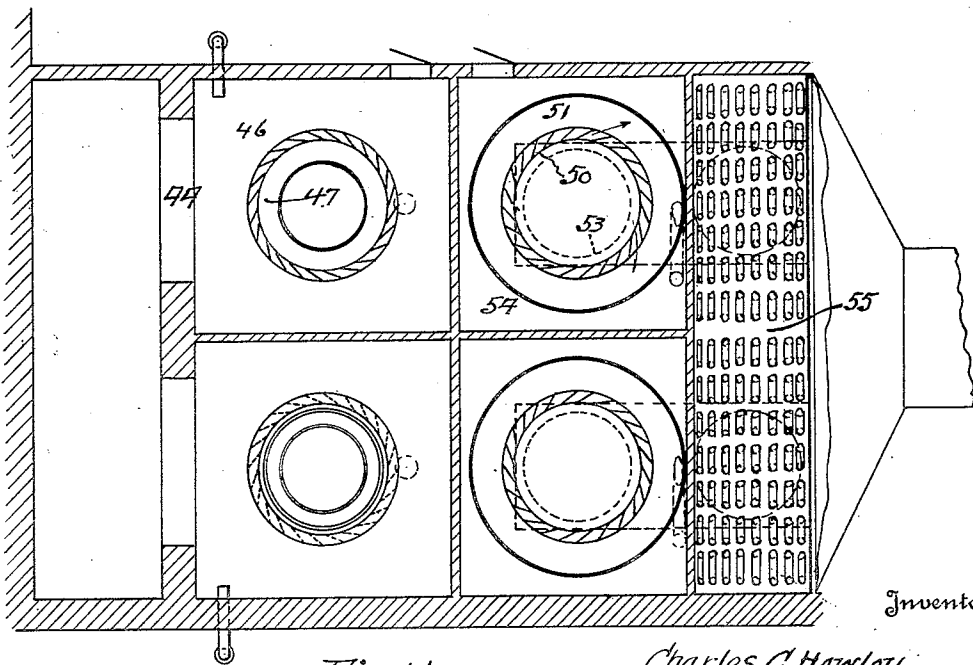


Fig. 11.

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UNITED STATES PATENT OFFICE

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GAS CONDITIONER

Application filed December 6, 1927. Serial No. 238,038.

In general this invention relates to the art of cleaning and otherwise conditioning various gases including air. Its leading use is in conditioning blast furnace gas but in a modified form it is suited for use in conditioning air for buildings. Still other uses will become apparent.

The object of the invention is to provide an apparatus which shall perform such conditioning functions more certainly, more perfectly, and more economically than heretofore and one in which all of the members, aside from valves and a booster fan shall be both fixed and stationary, with a view to lessening the expenditure of power in operating the apparatus. Another object is to provide a gas conditioner or washer which shall be of less height and yet occupy no more ground space than the gas cleaners now generally in use. Further to provide apparatus which, while employing large volumes of washing water, shall employ a minimum thereof and shall also serve to effectively dry the gas or air after it is washed. Again the object of the invention is to improve gas washers in the matter of precipitating the dust and clarifying the washing water before it leaves the apparatus. Still further objects will appear hereinafter.

The invention comprises a chambered structure containing a sequence of baffling and directing devices so co-ordinated and constructed as to attain the foregoing objects; and, will be readily understood on reference to the drawings which form part of this specification. In said drawings:—

Fig. 1 is a vertical section of a blast furnace gas washer or conditioner embodying this invention; Fig. 2 shows the apparatus in elevation and in conjunction with a heat exchanger; Fig. 3 is an elevation of a blast furnace dust catcher equipped with the novel dust and water separating pool; Fig. 4 is a horizontal section on the line 4—4 of Fig. 1; Fig. 5 is a horizontal section on the line 5—5 of Fig. 1; Fig. 6 is a horizontal section on the line 6—6 of Fig. 1; Fig. 7 is a horizontal section on the line 7—7 of Fig. 1; Fig. 8 is an enlarged sectional detail of the upper part of the gas drying portion of the apparatus; Fig.

9 is an enlarged sectional detail illustrating the hydraulic feed employed at the top of each gas washing tuyère; Fig. 10 illustrates the invention in a modified form adapted for use within low structures; and, Fig. 11 is a horizontal section thereof.

First the construction will be explained; then, the operation of the apparatus.

The main structure of a blast furnace gas cleaner or conditioner, following the design of Fig. 1, comprises a comparatively low tower which is defined by the upright cylindrical wall sections or courses 2, 3 and 4. The tower has three floors, marked respectively 5, 6 and 7. The gas supply main 8 is joined to a nozzle 9 which tangentially enters the side of the lower chamber 10. The upper part of the chamber 10 comprises an initial centrifugal dust separating chamber while the lower portion comprises a sump for the dirty water or other liquid used in the washing operation. The bottom side wall of the chamber 10 contains an opening 11 for the tangential discharge of the dirty water from the sump, for purposes hereinafter explained.

The floor 6 contains a large central opening which serves the double function of an upward passage for the gas and a downward passage for washing water. A tube 13, of the same size, hangs from the margin of the opening in the floor 6 and forms part of an annular water feeding passage 14, the latter being completed by the inner tube 15, of less diameter than 13. The tube 15 is widely spaced therefrom and is supported thereby or from the floor 6, as by side brackets 15'. The upper end of the tube 15 rises considerably above the floor 6 and with the wall 3 completes an annular water trough 17 at the bottom of the intermediate tower chamber 18 and at the top of the feed chamber 14. The flange or choke ring 15" appearing in Fig. 1, and best shown in Fig. 9, is uniformly spaced from the inner wall of the tube 13, and being only a little narrower than the chamber 14, forms a narrow water feeding slot or annulus S at the bottom of that chamber. The member 19 which hangs from the lower end of the tube 13 comprises a centrifugal washing tuyère. It is com-

posed of many long blades 19' positioned tangentially as best shown in Fig. 6, and together forming a circumferential series or ring of tuyères 19'', all having the same direction. The aggregate area of the tuyères 19'' by preference greatly exceeds the area of the gas main 8; while the area of the tube 15 may be quite the same as that of the main. The tuyère 19 has a bottom 19^a which contains a central opening 19^b. A tube 20 hangs from this opening and extends below the surface of the liquid, W, in the bottom or sump of the chamber 10.

The part 21 may be taken as representing any suitable by-pass valve by which the liquid in the trough 17 may be drained into the bottom chamber 10 without passing through the chamber 14, the tuyère 19 and tube 20.

The floor 7 contains a large central opening 22, and the chamber 18 contains a second gas washing tuyère 23. The tuyère construction throughout is the same as that described in connection with tuyère 19 except that at the bottom hole 23' thereof, instead of having a tube like the part 20, it is equipped with a spreader plate 24, attached to and spaced from the bottom 23'' of the tuyère 23. Preferably the spreader 24 is of greater diameter than the tube 15, and its presence results in the formation of the umbrella spray, W', above the tube 15. As before, the tuyère 23 is supported by a tube 25 which contains the annular water chamber 26 and the complementary tube 27, the latter having its choke ring 27 forming the feed slot S'. And as before the tube 27 rises above the floor 7 and completes an annular water feeding trough 28 thereon. As shown, the outer wall of the trough 28 comprises the tower wall 4. A supply of cold washing water or other liquid enters the trough 28 through a valved water main W''.

It should be noted that the water feed chambers 14 and 26 are not thin cracks but are of generous width and hence capable of holding substantial bodies or columns of water as indicated at respective points *c* and *c'* in Figs. 1 and 9, and are unlikely to become clogged with dust or dirt. The annular feed slots operate under the pressure of respective water columns *c* and *c'* in the annular chambers 14 and 26, and though narrow are similarly free from clogging. The columns of water are of special use as pressure compensating or balancing columns and will be further described.

According to the present experience, and having regard to the gas pressure differences which tend to raise or displace the columns *c*, *c'*, the annular feed chambers may best be several feet in height, and in designing the apparatus this precaution should be observed, particularly against momentary high pressures; though the exact dimension may always be varied to suit the maximum gas pres-

sure to be accommodated. Obviously, the height thus determined upon for the water feed chamber should not be changed because of a mere change in over-all diameter, made to suit the size of given incoming and outgoing gas mains; gas pressures remaining the same.

Further, it is best to employ a relatively tall tangential entrance nozzle 9 at considerable distance above the water in the chamber 10, while the tuyère 19 may be placed with its bottom quite close to that surface. The tall tubes 13 and 15 accord with such design. Again, as will presently be understood, the like tall tubes of the upper tuyère serve to convert the upper portion of the chamber 18 into a quiet setting space wherein the up-rushing gas from the lower tuyère may rid itself of entrained moisture before passing into the tuyère 23.

The third story of the tower comprises a gas drier whereby the moisture entrained by the gas rising from the tuyère 23 is got rid of. This drier portion of the apparatus may be of less diameter than the lower part of the tower and it is centrally positioned on the floor 7. Thus a suitably railed gallery or runway is conveniently provided at a point where the gas and water flow controls are usually situated.

Upon the cylindrical wall 4 is a preferably conical top 4' preferably distinguished by the shoulder or top proper 4'' and containing the gas outlet 29. The outgoing or clean gas main 30 departs from the outlet 29. This main 30 is preferably equipped with a pressure booster such as the motor driven fan 31 (see Figs. 1 and 2) by means of which the velocity of upward flow through the apparatus may be augmented and the after pressure increased in the main 30. Obviously the booster to any desired extent compensates any loss of initial pressure suffered by the gas during its passage through the apparatus. The power consumed in thus boosting the gas movement is quite negligible and the booster fan has the advantage of operating in clean dry gas. Within the casing formed by the wall 4 is a centrifugal emergence tuyère 32 which has an open bottom resting on the top of the gas tube 27. To avoid obstructing the flow, the aggregate area of this tuyère is greater than that of the tube 27. The body of the tuyère, see Fig. 4, is composed of tangential blades 32', preferably reversed with respect to the blades of the tuyères 19 and 23. The top of the tuyère 32 is characterized by a conical form which provides a vortex core 34, opposed to the outlet 29. The part 35 is a drain pipe which if provided with a choked lower end may extend from the bottom of the cup or cone 34 and deliver any drainage upon the plate 24. In the part 4' is a shoulder 4^a and a spaced truncated cone 36 which at the top is larger than the outlet 30.

29 and is spaced below the same. 37 represents an eject race and 38 a drain pipe therefor. The part 39 is a lining spaced from the wall 4 and which rises to a point just below the shoulder 4^a. Normally water sealed openings 39' at the bottom of the liner 39 prevent interference with the operation of the water trough 28.

The part 40 is a settling basin at the base of the tower and in communication therewith through the opening 11. The base of the tower is either wholly or partly accommodated by the basin 40 so that the portion remaining unoccupied in the basin 40 is of a crescent shape. The bottom 40' of the basin is much below the bottom 5 of the tower to accommodate the sludge which settles in the basin. An overflow opening 40'' is provided near the top of the basin and considerably above the bottom of the tower, it being evident that due to internal gas pressure the water level in the tower will always be lower than the water level W^x in the basin, and that the opening 11 is thus always water sealed.

When the apparatus is in operation the hot blast furnace gas continuously enters under pressure and with considerable velocity through the tangential nozzle 9. The outlet 29 is constantly open and the gas moves from the bottom to the top of the tower. By way of the pipe W'' cold water is continuously supplied to the water trough 28 and thence passes downward to the bottom of the tower. Thus the coldest water is presented to the coolest gas by which it is considerably heated. And the heated water, best adapted to accept dust, is presented to the hot entering gases in the tower chamber 10. As will be apparent, the water leaves the trough 28 through the feed chamber or annulus 26 and falling into the tuyère 23 drops to the bottom thereof. There the falling water encounters the spreader plate 24 by which the falling water is sprayed outward to form the water shower or umbrella above the tube 15 and trough 17.

The dirty gas entering at velocity through the nozzle 9 and impinging against the inner surface of the wall 2, takes on a rotary motion in the chamber 10. Such rotary motion of the then dry gas results in the centrifugal separation of much of the dry dust, which immediately spirals downward and sinks into the water in the sump. Finding no other avenue of escape, the partially purified gas enters the centrifugal tuyère 19, preferably without change of rotative direction, and obviously encounters a cylindrical shower of water descending within the tuyère, that is, from the feed slot S. Both gas and water take on a vigorous rotary motion in the tuyère 19, and the water having been preheated most of the remaining dust in the gas is caught and thrown down with the water and is thus delivered to the sump. The whirling and still hot gas whirls upward through the fully

adequate tube 15 and thus enters the chamber 18 in a whirling condition. That condition serves to centrifugally separate most of the water, if any, entrained by the gas, the water falling into the trough 17.

At this point it should be noted that the gas pressure beneath the slot S of the water feeder due to the whirling motion, is higher than in the tube 15, and that if the feed chamber or space 14 were freely open from top to bottom the gas would partly escape through that avenue and defeat the feed of water. By choking the bottom of the space 14 (also the space 26) the stream of water from the remaining slot is made of about "drop width," in consequence of which the flow of gas through the chamber is resisted and a pressure balancing or compensating water column (*c* or *c'*) is built up in the feed chamber. Once the balancing height or effective compensating column weight is attained in the annular spaces 14 and 26 any further water entering from above builds up an effective "head" in those spaces or chambers and thereafter the water will continue to shower into the tuyère from the respective slots S and S'. The size of a drop of water is very considerable and this being a measure of the width of the slots S' it should be evident that there is no likelihood that those slots will ever be clogged with dirt. At the same time the discharge of water from the slot in quantity may vary from nothing to the maximum so long as a column balancing pressure difference exists in the tuyère. Similarly variations of that gas pressure in each case only serve to vary the height of the compensating water column in the feed annulus. Correlatively the quantity of water may always be varied as desired by mere regulation of the valve belonging to the water supply main, and there is entire freedom from dependence upon finely perforated spray devices depending upon cleanliness and pressure for the effectiveness of their operation. Obviously a large number of generous sized holes, that is, of drop size or smaller, may be substituted for the annular slot at the bottom of the feed annulus, but just as obviously the feed would then be composed of individual streams, which are not to be compared to the annular or cylindrical sheet or veil of water which is supplied by the construction illustrated.

As explained, the gas emerges from the tube 15 in a whirling condition and encountering the umbrella spray W' is further cooled and cleaned thereby and rises in the chamber 18. That chamber is relatively capacious and most of the entrained water drops out of the swirling gas or is projected against the inner surface of the wall 3, returning to the trough 17 to join the feed to the lower tuyère. Next the gas enters the tuyère 23 where the washing and cooling process is repeated, and at this stage because of the intimate contact with

the cold water the gas is brought down virtually to the temperature thereof, thereby insuring the precipitation of the absorbed moisture burden of the gas; in other words dehydrating the gas, down to the dew point incident to that temperature. Thus the object or purpose to be accomplished by cooling the gas is reliably effectuated.

The above statement refers to the moisture content, that is moisture in a state of absorption and in quantity determined by the temperature of the gas. Notwithstanding the elimination of absorbed moisture by the cooling of the gas, in the present case it must be expected that considerable moisture in a state of suspension will be discharged with the whirling gas through the tube 27. Such moisture should be intercepted and returned to the system in order that the gas will finally emerge at the outlet 29 in both clean and dry condition. This is the office of the hereinbefore described top story or dryer portion of the tower. The gas emerges between the tangential blades of the top tuyère 32 and takes on a rapid whirling motion so to speak against the restraining wall opposed thereto. Thus the suspended moisture is centrifugally separated. Heavier accumulations sink to the bottom of the wall or liner 39. The remainder spirals upward and is centrifugally discharged or ejected into the space surrounding the liner 39. It should be noted that the bottom of that space is continuously water sealed to prevent upward passage of gas therethrough. Any moisture which escapes beyond the shoulder 4^a encounters the converging cone or accumulator 36 and is thereby guided into the race 37, which it enters centrifugally; thence to fall preferably into the basin 40, through pipe 38. Thus the gas is effectively dried or relieved of moisture except such moisture as may still be retained in a state of absorption and very little in quantity because of the low temperature of the departing gas.

From the standpoint of heat balances, the efficiency of the device is judged by the low temperature of the departing gas and by the high temperature of the departing water, the process being conducted with a view to having the water in the sump at a temperature just under the boiling point. Obviously this becomes a mere matter of regulating the flow of water from the main W".

As affecting the proportions of the tuyères 19 and 23 it should be noted that the water burden within the dust separating tuyère 19 may be lessened by by-passing a quantity of water direct to the chamber 10 through one or more valves 21. This may be desirable as a means of avoiding an excessive drop of pressure through the tuyère 19.

Further it is to be noted that the aggregate area of the tuyère 23, which accepts the whole burden of cold water, may be very properly

greater than the tuyère area of the washer 19; the better to distribute or extend the veil of water within the tuyère 23 with respect to the volume of gas passing there-through, and to avoid any excessive pressure drop.

As will be apparent, substantially all of the water employed falls into the sump or bottom of the tower. It may now be explained that the whirling motion of the tangentially entering gas is communicated to the water in the sump and with the aid of the whirling water discharged from the bottom tuyère the whole body of water in the sump is kept in a state of rapid rotation which insures a self-cleaning quality; also a tendency to centrifugally present the dust or solids at the lower corner of the sump and to eject them tangentially and forcibly through the hole 11, whereby the solids are caused to enter the settling basin more or less in stream form as distinguished from a condition of uniform suspension in a larger stream of water. By reason of this a quicker settlement of the solids in the basin is insured. Conversely, as the stream from the bottom of the tower enters the basin tangentially it has a tendency to keep the whole content of the basin in rotation, and as excessive rotation would slow down rather than hasten the precipitation of the dust the base of the tower is interposed and made to serve as a rotation obstructing baffle within the basin.

Fig. 3 of the drawings serves to suggest the combination of the described tower base and settling basin with an ordinary centrifugal blast furnace dust catcher 42. There as in all cases, the top of the basin is open so that the accumulations of dust may be readily removed from time to time.

Fig. 2 suggests a form of heat interchanger 43 which first serving as the passage for the dirty gas through the tangent nozzle 9 of the tower, shall later serve as a parallel passage for the clean gas from the top of the tower; whereby to impart to the cool clean gas the heat of the incoming dirty gases. Obviously a reduction of gas temperature is thus brought about in the bottom chamber 10 of the tower and less cooling water will be required therein.

That the invention lends itself readily to the conditioning of intake air in large quantities for public buildings and the like, is clearly indicated by the structure represented in Figs. 10 and 11. As no great reduction in air temperature is required this apparatus has only a single washing tuyère for each air intake opening 44. The apparatus extends horizontally, as in the basement of a building, between the intake opening 44 and the suction fan, the latter typified at 45. The first receiving chamber 46 contains a centrifugal washing tuyère 47 having a water

trough 48 at the top of the chamber and operating in the manner before explained. Thereby the dust is removed from the incoming air. Passing upward and through the top duct 49 the air encounters the centrifugal drying tuyère 50 which is arranged in the cylindrical chamber or casing 51. The latter has the now familiar moisture ejecting slot 52 directly in advance of the smaller outlet 53. The space 54 comprises the race in which the water is collected, to be ultimately discharged to the sewer. Obviously the entering air will be successively washed, cleaned and dried, and will be delivered to the building at a temperature little higher than that of the washing water. 55 represents a heater which is interposed between the dry air outlet 53 and the suction fan 45 for raising the temperature of the air if desired. In very cold weather the water may be shut off from the washer or hot water substituted. By means of this simple apparatus the air may be always effectively cleaned and conditioned to suit the state of the weather and the use to be made of the air.

In its smaller sizes and characterized by external walls or casings adapted to sustain higher pressures, this invention has a distinct and valuable use as an after cooler or heat exchanger in compressor lines and in oil vapor lines. Obviously in such cases the sump drain should be equipped with a discharge trap suited to the pressures of the fluids under treatments. Doubtless the invention has still further uses.

Having thus described my invention I claim as new and desire to secure by Letters Patent:—

1. The described conditioning apparatus comprising a casing which contains washing and drying chambers, the former having a sump in its bottom and provided with an inlet above said sump, in combination with a whirl-promoting tuyère fixed in said washing chamber and forming in part the avenue of communication between it and said drying chamber, means communicating with the upper interior portion of said tuyère and adapted to supply liquid to the interior of the tuyère for wetting the inner surfaces of said tuyère, said drying chamber having an outlet, a moisture separator fixed in said drying chamber and forming the avenue of communication with said outlet, and means for disposing of the separated moisture in advance of said outlet.

2. The described conditioning apparatus comprising a casing which contains washing and drying chambers, the former having a sump in its bottom and provided with an inlet above said sump, in combination with a whirl-promoting tuyère fixed in said washing chamber and forming in part the avenue of communication between it and said drying chamber, means relatively within and

adapted to supply liquid to the interior of the tuyère for wetting the inner surfaces of said tuyère, said drying chamber having an outlet, a whirl-promoting tuyère fixed in said drying chamber and forming the avenue of communication with said outlet, and means for disposing of the separated moisture in advance of said outlet.

3. The described conditioning apparatus comprising a casing which contains two wetting chambers and a drying chamber, the first chamber having a sump in its bottom and provided with an inlet above said sump, in combination with a whirl-promoting tuyère fixed in said washing chamber and forming an avenue of communication between it and the second chamber, a second whirl-promoting tuyère fixed in the second chamber and forming the avenue of communication with said drying chamber, means for supplying a wetting fluid to the interior of the second tuyère, a fluid receiver in the bottom of the second chamber, a fluid conduit leading therefrom to the top of the first tuyère, said drying chamber having an outlet, a moisture separator fixed in said drying chamber and forming the avenue of communication with said outlet, and means for disposing of the separated moisture in advance of said outlet.

4. The described conditioning apparatus comprising a casing which contains lower and upper chambers, the former having a sump in its bottom and provided with an inlet above said sump and the latter having an outlet in its top, in combination with a whirl-promoting tuyère fixed in said lower chamber and forming an avenue of communication between it and said upper chamber, and means at the bottom of the upper chamber for directing liquid into the interior and top of said tuyère for wetting the inner surfaces of said tuyère, thence to fall into said sump.

5. The described conditioning apparatus comprising a casing which contains lower and upper chambers, the former having a sump in its bottom and provided with an inlet above said sump and the latter having an outlet in its top, in combination with a whirl-promoting tuyère fixed in said lower chamber and forming an avenue of communication between it and said upper chamber, means at the bottom of the upper chamber for directing liquid into the top of said tuyère, thence to fall into said sump, and means for by-passing part of the liquid from the upper chamber into said lower chamber.

6. The described conditioning apparatus comprising a casing which contains two washing chambers, the first having a sump in its bottom and provided with a tangential inlet above said sump and the second having an outlet in its top, in combination with a whirl-promoting tuyère fixed in the first chamber

and forming an avenue of communication between it and the second chamber, a second whirl-promoting tuyère forming the avenue of communication between the second chamber and said outlet, and means for feeding liquid successively to the second and first tuyères, and means for conducting the liquid from the latter to said sump.

7. The described conditioning apparatus comprising a tower-like separating structure and means for admitting gas tangentially, into the lower part thereof, said structure having a liquid sump in its bottom and provided with a tangential outlet at the bottom of said sump, in combination with a settling basin to receive the product from the latter.

8. The described conditioning apparatus comprising a tower-like separating structure and means for admitting gas tangentially, into the lower part thereof, said structure having a liquid sump in its bottom and provided with a tangential outlet at the bottom of said sump, in combination with means for showering liquid in the upper part of said structure, and a settling basin to receive the product from the latter.

9. The described conditioning apparatus for hot gas, comprising a tower containing upper and lower separating and washing chambers, in combination with a tangential gas inlet for said lower chamber, a whirl-promoting tuyère centrally positioned in said chamber and forming the gas passage to said upper chamber, a vertical duct extending from the bottom of said tuyère to a point near the bottom of said lower chamber, a whirl-promoting tuyère forming the gas outlet of said upper chamber, means for feeding cool liquid into the top of the upper tuyère, thence into the top of the lower tuyère, the bottom of the lower chamber having a tangential drain, and a settling basin positioned to receive the liquid from the latter.

10. The described gas conditioning apparatus comprising a casing which contains a washing chamber, having a gas outlet in its top and a liquid sump in its bottom and provided with a gas inlet above said sump, in combination with a whirl-promoting tuyère fixed in said chamber and forming an inwardly and axial avenue for the gas between it and the outlet of said chamber, interposed liquid feed means for supplying washing liquid to the upper and inner part of said tuyère, said means including an annular liquid chamber which occupies said outlet and leads liquid downward into said tuyère, and the inner part of which annular chamber completes the avenue for the escape of the gas from said washing chamber.

11. In a conditioning apparatus, a casing containing an admission chamber, in combination with a whirl-promoting tuyère forming the gas outlet of said chamber, an annular liquid chamber above said tuyère, the

lower end of said annular chamber being in restricted communication with the interior of said tuyère, the upper end of said annular chamber being in open communication with the ultimate outlet of said admission chamber, and regulable means for feeding liquid into the top of said annular chamber.

12. A whirl-promoting tuyère, in combination with an admission chamber surrounding the same, a tube rising from the interior of said tuyère, a smaller tube within the first tube and therewith forming a liquid feeding annulus, means choking the lower end of said annulus to an opening substantially of liquid drop width, and regulable means for feeding liquid to said annulus.

13. A gas washer comprising a washing chamber provided with a gas inlet and having an opening at the top, in combination with an annular chamber depending from said top and occupying said opening, the inner wall of said annular chamber forming the gas outlet of said washing chamber, the upper part of said annular chamber being open for the reception of washing liquid at the pressure incident to the escaping gas, the lower end of said annular chamber being open for the discharge of said liquid but restricted to a width of drop size, a gas washing tuyère within said washing chamber and joined to and adapted to accept the liquid from said annular chamber, and means for the disposal of the liquid from said tuyère.

14. A gas washer comprising a substantially cylindrical combined liquid sump and gas washing chamber, the former having a tangential liquid outlet and the latter having a tangential gas inlet and provided with a gas outlet, in combination with means for mixing a washing liquid with the gas in said chamber, and, a liquid settling basin into which the outlet of said sump opens.

15. A gas washer comprising a substantially cylindrical combined liquid sump and gas washing chamber, the sump portion having a peripheral bottom outlet and the washing chamber portion having a tangential gas inlet, a liquid settling basin into which said peripheral outlet opens, liquid feeding means in the upper part of said chamber, and a centrifugal tuyère providing the avenue for the escape of the gas from said chamber.

16. A gas washer comprising a substantially cylindrical combined liquid sump and gas washing chamber, the former having a peripheral bottom outlet and the latter having a tangential gas inlet, a liquid settling basin into which said peripheral outlet opens, gas wetting means in the upper part of said chamber, and a centrifugal gas drying tuyère which provides the ultimate avenue for the escape of the wet gas from said chamber.

17. A whirl-promoting tuyère, in combination with an admission chamber surrounding the same, a tube rising from said tuyère, a

smaller tube within the first tube and therewith forming a liquid feeding annulus in communication with the interior of said tuyère.

5 18. A whirl-promoting tuyère, in combination with an admission chamber surrounding the same, a tube rising from said tuyère, a smaller tube within the first tube, and therewith forming a liquid feeding annulus communicating with the interior of said
10 tuyère and a deflecting disk depending below the lower opening of said tuyère and depending the same.

15 19. A whirl-promoting tuyère, in combination with an admission chamber surrounding the same, a tube rising from said tuyère, a smaller tube within the first tube, and therewith forming a liquid feeding annulus in communication with the interior of the
20 tuyère and a cylindrical tube depending from the bottom of said tuyère and submerged in liquid at its lower end.

25 20. A pressure gas washer having a tangential gas inlet and a gas outlet and having a liquid sump in its bottom, said sump having a tangential liquid outlet at its bottom in combination with a liquid basin adapted to receive the liquid from said tangential outlet of the sump.

30 21. A pressure gas washer having a liquid sump in its bottom, said sump, in turn, having a tangential outlet at its bottom in combination with a liquid basin to receive the liquid from said tangential sump outlet, said
35 basin being curved and partially encompassing said sump thereby permitting a widely distributed horizontal circular motion in said basin and enforcing sedimentation therein.

40 In testimony whereof, I have hereunto set my hand this 30th day of November, A. D. 1927.

CHARLES GILBERT HAWLEY.

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