

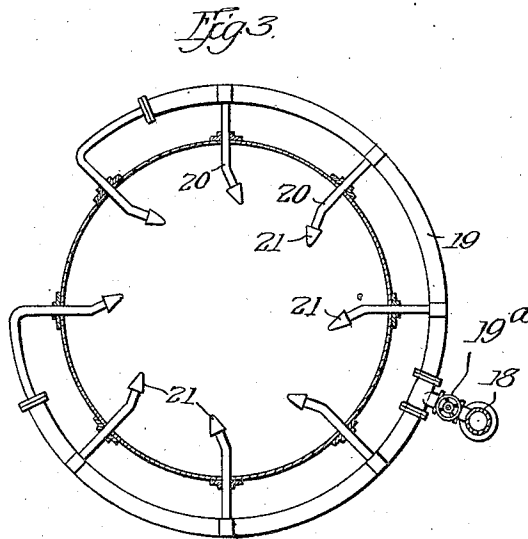
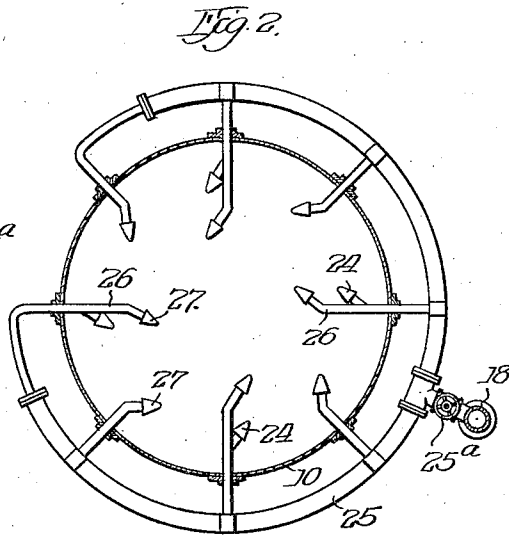
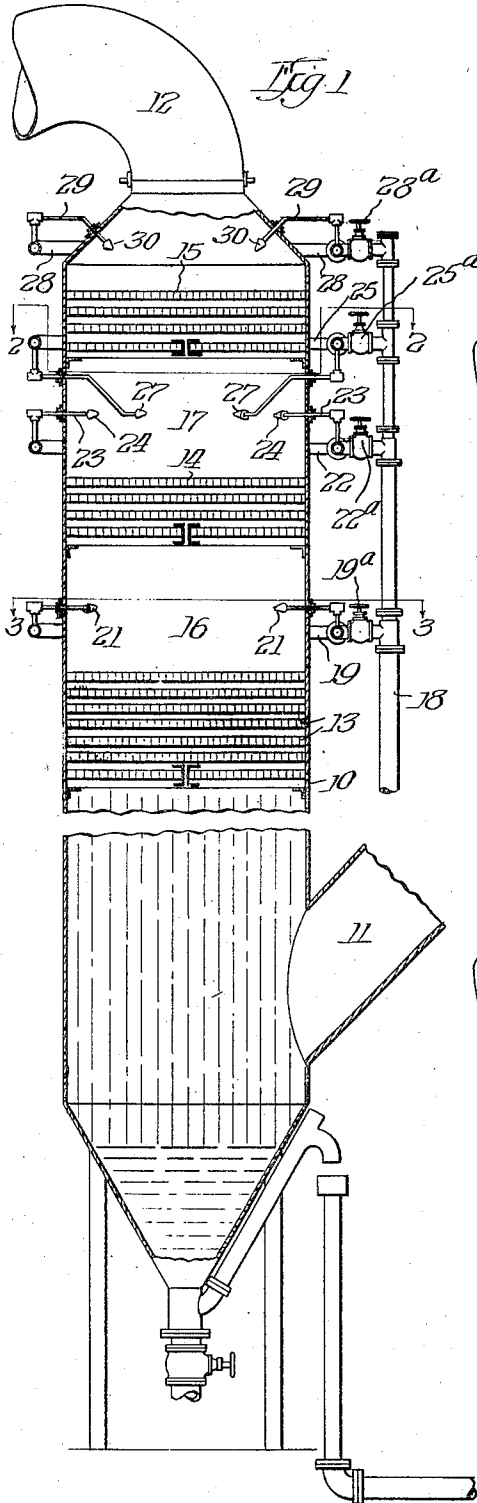
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APPARATUS FOR CLEANING GAS

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR CLEANING GAS.

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To all whom it may concern:

Be it known that I, WALTHER MATHESIUS, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Apparatus for Cleaning Gas, of which the following is a specification.

My invention relates to an apparatus for cleaning and washing gas and has particular reference to an apparatus designed for cleaning gas produced by blast furnaces in which a cleansing liquid is introduced into the gas container and into the gas passing therethrough in a plane at right angles to the travel of the gas through said gas container and at an angle with respect to a plane parallel to the longitudinal axis of said container and a whirling vortex of water is formed extending across the entire cross sectional area of said container adjacent the spray nozzles, the cleaning liquid being introduced into the container at a velocity sufficient to overcome the direction of the travel of the gas therethrough, and to compel the gas to partake in the whirling motion, thus bringing the gas and cleansing liquid into intimate contact and relation with each other and thoroughly scrubbing the gas and removing the suspended impurities therefrom whether in solid or vapor form.

I am aware that various forms of apparatus have been used heretofore for cleaning and washing gas of this character and that these washers are divided generally into two classes, namely, stationary washers and mechanically operated washers.

The ability of the latter class of washers to achieve a greater degree of cleansing than has so far been accomplished with stationary equipment, is conceded. However, particularly where large quantities of gas have to be cleaned the size and first cost of the equipment, together with the power requirements and other operating expenses, are such as to make installations of this type in great many instances economically prohibitive. A further objection to the use of this type of washer for large gas volumes is the resistance offered thereby to the gas flow, requiring the installation of booster fans of considerable size. This introduces a material element of danger as in the event of insufficient gas supply these fans will create a partial vacuum in the supply main system, which in the case of combustible gases

through infiltration of air has been the cause of serious explosions.

My invention does not refer to this mechanically operated form of gas washing apparatus but rather to the so-called stationary type and has for its primary object the bringing of the cleansing liquid and of the gas into greater intimacy of contact than has heretofore been accomplished in stationary washers.

The simplest form of such stationary gas washing apparatus is probably a spray tower in which a cleansing liquid is introduced near the top of the tower through suitable means of distribution and then falling by gravity as a rain to the bottom of said tower while the gas admitted near the bottom rises through this descending rain and is finally taken off near the top of the tower. Based on the well known fact that the principal reason for the difference in cleansing effect existent between the above described washer type and the more elaborate and costly mechanical equipment lies in the greater intimacy of contact obtained by the latter between the gas and the washing liquid, numerous attempts have been made to improve, in stationary washers, this intimacy of contact over that obtained in the ordinary rain tower. One form of apparatus employs to this effect certain baffling arrangements for the purpose of retarding the fall of the water and simultaneously breaking up the gas current into smaller unit streams of larger contact surface. Other types have aimed at still further improving the intimacy of contact by impinging the gas stream together with the cleansing liquid against suitable baffled surfaces which are interposed into the path of the gas and sometimes are disposed at an angle for the purpose of obtaining larger impinging surfaces and facilitating the removal, by the cleaning fluid, of accumulations of solids. The water used as a cleansing medium in the gas washers of the type just described is usually introduced into the tower by spray nozzles projecting upward and introducing the water into the gas current in the same direction of travel as the gas current. With this arrangement, the cleaning liquid, after having been sprayed against the impinging surfaces by means of the spray nozzles pointing upward falls back therefrom in a direction substantially opposite to that of the sprays and is, therefore, intercepted again

by these sprays and ultimately carried to the outer periphery of each spray area. In this manner each one of the spray nozzles forms above itself, a practically impervious spray cone which prevents the water from descending into the area below said spray cone and forces it toward the outer periphery and still more toward the center of the gas washing tower where it pours down in heavy solid streams thus defeating its own object with reference to finely dividing and uniformly distributing the cleaning fluid. The gases at the same time, are permitted to rise through these spaces protected by the spray umbrellas without being in intimate contact with the washing liquid. It will be readily seen that this condition is materially aggravated if as is customary in some types of washers in use today, a number of such spray sets, pointing upward, are superimposed in a washing tower. As the cleaning liquid descends from the upper tiers toward the lower sprays it is repeatedly forced toward the center of the gas washing tower or thrown against its outer shell, thus opposing the purpose of uniform distribution and intimate mixture of gas and cleaning fluid.

In my invention I claim to have been able to avoid the afore-mentioned disadvantages of the various gas washer types and to have succeeded with stationary equipment to closely approach or equal the performance of mechanical washers by obtaining a superior intimacy of contact between the gas and the cleaning fluid in the following manner. In a stationary gas container and into the gas passing therethrough in a plane at right angles to the travel of the gas through the said gas container a rapidly revolving washing spray is created so as to cover in a practically uniform manner the entire cross sectional area of said gas container at any given cross sectional plane located at right angles to the travel of the gas. By these sprays the gas current introduced, for instance, at the bottom of the gas washing tower and rising through it toward the outlet at the top, is deflected from its vertical path and carried along at a velocity decidedly higher than that prescribed by the area of the conduit and by the gas volume per unit of time into a swiftly revolving vortex of cleaning liquid. Thus the latter in finely divided form is brought into closest touch with the impurities to be removed from the gas, the high velocity prevailing during this performance not only effecting a most intimate contact between the smallest particles of gas, fluid and solids, but also tending to overcome any surface tension existing between the fluid and solids. In this way a wetting and an absorption of the solids by the liquid is accomplished and consequently an elimination of the solids from the gas.

A further object of my invention is the provision of a gas washer having a whirling vortex of cleansing liquid in the gas container at any given point in said container and covering uniformly the entire cross-section area of the said container wherein the cleansing fluid as it is eliminated by gravity from the vortex formed in said tower, distributes itself over the area immediately below the spray whirl uniformly and therefore assists in better cleansing the gas in said tower.

A further object of my invention is the provision of a gas washer, preferably of the vertical tower type having whirling vortices formed therein in spaced relation with each other whereby the water from the upper vortex falling down upon the lower vortex is picked up and forms a part of the lower vortex and is redistributed over the entire horizontal area of the gas washer tower uniformly so that in addition to securing intimate contact and relation with the gas and water and a thorough scrubbing of the gas by the whirling vortices the cleansing fluid in the gas washer is uniformly distributed throughout the entire space of said tower and thus all channelling of the gas is avoided.

Another and further object of my invention is the provision of a gas washer in which the acceleration of the gas current and the intimate contact of the cleansing liquid and the gas is accomplished without a material reduction in the area of the gas conduit so that no appreciable resistance is offered to the gas current as it passes through the washer, no back pressure is created in said gas current and boosters for forcing the gas through said gas washer are not required.

Another and further object of my invention is the provision of a stationary gas washer which approximates or equals the results which has heretofore been accomplished by mechanical washers only.

These and other objects of my invention will be more fully and better understood by reference to the accompanying sheet of drawings wherein

Figure 1 is a vertical sectional view of a gas washer tower embodying my invention;

Figure 2 is a horizontal cross sectional view on lines 2—2 of Figure 1 showing a concentric arrangement of spray nozzles;

Figure 3 is a horizontal cross sectional view on lines 3—3 of Figure 1 showing a single row of spray nozzles extending through the wall of the gas washer tower.

Referring now specifically to the drawings, a gas washer tower 10 is shown having a gas inlet pipe 11 at the lower end thereof and a gas outlet pipe 12 at the upper end thereof through which the gas passes from the tower. A set of spaced lower baffles 13 is provided having passages there-

through through which the gas passes in its upward course through the gas washer tower 10, the said set of baffles 13 extending over the entire cross sectional area of the said tower 10. A set of intermediate baffles 14 is also provided in said tower positioned above the set of baffles 13 and extending over the entire cross sectional area of said tower and through which the gas passes as it travels upward through the tower. A set of upper baffles 15 is provided also in spaced relation with each other and having passages therethrough through which the gas passes. It will thus be noticed that a space 16 is formed between the intermediate set of baffles 14 and the set of baffles 13; and a second space 17 is formed between the sets of hurdles 14 and 15.

A vertically extending water supply pipe 18 is provided outside of said gas washer tower 10 to which a circular pipe 19 is secured which extends around the gas washer shell 10 and has pipes 20, 20 extending through the gas washer shell with nozzles 21, 21 on the ends of said pipes 20, 20, the said pipes 20, 20 being turned at an angle with relation to the vertical plane of the tower 10 so that sprays of water passing from said nozzles into the tower completely fill the space 16 with a whirling vortex of water, thus bringing the water and gas into intimate contact with each other and resulting in the scrubbing of the gas as it reaches the space 16 in the washer tower 10, the velocity of the water being sufficient to overcome the velocity of the gas traveling through the tower in a vertical direction so that it is whirled around by the sprays of water passing from the nozzles 21, these sprays being arranged in the same horizontal plane so the spray is distributed over the entire spray nozzle area uniformly and completely with each nozzle directing its spray below, above, and behind each preceding nozzle, thus forming a swiftly revolving vortex of cleaning fluid in spray formation which is constantly accelerated and kept in motion by the velocity of the water passing from the spray nozzles. A valve 19^a is provided which controls the water supplied to the spray nozzles 21, 21.

A second circular pipe 22 is provided which is positioned above the pipe 19 and is connected to the vertical water supply pipe 18 with a valve 22^a interposed therebetween and has secured thereto a set of inwardly projecting pipes 23 having nozzles 24, 24 positioned thereon, these nozzles being disposed at an angle to the vertical plane of the washer tower and being arranged in substantially the same manner as the nozzles shown in Figure 2 except that their direction may or may not be reversed so that the whirling spray of water is directed into said tower in the same or the opposite direction

as compared to the spray in chamber 16. Spaced above the pipe 22 is a third circular pipe 25 also connected to the vertical pipe 18 and controlled by a valve 25^a. Entering pipes 26, 26 are provided which pass into the said gas washer tower 10 and have spray nozzles 27 secured thereto, the said pipes 26 being turned at an angle to the vertical plane of the gas washer tower in the same direction as the pipes 23 and forming a row of spray nozzles in the chamber 17 in the same horizontal plane as the spray nozzles 24, 24 and in concentric relation with the said spray nozzles 24, so that in the chamber 17 is formed a more intense whirling vortex of water jointly from the spray nozzles 27 and from the nozzles 24, this arrangement, is desired, imparting to the gas a higher velocity and a more violent scrubbing than that which takes place in the chamber 16 with the single row of spray nozzles arranged as shown in Figure 3.

After leaving the chamber 17, the gas enters baffles 15, which, during the regular operation of the washer may not be sprayed with cleaning fluid and which serve for the purpose of eliminating from the gas the entrained moisture carried off from the spray chambers. This entrained moisture is well known to frequently hold suspended a certain amount of very finely divided solids; it is the purpose of the baffles 15 to offer a multitude of surfaces for depositing such solids together with the entrained moisture thereon, thus enabling the gas to pass from the tower 10, through outlet pipe 12, having been freed of impurities as well as of entrained washing fluid.

At the upper end of the pipe 18 is provided a circular pipe 28 to which are connected inwardly extending pipes 29 passing through the walls of the gas washer tower 10 and having spray nozzles 30, 30 attached thereto, through which a spray of water is adapted to pass which is directed against the upper surface of the set of baffles 15, the supply of water being controlled by a valve 28^a. This valve may, in the normal operation of the tower, be kept closed and may be opened at convenient intervals only and for short periods of time, directing sprays of water from the nozzles 30, 30 against the baffles 15 in order to wash these baffles and remove therefrom particles of solids which may have adhered thereto and also to clean out the gas passages between the baffle blocks.

In operation of the device it will be understood that the warm dust laden gas enters the inlet pipe 11 and coming in contact with the water falling as a rain from the set of baffles 13 is cooled and relieved of its coarser impurities. Upon entering the baffles 13 and passing therethrough it comes in contact with a multitude of wetted

surfaces of the baffles and is forced to follow a tortuous path therethrough so that the gas is distributed throughout the gas washer tower and any channelling of the gas is broken up.

5 The gas thereupon enters the chamber 16 where it is subjected to the whirling action of the washing spray created by the nozzles 21, 21 and has its direction of travel changed and is compelled to participate in the whirling motion of the vortex of water formed by the spray nozzles 21 and is given a thorough scrubbing. The washing fluid, after the whirling force is spent, drops out of the vortex formed in the chamber 16 by gravity

10 and passes downward over the set of baffles 13 and therethrough to the bottom of the gas washer tower. The gas after passing through the vortex of water in the chamber 16 passes through the set of baffles 14 where again it follows a tortuous path through the said baffles, and is distributed throughout the cross-sectional area of said tower. The gas thereupon passes into the chamber 17 where it is again forced into a rapidly whirling motion by the vortex of water coming from the set of spray nozzles 24, 24 and the nozzles 27, 27 and given a thorough scrubbing and whirling, the particles of gas and water being brought into intimate relation and contact with each other and the gas being completely scrubbed and freed of the particles of dust and dirt carried therein, all this due to the higher velocity and the more violent agitation that exists in chamber 17 because of the greater number of nozzles in use and the concentric arrangement of the spray nozzles. After leaving the space 17, the gas passes through the set of baffles 15 following a tortuous path therethrough and being relieved of the entrained moisture carried by the gas after passing through the sprays of water as heretofore described and depositing upon the surfaces of the said baffles the solids carried by the entrained moisture. The gas thereupon passes outward through the outlet pipe 12. It will thus be understood that the spray nozzles may be positioned in any relationship with each other and may be turned at any angle with respect to the vertical plane of the tower, so long as the essential feature is maintained, namely, the formation, within the gas washer throughout any given sectional area thereof, of a whirling vortex of cleaning fluid through which the gas must pass, the gas being picked up by the vortex and given a thorough scrubbing with an even distribution of water and gas throughout the entire cross sectional area of the said gas washer tower. The water passing downward from the upper vortex is picked up by the lower vortex of water, participates in its whirling movement and is redistributed as it passes downward by gravity to the bottom of the washer

tower, thus forming in a stationary gas washer revolving sprays of cleaning fluid in spaced relation with each other, and thus bringing the gas and fluid into intimate contact with each other and effecting when applied in combination with suitable arrangements for preliminary and after treatment of the gas a high degree of cleansing not hitherto possible with a minimum amount of cleansing fluid all because of the superior intimacy of contact of the gas and cleansing fluid and also the uniform distribution of the washing fluid throughout the entire washer tower.

While I have described more or less precisely the details of construction, I do not wish to be understood as limiting myself thereto, as I contemplate changes in form and the proportion of parts and the substitution of equivalents as circumstances may suggest or render expedient without departing from the spirit or scope of my invention.

I claim:

1. In combination, a gas washer comprising a gas container having a gas inlet and a gas outlet, and spraying means adapted to spray a liquid for forming a vortex of cleansing liquid in said container extending across its entire cross-sectional area whereby all of the gas passing through the container is subjected to the washing action of the vortex.
2. In combination, a gas washer comprising a gas container having a gas inlet and a gas outlet, a plurality of stationary spray nozzles positioned in said container adjacent the walls thereof and directed angularly inward whereby the spray from said nozzles forms a vortex extending across the entire cross-sectional area of the container, and means for supplying a cleansing fluid to said nozzles.
3. In combination, a gas washer comprising a gas washer tower having a gas inlet and a gas outlet, a plurality of sets of spray nozzles, each set of spray nozzles being arranged in a plane transverse of the tower with the nozzles angularly disposed in the plane, at least one set of said spray nozzles comprising a plurality of concentrically arranged series of nozzles, whereby an effective washing spray is maintained throughout the cross sectional area of the tower.
4. In combination, a gas washing tower having a gas inlet and a gas outlet, a series of spaced baffles in said tower, and spraying means adapted to spray a liquid whereby a whirling vortex of cleansing liquid is introduced in said tower, the said whirling vortex extending across the entire cross sectional area of the said tower between the sets of spaced baffles.
5. In combination, a gas washer comprising a gas container having a gas inlet and

a gas outlet, a plurality of stationary spray nozzles positioned in said container adjacent the walls thereof and directed angularly inward whereby the spray from said nozzles forms a vortex extending across the entire cross-sectional area of the container, a plurality of vertically spaced baffles in said tower located above and below said nozzles, and means for supplying a cleansing fluid to said nozzles.

6. In combination, a gas washer comprising a tower having a gas inlet and a gas outlet, a series of spaced baffles in said tower, sets of spray nozzles arranged in horizontal planes between such baffles, one of said sets comprising an inner and outer row of nozzles placed in concentric relation with each other, each spray nozzle being directed at an angle with respect to the vertical plane of the tower, and means for supplying water to said spray nozzles at a velocity greater than the flow of gas through said tower, whereby the entire cross-sectional area of the tower is covered by an effective washing spray.

7. In combination, a gas washer comprising a tower having a gas inlet and a gas outlet, spraying means adapted to spray a liquid for forming a spray vortex covering the entire cross-sectional area of the tower and whirling in one direction, a series of baffles above said vortex forming means, and

means for forming a second vortex covering the entire cross-sectional area and whirling in the opposite direction located above the baffles.

8. In combination, a gas washer comprising a tower having a gas inlet and a gas outlet, three series of baffles vertically spaced in the tower and located between the gas inlet and gas outlet, spraying means adapted to spray a liquid for forming a spray vortex whirling in one direction located between the lower and intermediate baffles and means for forming a spray vortex whirling in the opposite direction located between the intermediate and upper baffles.

9. In combination, a gas washer comprising a tower having a gas inlet and a gas outlet, three series of baffles vertically spaced in the tower and located between the gas inlet and gas outlet, angularly disposed nozzles for introducing liquid to form a spray vortex covering the entire cross-sectional area of the tower and whirling in one direction, located between the lower and intermediate baffles, and nozzles for introducing liquid to form a spray vortex covering the entire cross-sectional area of the tower and whirling in the opposite direction, located between the intermediate and upper baffles.

Signed at Chicago, Illinois, this second day of June, 1922.

WALTHER MATHESIUS.