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GAS WASHING APPARATUS

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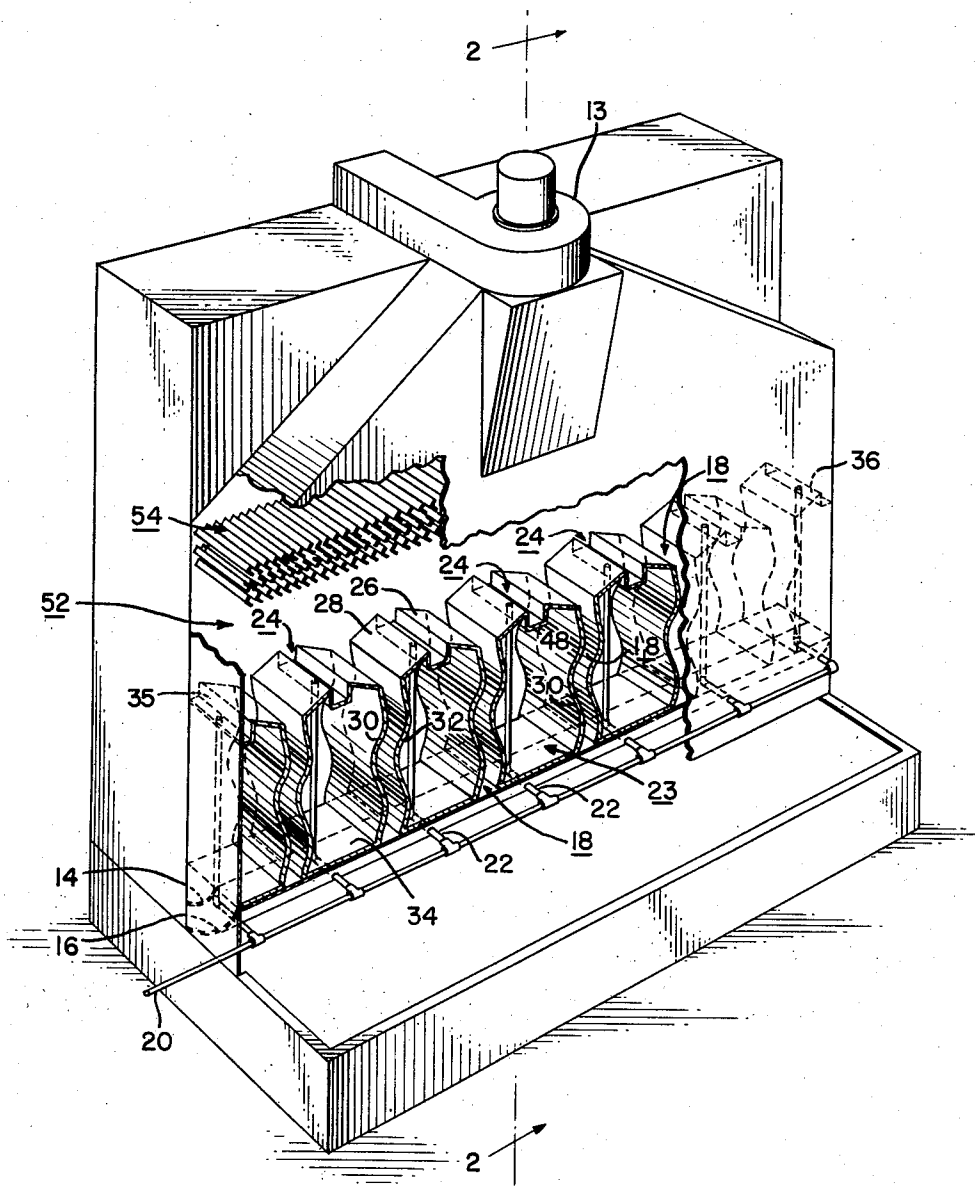


Fig. 1.

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2 Sheets-Sheet 2

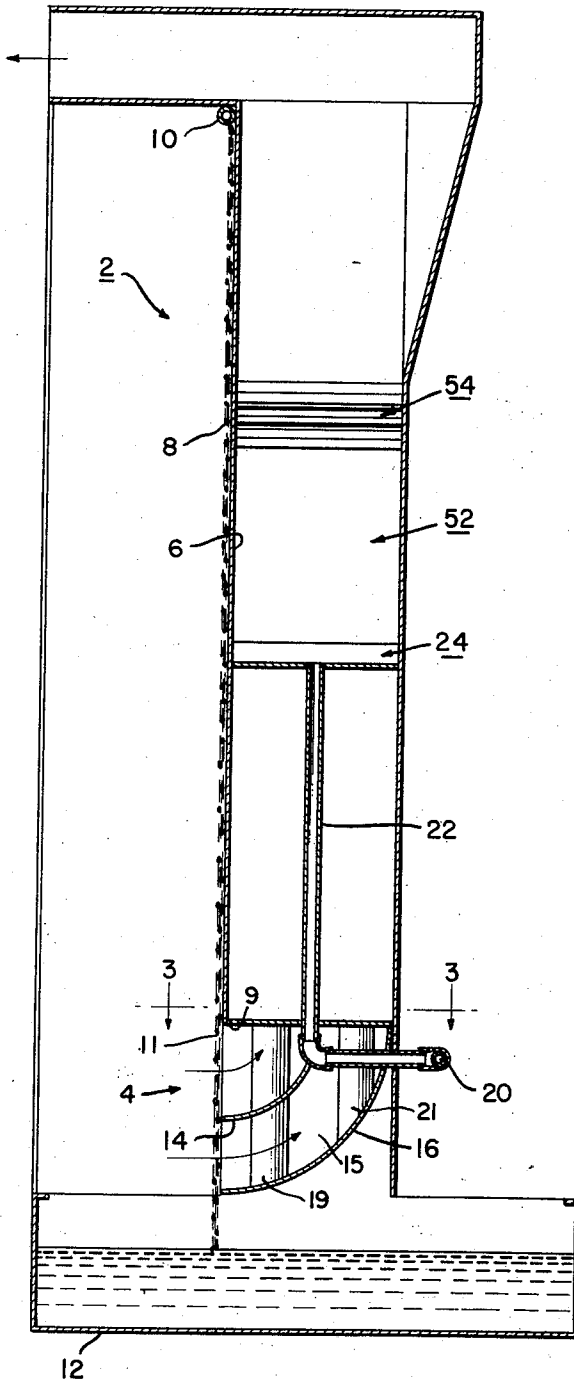


FIG. 2.

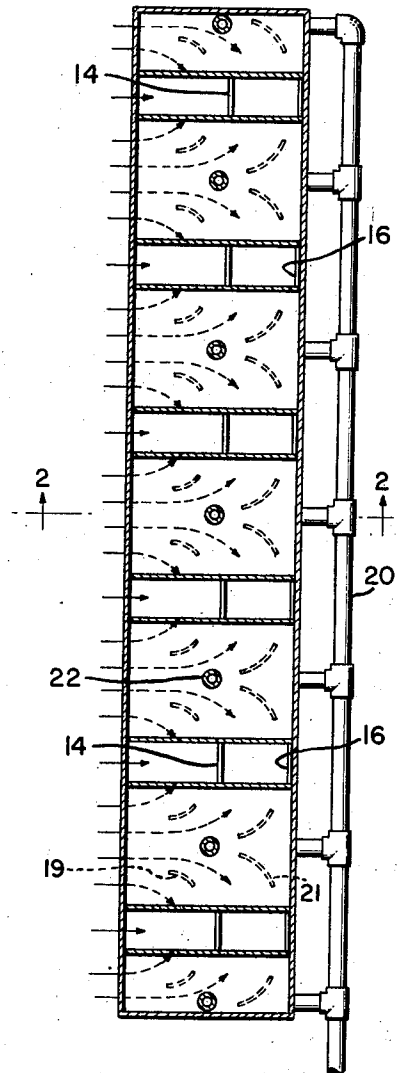


FIG. 3.

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GAS WASHING APPARATUS

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1 Claim. (Cl. 261—24)

This invention relates to gas-washing apparatus and is illustratively described as embodied in air-washing apparatus of the type used for removing particles such as dust or paint spray from the air. Such air-washing apparatus is particularly well adapted for use in connection with industrial spray painting, polishing, and sanding operations and prevents the overspray material or dust from these processes from contaminating the surrounding air and collecting upon nearby machinery. This apparatus greatly improves the extremely difficult working conditions which formerly used to accompany these processes. The present invention is in the nature of a further improvement of gas-washing apparatus now on file in U.S. applications Serial Nos. 515,997 and 458,336.

Among the many advantages of the air-washing apparatus described herein as embodying this invention are those resulting from the fact that the apparatus has a high efficiency and air-cleaning capacity. A relatively small installation handles a large quantity of contaminated air, thoroughly washing the air, removing substantially all foreign particles therefrom, and returning the air to the atmosphere in clean, relatively dry condition. It has become possible by the use of this invention markedly to reduce the size of air-washing apparatus and yet to assure the user of efficient and thorough treatment of a large quantity of contaminated air. Another advantage is the suitability of this apparatus for continuous operation in connection with mass production industries. It requires substantially no maintenance or attention even during operation over long periods of time. Moreover, the compactness of the air-washing device described herein, enables a manufacturer readily to locate the apparatus at any desired point along an assembly line.

Because of the large size of previous air-washing apparatus, certain manufacturing operations heretofore have required the use of separate rooms or the employment of an isolated corner of the factory to which the manufactured articles were carried. In many cases this caused awkward arrangements of the assembly lines. Now these operations can be carried out smoothly in the assembly line. This invention not only reduces the floor area but lowers the minimum height from that required by other devices of similar capacity. A higher efficiency of manufacture results from using this device and many heretofore unusable spaces of a factory can now be utilized to increase the plant capacity.

In our co-pending applications we have described a gas-washing apparatus having a single serpentine passage through which the contaminated gases pass and through which, at a predetermined rate, a washing liquid is directed against the passage of the gas. The undulations of the serpentine passage desirably create a turbulence at certain points in the path of the gases which mixes the washing liquid with the gas. Foreign particles entrained by the gas are picked up and conveniently carried off by the washing liquid.

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In the illustrative embodiment of this invention we use a plurality of relatively small, parallel serpentine passages arranged to deflect and swirl the air from side to side as it passes through. These passages are side by side, the air in passing through the apparatus is subdivided uniformly into separate streams flowing upwardly through these passages. Thus, each passage contributes equally to the air-washing operation.

In the accompanying drawings, we have shown a preferred embodiment of our invention and have described the same in the specification; it is to be understood that this description is not intended to be exhaustive, but on the contrary, is chosen for the purpose of illustrating the invention in order that others skilled in the art may fully understand the invention, its principles and the application thereof and that they may embody and adapt it in various forms; each as may be best suited to the requirements of its particular use, without departing from the scope of the claim.

Figure 1 shows a rear perspective view of the air-washing apparatus partially broken away to disclose the multiple serpentine air passages contained therein;

Figure 2 is a vertical sectional view of the air-washing apparatus taken generally along the line 2—2 of Figure 1 vertically through the center of the apparatus showing the path the air takes upon entering and leaving one of the several serpentine passages;

Figure 3 is a sectional view on a horizontal plane taken along the line 3—3 of Figure 2 looking down and illustrating the uniform distribution of the incoming air as it passes into the multiple serpentine air passages;

Referring first to Figures 1 and 2, the work piece to be spray painted or sanded or otherwise processed is conveyed into and out of a booth close to a front recess 2 of the air washing device. The work piece is maintained in this position during the spray painting or sanding operation. The overspray or dust from this operation is sucked by the air into the air-washing apparatus where it is efficiently trapped and removed from the air. The air intake entrance 4 of the gas-washing apparatus is located at the lower end of a flood sheet 6 and extends across the bottom of the air washer in the form of a long rectangular opening. Usually the amount of overspray or dust or other foreign material resulting from the industrial operation being carried on in the region 2 is far in excess of the quantity which can be suspended in the air. For this reason the operator and location of the work piece is so arranged that the foreign material is directed toward the flood sheet 6. To catch this foreign material and carry it down into a reservoir tank 12 at the bottom from which it is conveniently removed, a liquid screen 8 continually flows down over this flood sheet. This liquid screen advantageously prevents the flood sheet 6 from becoming coated with paint and dust. Liquid is pumped into a spray pipe 10, which extends across the full width of the top of the flood sheet. Along the bottom of this spray pipe are spaced a number of nozzles which direct a spray of liquid downwardly and inwardly against the flood sheet, as seen in Figure 2. When the descending liquid screen 8 reaches the bottom edge 9 of the flood sheet it cascades across the air intake forming a liquid curtain 11 and then falls into the reservoir tank 12.

The washing liquid used is usually water carrying in solution suitable surface-active agents, detergents, anti-foamants, and rust-inhibiting agents. And where paint overspray is being handled, suitable paint "killing" agents are added, for example, such as those disclosed in the co-pending U.S. applications of Orlan M. Arnold, Serial No. 316,049, filed October 21, 1952, and issued as Patent No. 2,739,906, dated March 27, 1956, and Serial No. 479,032, filed December 31, 1954, in the names

of Arnold and Harbin. The foreign material is then removed from the liquid in the reservoir by suitable filtering and the liquid is recirculated through the apparatus. This filtering may advantageously be carried on by apparatus such as that disclosed by Emil Umbricht, Dewey Evans, and Gerrit Steenhagen in co-pending application Serial No. 483,026, filed January 20, 1955, now Patent No. 2,833,417, dated May 6, 1958. This recirculation is carried on by a suitable pump (not shown) having its intake in the reservoir 12, for example, this pump may advantageously be as disclosed by Emil Umbricht in application Serial No. 357,450, filed May 26, 1953, with its discharge connected to the pipe 10 and also to a pipe 20, for reasons explained later.

The contaminated air in the front region 2 is drawn downward through the entrance 4 and is then sucked up into a number of serpentine passages 18 by operation of a fan 13. The air in passing through the entrance 4 is given a further cleaning by passing through the liquid curtain 11 descending from the flood sheet across the entrance 4.

Behind the entrance 4 is an intake chamber 15 defined by an upwardly curved wall 16 and including an upwardly curved baffle 14 which smooths the air flow as it is deflected upwardly into the serpentine passages. At the same time as the incoming air is being deflected upwardly, it is divided by diverging baffles 19 and 21 (please see also Figure 3). The air thus separates uniformly and passes up into the serpentine passages 18.

In Figure 1, the rear of the air washing apparatus is shown broken away to reveal the arrangement of these multiple serpentine passages. These passages are defined by a number of box-like members 23, each having a flat bottom panel 34. These panels close over the top of the intake chamber 15 except for the rectangular openings between them, seen most clearly in Figure 3, which serve as the mouths of the serpentine passages 18. The tops of these box-like members 23 are defined by troughs 24 and downwardly sloping water sheds 26 and 28, whose purpose is explained later. Pairs of generally upright smoothly undulating walls 30 and 32 form the sides of the box-like members and define the surfaces of the serpentine passages. These walls 30 and 32 may be uniformly spaced apart with the convex portions of one wall directly opposite the concave portions of the adjacent wall or the walls may be increased in distance apart from bottom to top. Thus, the cross sectional area of the serpentine passages 18 is constant throughout, or, in certain instances where these walls 30 and 32 diverge somewhat in an upward direction, this cross sectional area increases gradually in progressing from bottom to top of the individual passages 18.

The multiple serpentine passages 18 formed between these box-like members are generally parallel and identical. The contaminated air is directed smoothly upward into them by the curved surfaces of the baffles 14, 19 and 21. As soon as the air has entered a passageway 18 and begins its upward ascent, it is swirled back and forth into intimate contact with further washing liquid. This liquid is carried up from the pump through a manifold pipe 20 and into individual supply pipes 22. These pipes 22 feed the liquid at a predetermined rate into each of the horizontal supply troughs 24. The liquid overflows from the trough 24 and maintains a continuously moving film of water on the inclined shed surfaces 26 and 28. From these inclined surfaces 26 and 28 the water flows down along the surfaces 30 and 32 of the serpentine passages 18. These inclined surfaces are connected to the tops of the two side walls of the adjacent serpentine passages as shown in Figure 1. Thus, with the exception of the two end troughs 35 and 36, each supply trough 24 advantageously furnishes liquid to the two serpentine passages; each trough being located midway between one passage and the next so

that flow of water down both sides of each passage is assured.

This downward flow of water collects the particles of foreign matter which are thrown against the walls 30 and 32 and thus further cleans the air.

The quantity of water which flows down each of the serpentine walls 30 and 32 is slightly in excess of the water which can be retained on them by surface tension. Therefore, under each convex portion 48 of these walls some of the water falls away from the wall and drops across the air passage and strikes the opposite wall. Similar release of the water occurs underneath other convex portions of the walls 30 and 32. Thus, because of the undulations along the air passage, water droplets cascade back and forth across the air path and intimately mix with the air which is in a swirling, turbulent condition at these points due to the undulations in the passages. The contaminating matter in the air is thereby thoroughly mixed with the descending water and is carried away.

After traveling through one of the several serpentine air passages and after being cleaned by the cascading washing liquid in the respective passages the cleaned air then passes up into a plenum chamber 52. This plenum chamber is located in the gas-washing apparatus immediately above the multiple serpentine air washing passages and below a group of moisture eliminators 54. This plenum chamber is relatively large in volume in relation to the total volume of the serpentine air passages, for the box-like members 23 which form the sides of the serpentine passages occupy a large portion of the space in the lower part of the apparatus. Thus, advantageously, as the air emerges from the serpentine passages and enters the plenum chamber 52 its velocity is sharply reduced because the effective volume of the plenum chamber is much greater than the volume of the serpentine passages.

This sudden reduction in velocity drops out any remaining particles carried by the air from the serpentine passages. These particles drop down and become trapped in the liquid films on the inclined sheds 26 and 28. Then the air is drawn upward and passes through the moisture eliminators 54, constructed of a series of bent metal strips and arranged to provide a zig-zag path for the air. As the air passes through these moisture eliminators, any few remaining water droplets are removed from the air as the droplets strike the metal strips in the eliminator. The clean air is then drawn on up and expelled to the atmosphere by the fan 13.

From the foregoing it will be understood that the embodiment of the present invention described above is well suited to provide the many advantages set forth, and since different embodiments may be made of this invention and as the apparatus herein described may be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings to be interpreted as illustrative and not in a limiting sense and that in certain instances, some of the features of the invention may be used without a corresponding use of other features, or without departing from the scope of the invention.

We claim:

Apparatus for handling air having contaminating material entrained therein comprising a substantially vertical wall defining a flood sheet having a substantially horizontal lower limit and means defining an elongated horizontal air entrance opening beneath the lower limit of said flood sheet, first liquid supply means supplying liquid to the upper portion of said flood sheet and forming a liquid curtain flowing down over said flood sheet and across said air entrance opening, a plurality of continuously smoothly curved walls arranged in spaced generally upright positions and extending back behind said

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flood sheet, said walls having vertically spaced concave and convex areas, pairs of adjacent walls defining a plurality of serpentine passages passing upwardly therebetween, the lower limits of said serpentine passages beginning behind said elongated horizontal air entrance opening at spaced points therealong, said serpentine passages having progressively increasing cross sectional areas from bottom to top, second liquid supply means feeding liquid at a controlled rate to the upper portions of all of said serpentine passages, a plurality of vertically spaced horizontally extending air deflectors behind said air entrance opening and curving inwardly and upwardly, the lower limits of said serpentine passages beginning above the inner upper limits of said air deflectors, a plurality of horizontally spaced vertically extending air deflectors, adjacent pairs of said latter deflectors converging toward the respective lower limits

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of said serpentine passages, and blower means forcing the contaminated air in through said air entrance opening and upwardly through said serpentine passages.

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