April 4, 1967 H. E. WEISENBORN 3,312,347

APPARATUS FOR REDUCING PARTICLE CONCENTRATION IN VOLUME OF LIQUID CONTAINING SAME

Filed June 2, 1965 2 Sheets-Sheet 1

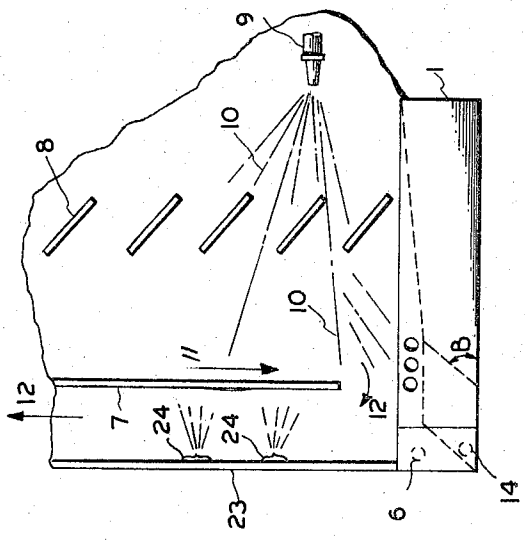


FIG. 2

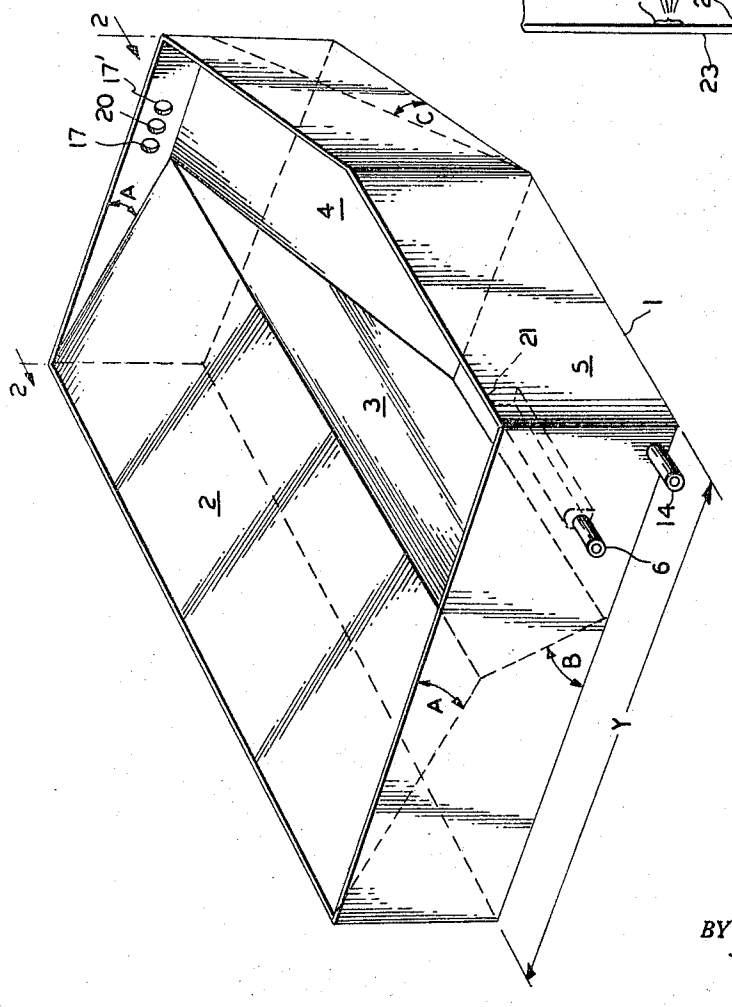


FIG. 1

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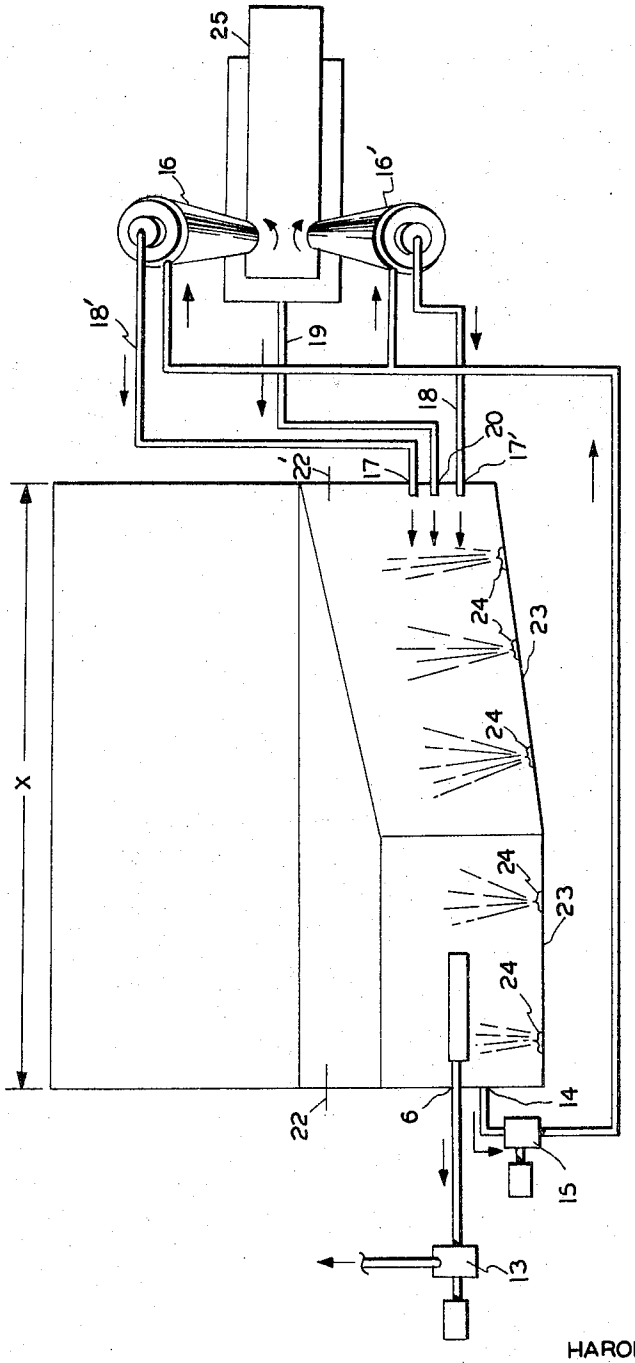


FIG. 3

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APPARATUS FOR REDUCING PARTICLE CONCENTRATION IN VOLUME OF LIQUID CONTAINING SAME

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4 Claims. (Cl. 210—195)

This invention deals generally with an apparatus for reducing the concentration of particulate matter in a volume of liquid containing same, and more particularly with an apparatus and method for substantially continuously preventing excess build-up of particulate material in a water-washed, spray booth system.

In the art of liquid spraying coatings suspended in an aqueous medium, particularly ceramic glazes and porcelain enamels, continuous and periodic water-washed spray booths have been and are widely used.

Typically, a water-washed spray booth comprises a box-like enclosure with an opening in one side thereof for an operator to manipulate a pneumatic spray gun, the opposing wall of the spray booth consisting of a series of louvers or baffles of varying design, behind which a continuous cascade of some liquid, usually water, continually flows downwardly.

Conventional exhaust means is normally used to apply a negative pressure between the baffles and the cascade.

In operation of conventional water-washed spray booths then, the article to be sprayed is either placed in the booth on a periodic basis, or passed therethrough continuously on suitable conveyor means, and an operator sprays each article with a pneumatic spray gun connected to a supply of aqueous suspended ceramic or enamel glaze, and a source of air pressure. The overspray from the spray gun is carried past the article to be coated, through the louvers at the rear of the spray booth, at which point a certain amount of airborne particulate matter will be drawn upwardly and discharged by the exhaust means, with the bulk of the overspray impinging into and being picked up by, the water cascade at the rear of the spray booth and washed downwardly thereby into a receptacle for catching same. Previously, receptacles have been in the form of simple, flat bottomed, rectangular tanks.

The primary purpose of the negative pressure behind the baffles is to insure the even flow of overspray past the article to be sprayed, to thereby minimize turbulence whereby overspray would create an undesirable cloud or haze of material within the spray booth, obscuring the vision of the operator and causing overspray to drift back toward the operator.

Conventional water-washed spray booths have operated very well in the past, but their one drawback has been the fact that no practical method of continually removing the concentration of particulate material which accumulates has been devised.

That is, in the conventional system hereinabove described, the cascade of water continuously flowing past the baffles at the rear of the spray booth picks up overspray and washes it down into a tank-like receptacle. A recirculating pump appropriately situated picks up a certain amount of the water which comes into the receptacle from the cascade at a point of least concentration of particulate material, and recirculates same upwardly and back over the cascade wall.

However, as the concentration of particulate matter in the form of very finely ground enamel or glaze frit, continues to build up within the simple square bottomed receptacle, there comes a time when the volume of the water in said receptacle is so small, due to the tremendous build-up of particulate material in the bottom thereof in

the form of a mud, or sludge, that it is no longer possible to draw off any water for recirculation which does not contain an objectionably high concentration of particulate material.

Utilizing past devices, when this point was reached, it was necessary to shut down the spray booth completely while a crew proceeded to move into the tank and shovel the accumulated sludge out of the receptacle into suitable containers for removal from the vicinity.

Although various means have been attempted to continuously remove liquid from the receptacle and filter same, these have only been partially successful inasmuch as no suitable means have ever been devised for preventing rapid concentration and build-up of particulate material in certain "dead areas" of the system.

It is therefore an object of this invention to provide a new and improved apparatus for substantially continuously reducing the concentration of particulate material in a volume of liquid containing the same.

It is a further object of this invention to provide a water-washed spray booth system which can be operated substantially continuously without the need for shutting same down for the purpose of removing particulate material from the water-wash receptacle.

It is a further object of this invention to provide a novel water-washed spray booth recirculating receptacle having a contoured bottom of such configuration that "dead areas" of particulate material accumulation therein are reduced to thereby minimize particulate material build-up in the same during operation.

It is a further object of this invention to provide a water-washed spray booth system receptacle having a contoured bottom of such configuration that said bottom, in combination with recirculating means, and means for continuously removing, filtering and returning a volume of liquid to the system, which system minimizes "dead areas" in the receptacle to thereby greatly reduce particulate material build-up within the system.

Other related objects embodied herein will become apparent as the disclosure proceeds.

Briefly stated, the preferred embodiment of my invention comprises a receptacle for a water-washed spray booth system having side walls and a bottom, the latter comprising a contoured surface having at least four generally planular surfaces, three of which reside at angles substantially greater than 0°, but substantially less than 90°, with the horizontal, each of said three surfaces intersecting the plane of at least one another of said three surfaces, the fourth surface residing at 2° or less with the horizontal and constituting an area no greater than described by a rectangle having one side thereof longer than half the length of said receptacle, and the other side no longer than a third the width thereof, as "length" and "width" are hereinafter defined, means for continuosly bleeding off a fractional quantity of said liquid plus particulate material contained therein from said receptacle, and delivering same to a separator to substantially separate said particulate material from said bled-off quantity of liquid plus particulate material, and returning said bled-off liquid, substantially free of particulate material, to said receptacle so as to reduce the concentration of particulate material in the volume of liquid contained therein.

In the attached drawing,

FIG. 1 is a perspective view of the novel receptacle of this invention.

FIG. 2 is a view of the system seen from the end of the receptacles designated 2—2 in FIG. 1.

FIG. 3 is a semi-schematic plan view of the system showing the recirculating and filtering systems in combination with the novel receptacle of this invention.

Referring now more specifically to the drawings, in FIG. 1 the novel receptacle of this invention is indicated generally by 1, with Y denoting its width. The contoured bottom thereof consists of the planes, respectively, 2, 3, 4 and 5. Plane 2 resides at the angle indicated by A at from about 3° to about 22° with the horizontal; plane 3 resides at an angle B of from about 35° to about 55° with the horizontal; plane 4 reposes at an angle C of from about 13° to about 23° with the horizontal, and plane 5 at an angle less than 2° with the horizontal.

Referring now to FIG. 2, which is an end view FIG. 1 taken along the plane 2—2 of FIG. 1, there has been disposed over the receptacle 1 a vertical water cascade wall 7 and a series of baffles 8.

In operation, a pneumatic spray gun 9 sprays into the booth enclosure as shown in FIG. 2, the spray dispersion indicated generally by 10 striking the cascade wall 7 along the face of which water is cascading downwardly as indicated by the arrow 11. Conventional exhaust blower means exerts a negative pressure upwardly as evidenced by arrows 12 between cascade wall 7 and the rear spray booth wall 23 which negative pressure urges overspray downwardly toward receptacle 1, beneath cascade wall 7 and upwardly between cascade wall 7 and wall 23. Any particulate material not flushed down into receptacle 1 by cascade 11, is caught in the water spray from nozzles 24 disposed in wall 23, supplied by any conventional means not shown, the spray from nozzles 24 washing the bulk of particulate matter down into receptacle 1.

Referring now to the plan view of the system depicted in FIG. 3, X denotes the length of receptacle 1, which is always maintained filled to a point above outlet 6 by any suitable source of fresh water relying on a conventional, constant-level float system, not shown. Liquid is continually drawn off from outlet 6 by pump 13 which delivers its volume of liquid by any conventional means not shown to a manifold system at the top of cascade wall 7, from there to flow thereover downwardly into the receptacle as shown in FIG. 2. Outlet 6 is alway situated at some point at least higher than half the height of receptacle 1.

Outlet 14, situated in close proximity to the lowest point in receptacle 1 continually draws off a volume of liquid from the receptacle via pump 15 which directs same to a system for continually separating particulate material therefrom and returning said volume of particulate-free fluid to the receptacle. Depending upon the requirements of a given system, outlet 14 could be situated in plane 5, which may repose horizontally, or at an angle up to 2° with the horizontal.

The material drawn off by pump 15 is sent to two centrifugal separators 16 and 16' of the hydrocyclone type, which remove the bulk of particulate material from the volume delivered to them, discharging a greatly reduced volume of liquid containing a high concentration of particular material onto a continuous filter 25, said centrifugal separators 16 and 16' returning their respective volumes of particulate-free liquid to receptacle 1 at points 17 and 17' via lines 18 and 18' respectively. The filtrate from continuous filter 25, situated higher than receptacle 1, flows by gravity back to receptacle 1 via line 19, the filtrate entering the receptacle at point 20.

Outlet 6 from whence is drawn liquids for recirculating past the working face of the cascade wall utilize a hood 21, open only at the bottom, to permit particulate material to fall past the outlet 6, rather than be drawn up into it, the liquid entering the hood for outlet 6 from underneath.

The points 22 and 22' in FIG. 3 indicate approximately the position of vertical cascade wall 7 which extends the full length of receptacle 1, although this position may be adjusted in either direction, toward or away from, the location of the spray operator.

As a working example then of a specific application of my novel apparatus, the receptacle of which has approximately a 24" water level depth at its deepest point, and an 800 gallon per minute capacity for recirculation via outlet 6 to the water-washed cascade wall, consider the situation wherein the particulate material will consist of very fine particles of porcelain enamel frit and clay at an operational concentration, measured at the outlet 14, of approximately 0.65 ounce of solids per gallon consisting of frit and clay particles.

From outlet 6, volume to be recirculated out of receptacle 1, and returned thereto over cascade wall 7, would be approximately 800 gallons per minute, with said recirculated volume undergoing no reduction in particulate material contained therein during recirculation.

Pump 15 draws off the material having the foregoing concentration at a rate preferably ¼ to ⅓ the volume recirculated via outlet 6, in this instance, 200 gallons per minute diverting 100 gallons per minute each to centrifugal separators 16 and 16' as depicted in FIG. 3.

In operation, the centrifugal separators would each return 96 gallons per minute to receptacle 1 via points 17 and 17' the return containing a concentration of substantially zero particulate matter, separator 16 and 16' at the same time discharging 4 gallons per minute each on automatic continuous filter 25, a liquid having a concentration of 6.56 ounces solids per gallon. The filtrate from continuous filter 25 would then be returned at approximately a rate of 8 gallons per minute at point 20, the filtrate containing substantially zero solids. The continuous filter discharging substantially dry particulate matter into a suitable receptacle for removal.

By experience, it has been found that plane surfaces 2, 3 and 4 disposed respectively within the range of angles A, B and C as described above, are highly conducive to uniformly working particulate material continuously toward outlet 14 to thereby permit effective and continuous removal thereof with a minimum of accumulation in "dead areas" to thereby obviate the need for periodic shutdown and removal of sludge build-up.

The effectiveness of the instant design depends in great measure on the disposition of inlets 17, 17' and 20 in the face opposite that wherein is situated outlets 6 and 14. And, although inlets 17, 17' and 20 are shown as being disposed generally coincidently with planular surface 4, this invention contemplates that the inlet points may be adjusted along the face indicated, possibly in conjunction with the replacement source of fresh water, to play across wider areas of faces 2, 3 and 4 to encourage washdown of particulate matter toward outlet 14.

Depending upon the prevailing conditions of particulate matter concentration, the number of spray guns utilized in a given booth, its length, width, etc., the centrifugal separators may be increased in number as may the continuous filters so as to effectively remove the desired quantity of particulate matter per unit time.

In order to take full advantage of the novel combination of slopes of the contoured bottom of the spray booth receptacle of the instant invention, it has been found that the total quality which is recirculated to the cascade via outlet 6, from approximately ¼ to ⅓ of that quantity must be bled off at a point of maximum particulate material concentration, taken to substantially zero concentration of particulate material and return to the receptacle in a face opposite that from whence it was taken.

Although the outline of my receptacle is generally rectangular, this may be varied so long as the contoured bottom as described above is retained, with outlets and return inlets in opposite walls.

If the slopes of the contoured bottom of this invention are too shallow, dead areas result, permitting undesirable sludge build-up, which in turn gradually decreases the slope still more, ultimately resulting in a condition requiring shut-down and cleaning. If the slopes are too steep, there is too much generally flat area, and build-up from dead areas again results. Too, if slopes are too steep, or

of a number different from those required by this invention, excessive turbulence occurs, particularly in the vicinity of outlet 6, preventing the free passage and settling of particulate material past outlet 6, to outlet 14 for filtering.

I claim:

1. In an apparatus for continuously reducing the concentration of particulate material in a continuously circulating main volume of liquid containing same, said apparatus comprising means for continuously bleeding off a fractional quantity of said main volume plus particulate material contained therein and delivering same to filtering means to substantially remove said particulate material from said bled off quantity of liquid plus particulate material, and return said bled off liquid, substantially free of particulate material to said apparatus, the improvement in said apparatus comprising a unitary concentration and separation receptacle for receiving and discharging said continuously circulating liquid, said receptacle having at least four substantially vertical side walls and a bottom bounded by said side walls, said bottom comprising a contoured monolithic surface having four generally planular surfaces, three of which reside respectively at angles of 3 to 22°, 35 to 55°, and 13 to 23° with the horizontal, at least two of said three surfaces residing at different angles from each other, each of said three surfaces intersecting the plane of at least one other of said three surfaces, the fourth surface reposing at an angle from 0° to 2° with the horizontal, first outlet means for bleeding continuously via one of said side walls bounding said fourth surface, a fractional quantity of said main volume plus concentrated particulate material from a point in close proximity to said fourth surface and delivering same to aforesaid filtering means, second outlet means, situated in a side wall bounding said fourth surface at a point above said previously mentioned first outlet means, for continuously drawing off a volume of liquid substantially free of said particulate material from said receptacle, inlet means situated in a wall opposite the side wall in which said second outlet means is situated to return to said receptacle the liquid portion of the material drawn from

said receptacle via said first outlet means following removal therefrom of said particulate material by said filtering means, to provide an improved, unitary, simplified apparatus having a concentration and separation receptacle for continuously reducing the concentration of particulate material in a main volume of continuously circulating liquid containing same.

2. The apparatus of claim 1 wherein a multiplicity of liquid jets are disposed along the interior of one of said side walls adjacent said second outlet means, said jets positioned to project into said receptacle in a direction generally normal to the direction of flow from said second outlet means.

3. The apparatus of claim 2 wherein there is positioned immediately above said receptacle, and contiguous with said side wall containing said jets, a substantially vertical back wall of a porcelain enamel spray booth, a substantially vertical spray baffle positioned inwardly of said back wall, the bottom of said baffle being in non-contacting relationship with said receptacle, and means for continuously cascading down the face of said baffle opposite said back wall, the volume of liquid continuously drawn off by said second outlet means.

4. The apparatus of claim 3 wherein blower means is positioned to provide an upward current of air between said back wall and said baffle.

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