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SLURRY MIXING METHOD AND APPARATUS

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2 Sheets-Sheet 2

Fig. 2.

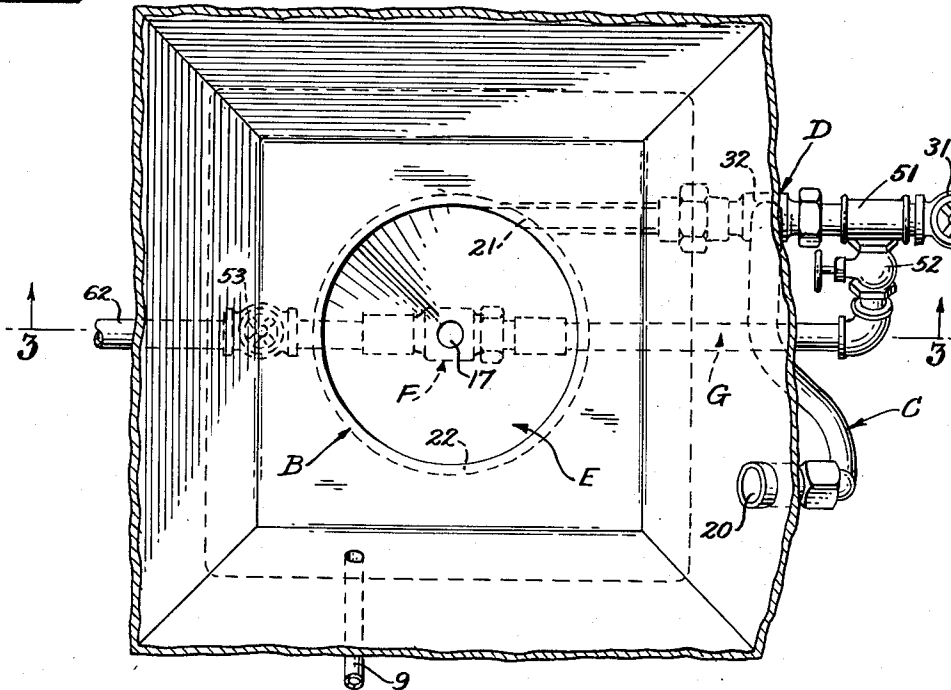
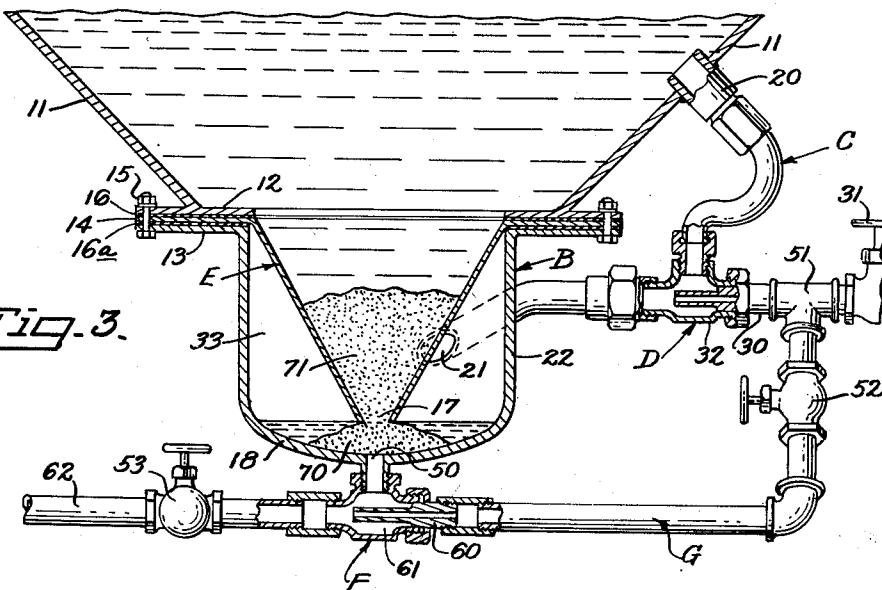


Fig. 3.



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SLURRY MIXING METHOD AND APPARATUS

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This invention relates to creating and maintaining liquid suspensions of finely divided solid particles and, more particularly, to a method and apparatus for creating and maintaining liquid slurries useful in wet-blast surface treating and liquid honing of machine parts and the like.

In the wet-blast treating or honing of machine parts, a liquid slurry of finely divided or powdery abrasive grit is impinged at high speed against the surface to be treated. The gentle surface abrading action resulting from such processes may be used in a multitude of industrial operations. Typical applications are: removal of burrs or directional grinding lines from machine parts; preparation of various industrial implements for metal plating; applying mat finishes to preselected areas of machinery; and removing heat treat scale from precision parts to insure dimensional accuracy. While hundreds of other applications will suggest themselves to those skilled in the art, each has in common the requirement of a reservoir of treating liquid in which the finely divided grit is uniformly dispersed. Another common requisite is that the fine abrasive grit be uniformly dispersed in the treating liquid throughout the surface treatment; otherwise the abrading action will be irregular or uneven or be difficult to control.

In conventional apparatus for the purpose, finely divided abrasive is mixed into the liquid either by mechanical agitation or by circulation of both the liquid and the abrasive through simple liquid pumps, such as force pumps or centrifugal pumps employing rotating impellers or radial blades. However, procedures involving mechanical agitation or circulation are subject to many serious drawbacks. For example, mechanical agitation is neither efficient in mixing gross amounts of abrasive and liquid into liquid suspension nor in maintaining a uniform dispersion of the abrasive, particularly where very fine, powdery abrasive is used. Also agglomerations of finely divided grit may settle or collect and resist mixing into the slurry. When circulating pumps are used, the same problems are encountered, and a common defeat is the clogging of pumps, valves, or treating heads with collections or aggregates or fine powdery grit. As a result, uneven or skipped areas are apt to occur on the work surface. In addition, the passage of abrasive between relatively moving pump parts causes wear which, if prolonged, may result in excessive leakage or slip between the parts and from the high pressure sides of pistons, impellers, and vanes.

An important object of the present invention is to provide an improved device for creating and maintaining liquid suspensions of finely divided, powdery, abrasive particles which employs no moving parts.

Another object of the invention is to provide a device for mixing and maintaining liquid slurries of finely divided abrasive materials which is highly resistant to abrasive wear.

Another object is to provide a device for creating, maintaining, and storing abrasive slurries which may be readily

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drained to permit a change in the particle size of the abrasive material.

Another object of the invention is to provide a process for rapidly creating liquid slurries of finely divided abrasive materials which makes use of the different velocities of liquid and air under the same impelling air pressure to effect complete agitation at a contacting interface of liquid and abrasive.

Another object is to provide a method of creating and maintaining liquid slurries, without the use of relatively moving machine parts, by which slurry liquid may be rapidly mixed into finely divided powdery abrasive material, a little at a time, and the resulting mixture circulated into the slurry liquid until all the powdery abrasive is uniformly dispersed in the liquid.

Other objects and advantages of the present invention will be apparent from the following description and from the drawings in which:

Fig. 1 is a view in front elevation of a device for creating and maintaining liquid suspensions of finely divided abrasive materials embodying my invention.

Fig. 2 is a view in horizontal section along the line 2—2 of Fig. 1, and

Fig. 3 is a view in vertical section along the line 3—3 of Fig. 2, with certain parts shown in elevation and others in section for the sake of clarity.

Broadly considered, my invention is directed to a method and apparatus for rapidly dispersing and maintaining in liquid suspension fine, powdery abrasive or treating materials. Such materials are often quite finely ground, particularly in the liquid honing or polishing of machine parts. In some cases the abrasive may be sufficiently fine to pass a 5,000 mesh screen and have a texture resembling that of a fine face powder. In contrast to the usual tedious practice of mixing gross amounts of slurry, I have found that upon contacting small amounts of these fine, powdery materials with a small but rapidly whirling mixture of liquid and air, a thick slurry will form which may be readily dispersed in a larger amount of liquid to form liquid suspensions of remarkable smoothness. In particular, I have found that powdery abrasive may be thoroughly dispersed in a whirling mixture of air and water much more efficiently and in much less time than in previous devices employing mere mechanical agitation or circulation of the water alone. I have also found that the different velocities of the air and water under the same impelling pressure may be used to effect a much more thorough agitation of the abrasive with the water. An additional effect of the whirling air and water mixture is to enable preformed or packed aggregates of the fine abrasive to be rapidly broken up and dispersed into the slurry.

In carrying out my invention, I have devised what now appears a device of unusually simple construction, which employs no moving parts, and which consequently, is highly resistant to abrasive action. Broadly, my new apparatus includes a tank A which has a mixing chamber B and an external circulating conduit C. The conduit C is provided with an air jet pump D which, upon actuation by a source of compressed air, operates to impel both air and water tangentially into a rapidly whirling mixture in chamber B. Within the chamber exposed portions of fine abrasive that have settled to the bottom of tank A and spread below baffle E mix with this whirling mass, a little at a time, to form a thick slurry. Air separated from the whirling mixture then acts to drive the thick slurry up through an orifice in baffle E and back into tank A. Continued circulation of both water and slurry through air jet pump D soon mixes all the fine abrasive into a smoothly dispersed suspension, which is maintained in its suspended state by circulation. Since the entire

mixing operation is performed without the aid of moving parts or the necessity of maintaining close tolerances, the dangers of excessive or detrimental wear due to abrasive particles in a circulatory system are practically eliminated.

Referring to the drawings in detail, Fig. 1 shows treating chamber A supported in a convenient manner on legs 4. In the illustrated apparatus the tank A is provided with hand holes 5 and a viewing window 6 for the operator. A wire screen 7 is positioned just below the hand holes to support the work piece being treated. An abrasive blasting head 8, of any conventional design, is mounted within the tank and is supplied with abrasive slurry from the bottom of tank A by suction conduit 9. As will be clearly understood by one skilled in the art, both the treating head and suction pumping mechanism may be conveniently operated by compressed air admitted through air supply line 10.

The bottom of the treating tank is in the shape of an inverted truncated pyramid having walls 11, although any other tapering construction, such as conical, might be successfully employed. Secured to bottom portions of walls 11 is an apertured plate 12. A cylindrical mixing chamber B is suspended from tank A by a second apertured plate 13 which may be conveniently secured to plate 12 by bolts 15. A baffle E is supported between the plates 12 and 13 by a flanged portion 14 so as to depend into chamber B. Any convenient means, such as gaskets 16 and 16a, may be used to maintain a leaktight connection between the plates 12 and 13 and baffle E. In its preferred form, baffle E is a truncated, inverted cone with its small opening 17 spaced a short distance above a dished bottom 18 of chamber B.

Externally connecting tank A and chamber B is conduit C. An upper or suction end 20 of conduit C is rigidly secured in one wall 11 of tank A. The lower end of conduit C provides an inlet 21 into chamber B. In a preferred embodiment inlet 21 is directed tangentially downward with respect to an outer shell 22 of chamber B so that liquid passing through inlet 21 will be spun around the inside of chamber B on its downward path into the chamber.

Intermediate its ends, conduit C is provided with an air jet pump D, which may be of any conventional type. In a preferred embodiment, the pump is actuated by a source of compressed air (not shown), in communication with jet pipe 30. A valve 31 controls the admission of air to pump D. On opening valve 31, compressed air flowing through jet pipe 30 creates a vacuum within the pump casing 32 causing water in tank A to flow from outlet 20 into the pump. There, the water is mixed with the entering air stream and is impelled at a rapid rate through inlet portion 21 of conduit C into a rapid whirling mixture of air and water within chamber B. The heavier water thrown outwardly against casing 22 displaces most of the air inwardly into a space 33 between baffle E and casing wall 22. Continued spiraling movement of the water mixed with some air brings it into contact with abrasive 70 which has collected within the baffle E and spread outwardly from baffle opening 17 over chamber bottom 18.

The whirling contact of water and air with peripheral portions of the abrasive immediately causes a thorough intermixing at the interface, forming a thick, wet slurry. The thoroughness of the mixing is aided materially by a variation in speed between the air and water spiraling into chamber B from jet pump D. It has been determined that, under the same pressure, air will travel six times as fast as water. In chamber B, this difference in the velocity of the entering air and water produce a turbulence or vigorous agitation of the exposed abrasive with the water, causing the abrasive to quickly disperse in the water swirling about the bottom of cone E.

In the meantime air pressure building up in air space 33 by continued movement of air and liquid into chamber B causes the slurry mixture formed to be pushed upward-

ly through the abrasive within baffle E. As the whirling movement of the abrasive and water continues, more and more of the abrasive is mixed into the thick slurry until finally all of the abrasive below opening 17 and most of the abrasive within baffle E are involved in the rapidly whirling motion. As more and more of the slurry formed is pushed upwardly by air pressure into the cone, portions of the slurry eventually find their way through tank A and back to outlet 20 of conduit C. Soon a homogeneous mixture of slurry is formed within chamber B and extending upwardly into tank A. It is now but a matter of a few seconds before the thoroughly dispersed slurry is mixed with the remaining water, up to the surface level at 75, by continuing circulation through conduit C, chamber B, and tank A. In this way, water in tank A may be quickly and efficiently mixed with masses of fine powdery abrasive which have settled or collected at the bottom of the tank and in baffle E, with the abrasive being thoroughly dispersed in the water within minutes after opening valve 31.

Generally the abrasive or treating material is supplied to tank A through a door 40 in a side or top portion of the tank. In carrying out liquid honing or polishing operations it is often necessary to vary the particle size of the abrasive material. Accordingly, a second air jet pump F may be provided to remove the abrasive mixture from the tank. In the illustrated apparatus, this second pump is connected to a bottom outlet 50 in chamber B. A second external conduit G connects pump F to the source of compressed air through valve 31 and T fitting 51. Preferably, auxiliary valves 52 and 53 are also provided to facilitate the draining operation. To drain tank A, a liquid suspension of water and abrasive is created, as before, by opening valve 31. Upon opening valve 53, and then valve 52, air is admitted to jet pipe 60 creating a vacuum in chamber 61 of air jet pump F. Water and abrasive immediately flow from chamber B through opening 50, into the chamber 61, and out through drain pipe 62 until the tank is empty. If desired, the tank A may also be hosed out through opening 50 to assure that all of the abrasive particles are removed. The valves 53 and 52 may then be closed and tank A filled with water and abrasive of different particle size.

In wet-blast treating a surface the over-all operation of the device is as follows:

At the end of a treating operation, valve 31 is closed, shutting off the supply of air to air jet pump D. During the period of shut-down, abrasive in tank A settles naturally to the bottom of the tank and slides down walls 11 into baffle E. At the bottom of baffle E, abrasive spills out into chamber B and spreads over the bottom wall 18 until the build-up of abrasive about the lower end of the baffle establishes static conditions, somewhat as shown in Fig. 3. In this settled or equilibrium state, the abrasive particles tend to pack or aggregate into a homogeneous mass in a manner typical of very finely divided powdery material. To start blasting operations, valve 31 is opened full causing a rush of air through jet pipe 30 and into chamber B, preceding the movement of water through conduit C. This initial blast of air tends to break up the caked abrasive in the area 70. When sufficient water has been sucked from tank A into pump chamber 32, intermixed water and air are impelled through opening 21 and into chamber B. After the initial air blast the valve 31 may be closed down somewhat to obtain a more uniform flow of water through conduit C. As the water and air enter chamber B, centrifugal force acting on the heavier water displaces most of the air inwardly so that it collects in area 33. As previously explained, the downwardly swirling movement of the water plus some entrained air causes peripheral portions of the abrasive in area 70 to be vigorously agitated with the encircling water and air and to mix with the water into a thick slurry, in a progressive inward mixing movement, until most of the abrasive in both areas 70 and 71 is mixed into

a rapidly whirling thick slurry. In the meantime, air pressure building up in area 33 drives this thick slurry up through the baffle E and into tank A where it becomes intermixed with water. Continued circulation of water through conduit C, chamber B and tank A soon causes an intimacy of mix sufficient to create a smooth, finished slurry product. It is important that the entire operation can be performed in a relatively short time, usually a very few minutes after opening valve 31. After this thorough mixing the slurry in tank A is ready for whatever wet-blast surface treatment is to be performed, and may be withdrawn through conduit 9 by the suction pumping mechanism for blasting through a treating head 8.

As will be apparent from the operation just described, the method and apparatus of the present invention makes possible a gradual mixing of a small amount of liquid with peripheral, exposed surfaces of packed or caked abrasive until all of the abrasive is thoroughly mixed into a thoroughly mixed liquid suspension. The invention also makes possible the ready mixing of powdery abrasive materials into fine slurries in a manner that prevents the particles from aggregating within the slurry mixture. As a result, skipped areas, indicating interruptions in the treating or abrading action are virtually eliminated. In addition, the air jet principle of circulation not only provides the apparatus with a means to break up pre-formed aggregates but also prevents destructive or excessive wear of the apparatus due to a continuous circulation of abrasive particles. Similarly, it is possible to provide a mixing chamber of rugged, simple construction, involving no moving parts, that possesses a durability not known with prior art devices.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. For example, the placement of baffle E with respect to the bottom 18 of chamber B will tend to regulate the amount of abrasive mixed at one time at the periphery of the whirling action. Thus, a greater spacing between baffle E and bottom wall 18 will cause larger quantities of abrasive and liquid to come into initial contact. It is also contemplated that baffle E might be mounted for vertical adjustment to accommodate wide variations in mixing requirements. Accordingly, the disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. In a wet-blast surface treating apparatus of a type adapted for liquid honing of machine parts and the like, stationary means for creating and maintaining a suspension of finely divided abrasive particles in the liquid comprising: a tank; a bottom chamber protruding from said tank; an external conduit leading from said tank to a tangential inlet into said chamber; air jet means in said conduit in fluid communication with a source of air under pressure and constituting the sole means for impelling liquid from said conduit into said chamber; and baffle means in said chamber separating said tangential inlet from said tank and forming a division wall between said tank and said chamber, said baffle means being provided with a generally central aperture; whereby finely divided abrasive material collecting above said baffle means will be whirlingly intermixed with liquid in said tank and maintained in liquid suspension by a flow of liquid tangentially into said chamber and upwardly through said aperture.

2. The device of claim 1 in which the vertical contour of the chamber is cylindrical.

3. The device of claim 2 in which said baffle means is in the shape of an inverted truncated cone.

4. In a system adapted for liquid honing of machine parts and the like, stationary means for creating and maintaining a suspension of finely divided abrasive par-

ticles in the liquid comprising a tank, a circulating chamber positioned below said tank and having fluid access thereto, baffle means extending down into said chamber and dividing said chamber from said tank, said baffle means being provided with a small opening adjacent and above a lower portion of said chamber, an external conduit leading from an outlet in said tank to an inlet in said chamber above said baffle opening, said inlet being directed tangentially downward with respect to said chamber, an air jet means in said conduit to induce flow of intermixed liquid and air from said tank to said chamber, and a source of air under pressure connected to said jet means, whereby air pressure developed in said chamber outside said baffle means will drive a whirling mixture of liquid and abrasive up through said small baffle opening into constant admixture with the liquid in said tank.

5. In a system adapted for liquid honing of machine parts and the like, stationary means for creating and maintaining a suspension of finely divided abrasive particles in the liquid, comprising: a tank; a circulating chamber positioned below said tank and having fluid access thereto; baffle means extending into said chamber, said baffle means being provided with a small opening adjacent a lower portion of said chamber; a first, external conduit leading from an outlet in said tank to an inlet in said chamber, said inlet being directed tangentially downward with respect to said chamber; first air jet means in said conduit to induce flow of intermixed liquid and air from said tank to said chamber; a second air jet means in communication with said circulating chamber; a second conduit leading from said air inlet to said second air jet means, so that said tank and chamber may be easily emptied of liquid and abrasive by diverting air pressure to said second jet means; and a source of air under pressure connectable to both said jet means, whereby air pressure developed in said chamber outside said baffle means will drive a whirling mixture of liquid and abrasive up through said small baffle opening into constant admixture with the liquid in said tank.

6. In a wet-blast surface treating apparatus, a device for creating and maintaining a suspension of finely divided abrasive materials in the liquid without the use of moving parts, comprising a tank having a bottom opening, a circulating chamber positioned below said opening, an impervious truncated inverted cone depending into said chamber from said opening, the truncation providing an aperture therethrough at the bottom thereof, an independent external conduit leading from said tank to a tangential entry into said chamber, an inlet into said conduit for air under pressure, and air jet means in said conduit to induce flow of intermixed liquid and air from said tank to said tangential entry into said chamber, whereby finely divided abrasive collecting in said cone may be quickly and efficiently mixed and constantly suspended in the liquid in the tank by a rapid whirling of air, liquid, and abrasive circulating through said chamber.

7. In a wet-blast surface treating apparatus of a type adapted for the liquid honing of machine parts and the like, a device for mixing and suspending finely divided abrasive in the liquid comprising: a tank having an opening in its bottom, an enclosed chamber secured to said bottom about said opening, said chamber having a side inlet directed tangentially downward with respect to said chamber and a bottom outlet, a hollow truncated cone depending from said bottom into said chamber, said cone having a small opening adjacent the bottom of said chamber, a first external conduit connecting said tank to said side inlet in said chamber, a first air jet in said first conduit, a source of compressed air in communication with said first air jet, valve means controlling air flow from said source of compressed air, a second air jet connected to the bottom outlet of said chamber, a second external conduit connecting said source of compressed air to said second air jet, and valve means on

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the downstream side of said second air jet, whereby finely divided abrasive collecting in said cone may be mixed with and suspended in the liquid in the tank by opening said air control valve, and the tank drained by opening said downstream valve.

8. In a wet-blast surface treating apparatus of a type adapted for the liquid honing of machine parts and the like, a device without mechanical impellers or other moving parts for mixing and suspending finely divided abrasive in the liquid, comprising: a tank having an opening in its bottom; an enclosed chamber secured to said bottom and extending downwardly therefrom about said opening, said chamber having a side inlet directed tangentially downward with respect to said chamber; a hollow truncated cone depending from said bottom into said chamber and dividing said tank from said chamber; said cone having an opening adjacent the bottom of said chamber; an external conduit connecting said tank to said side inlet; and air jet means in said conduit for impelling liquid therethrough.

9. In a wet-blast surface treating apparatus of a type adapted for the liquid honing of machine parts and the like, a device for mixing and suspending finely divided

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abrasive in the liquid, comprising: a tank having a downwardly tapering bottom wall with a generally central opening therethrough at its lower end; a generally cylindrical enclosed chamber encompassing and secured to said bottom wall and extending above and below said opening, said chamber having a side inlet above said opening directed tangentially downward with respect to said chamber; an external conduit connecting an upper portion of said tank to said side inlet in said chamber; air jet means in said conduit; and a source of compressed air in communication with said air jet means, whereby finely divided abrasive collecting in and below said bottom wall may be mixed with and suspended in the liquid in the tank.

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