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METHOD FOR POWER WASHING, SURFACE REFORMING AND THE LIKE

Filed June 7, 1961

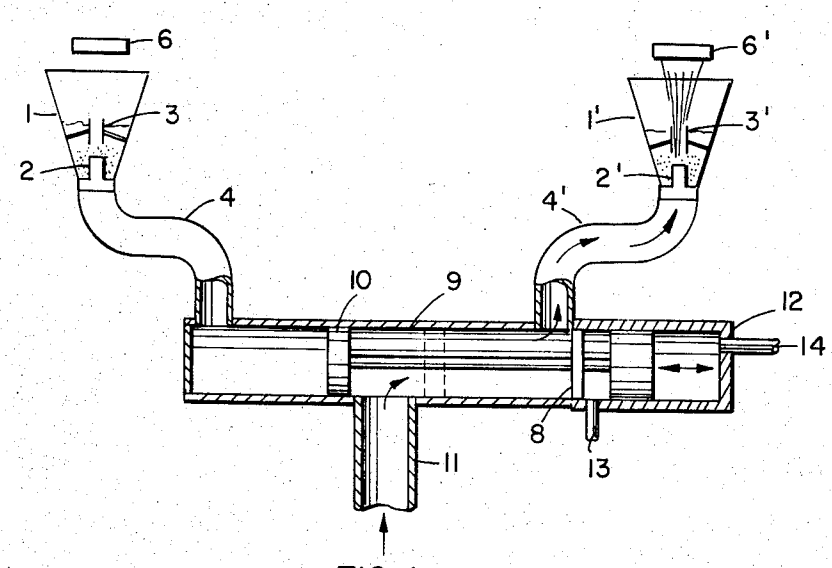


FIG. 1

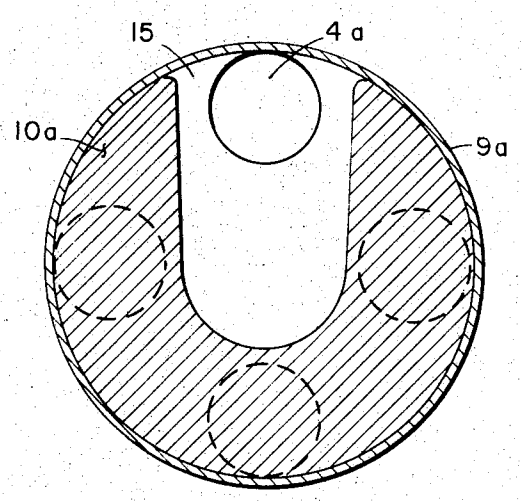


FIG. 2

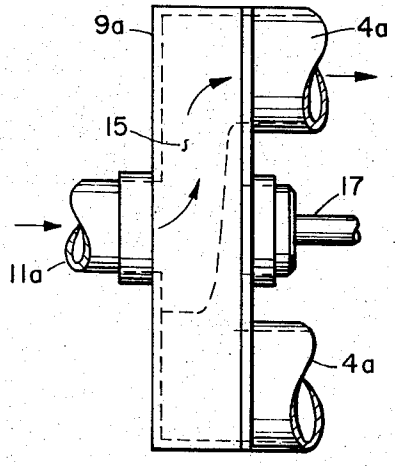


FIG. 3

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METHOD FOR POWER WASHING, SURFACE REFORMING AND THE LIKE

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6 Claims. (Cl. 134—34)

This invention relates to an improved method for power washing, surface re-forming and the like, e.g., for deburring, abrading, or peening operations. More particularly the invention relates to a method in which intermittent high velocity liquid jets are used without the "water-hammer" and other disadvantageous effects of sudden stoppage and difficulties of rapid build-up of the required high velocity.

Such problems are presented especially in the surface treatment of manufactured metal parts, e.g., for cleaning, removal of scale, deburring etc., and in some cases, for alteration of the surface microcrystalline structure by methods such as shot peening. All such procedures will be referred to generally in in this specification and claims as "surface re-forming." There have heretofore been known in this art power washers, using sprays and jets in various ways for loosening and washing away soil of various kinds. These have included mechanical devices for moving the parts being treated into various orientations to the jets, and for moving jets into suitable orientations, even for pushing jet carrying mandrels into small openings. The present invention supplements or replaces such expedients by intermittent jets which strike with sudden high velocity and then allow the liquid to drain away and strike again with the high velocity jet when enough of the liquid has drained back along the surface so that the jet can be fully effective once more and repeating as often as required.

The result of this is to make a given amount of water or other treating liquid do more useful work and likewise to increase efficiency of use of energy imparted to the liquid in the high velocity stream.

In a prior application of our co-workers Nicholas J. Panzica, Robert G. Millhiser, and Warren W. Wool, Jr., Ser. No. 67,396, filed Nov. 6, 1960, now Patent No. 3,233,865, there was set forth a diversion-type valve useful in washing and surface reforming methods. We have adapted the use of such diversion equipment to give intermittent or pulsating jet action.

The present invention provides improved apparatus for intermittent jet action.

In the copending application of Umbricht and Johnson, Ser. No. 9,910 filed Feb. 19, 1960, now issued as Patent No. 3,150,467, a new method of surface re-forming by blasting with solid particles suspended in a suitable liquid is described and claimed. A clear liquid such as water is forced at high velocity from orifices to form jets of a suspension of solid particles for the surface re-forming operation. These particles may be various grits, for abrasive scouring, deburring, etc. or, in the case of peening, steel shot and the like. The jets pick up and accelerate surface-reforming particles by ejector action; and, when an object to be treated is placed in the path of the jets, very effective surface-reforming results.

These processes have revolutionized the surface treatment of many parts, particularly metal castings in the automotive industry. The outer surfaces of such castings can readily be treated by the process and apparatus previously disclosed in applications of myself and my coworkers; but difficult problems are encountered with parts having scale or adhering flakes, etc., to be removed or small cavities, for example tapped holes to be smoothed, deburred, cleansed of oils, chips, abrasives, etc. Once

such surface is covered with the liquid and especially when small holes are filled with the liquid, the surfaces are insulated thereby from the intended action of the jets, and then there is no longer any strong blast of suspended solids actually striking the surfaces to be treated.

The present invention facilitates cleaning out small cavities by intermittent blasts of liquid, with or without suspended grit, which strike the cavity opening at a suitable angle. The present invention has an additional unexpected advantage that it improves the overall surface reforming effect even on level surfaces. This is a very advantageous and rather uncommon phenomenon. Usually whn a special problem is solved by a modified process there has to be some compromise, and it is rare that the overall operation of the general process is actually improved.

In operations using the present invention, we frequently interrupt the flow of the cleaning solution or surface reforming liquid, and repeatedly subject the surfaces to bursts, or sudden blasts, of the treating liquid. If the jets are pulsed, for example operating on and off for only a fraction of a minute, even as briefly as a second each, the suspension drains back from its condition of dynamic balance during the jet flow so that, even in the small cavities from which the liquid cannot fully drain out, it no longer prevents the next pulse of the jet from producing an effective scouring, etc. of the inner surfaces of cavities, and the other surfaces over which the liquid drains. Advantageously, the part is held or turned so that liquid will drain out from such cavities while the jet is interrupted. As a result, thorough cleaning and/or surface re-forming of the surfaces is effected in one machine and without need for hand labor.

Surprisingly, even on large surfaces which do not present the problem of small cavities the effectiveness of the blasting operation is actually improved by such intermittent bursts and interruptions. Apparently the sudden onset, as a jet starts, improves the cleaning and removal of surface scale and the like, probably because sudden impact stresses before any reaction effects have occurred to obstruct or counter balance them. In any event the removal of the undesirable material is actually improved by pulsing the jets, and the present invention is not limited to any theory of why this is so.

The jet pulsation and interruption can be effected, to some extent, by a simple on and off valve, but it is much better to divert a continuously flowing high velocity stream successively to different jet orifices. In this way a constant load on the pump is maintained and the inertia of the flowing stream is utilized to get sudden bursts of the liquid, rather than gradual acceleration at each set of orifices, thus attaining much greater effectiveness than if the flow were actually stopped altogether. Where there is a plurality of jet orifices, the high pressure water is periodically and successively diverted to the several orifices in turn; but, where that is not feasible, the flow can be diverted back to a reservoir in order to avoid interruption of flow in the high pressure stream. The shift from one path to another should be as rapid as possible so as to provide a sudden burst of liquid from the jet to which the flow is diverted. In the specific description, to follow, two types of valves for carrying out this invention are illustrated. It should be understood that these are typical, and representative of others which can be used.

The invention will be described in more detail in conjunction with the accompanying drawings in which the invention is applied as an improvement with the Umbricht and Johnson apparatus referred to above. In these drawings:

FIG. 1 is a section, in semi-diagrammatic form, of a piston type valve; connected to two blasting jets shown diagrammatically;

FIG. 2 is an end view of a different type of valve, and

FIGURE 3 is a side view of the same type of valve as FIG. 2.

In FIG. 1 the bottom portions of two blasting tanks are shown diagrammatically and broken away. Each tank **1** is illustrated as formed with a conical settling chamber in which is a jet nozzle **2** and a coaxial blast tube **3**. The water is supplied under relatively high pressure through nozzles **2** from the conduit **4**.

In operation a blast of water through each of the nozzles **2** in turn, entrains some of a slurry of surface reforming solids which settles in the bottoms of tanks **1** around the gaps between the orifices **2** and blast tubes **3**. This slurry, entrained with the high velocity liquid jets, is then accelerated in the blast tubes **3** so that it strikes with high velocity on articles **6** which are positioned or moved into the blast from tube **3**. The positioning and movement of such articles is now known, and examples are disclosed in prior patent specifications, e.g., those Umbricht and Johnson applications identified above and D. M. Evans Patent No. 2,832,461, Apr. 29, 1958, O. M. Arnold No. 2,900,991, Aug. 25, 1959, E. Umbricht and D. M. Evans No. 2,918,071, Dec. 22, 1959, Umbricht, Evans and W. Johnson No. 2,925,614, Feb. 23, 1960, Umbricht & Evans No. 2,926,674, Mar. 1, 1960, and No. 2,926,675, Mar. 1, 1960, and the continuation-in-part application Ser. No. 371,175, filed May 26, 1964, now Patent No. 3,187,883.

The clear liquid supply conduits **4** communicate with a valve chamber **9** in which a slide valve **10** moves periodically. High pressure water inlet **11** is at a central position in valve **9**.

In the position illustrated in the drawing with the piston at the left, the conduit **4** is closed and conduit **4'** provides open passage for the high pressure liquid from **11**. Hence a high velocity jet will flow from the orifice **2'** and a blast from **3'** will be established in the right-hand tank **1'**. Periodically, for example every other second, the piston valve rapidly moves to the position shown in dashed lines, diverting flow from the right-hand tank to and through the orifice **2** of the left-hand tank. The sequence is repeated continually; and articles **6** which are positioned in the blast are thus treated, first being struck by the blast and then allowed to drain, and then, when the surface is once more freed of liquid, again being subjected to the blast. Because the flow of liquid is successively and alternately directed to the jets **2** and **2'**, without stopping the flow of liquid, the blast is of greatest possible velocity and impact force at all times, and deterioration of apparatus by "water hammer" and other inertial effects is substantially avoided.

It will be noted that the intermittent or pulsed jet formation is effected in clear liquid supply, but the liquid may nevertheless carry some fine abrasive particles. The diversion is controlled by operation of the motor **12**, which is sealed from the liquid by a gland **8**. The fluid pressure motor **12** and the means for supplying fluid pressure and suction alternately to its connections **13** and **14** may be of types already known in the art.

Because the tanks **1** are shown in transverse vertical section, it appears as if each tank had only a single orifice. This may often be so, but in many cases a plurality of orifices and blast tubes or a slot orifice and elongated blast tube, e.g., as set forth in the said prior applications, are used, so that a ribbon-like jet is produced, which is advantageous in the treatment of some articles. Where there are multiple jets, it is by no means necessary that the diverted flow go to a different machine or a different tank. On the contrary, it is often more advantageous to divert the flow from one jet to another in the same blast tank.

For some operations it is desirable to have multiple sets of orifices in each blast tank. These orifices and blast tubes advantageously are at different angles each best suited to treating a particular part of the article to which it is directed. The present invention is well suited to the pulsing of such multiple jet sets.

Another type of interrupting valve, which acts also as a distributor, is shown in FIGS. 2 and 3. Here a valve body **9***a* is provided with a plurality of outlets **4***a* in its face. Within the body **9***a* is a rotatable distributor **10***a* having a hollow arm or slot **15**. The axial inlet, or liquid feed pipe **11***a* communicates with the hollow passage of the slot or arm; and the passage extends outward so as to communicate also with the outlets **4***a*. As the shaft **17** turns the distributor **10***a*, the slot **15** successively communicates with one outlet **4***a* after another, as is best seen in FIG. 2; and therefore in a single revolution the high pressure liquid will successively have been directed to each of four outlet tubes in turn. Because the slot **15** communicates with each outlet **4***a* before it is cut off from the previous one, the high velocity flow of liquid is never shut off, and the inertia of the liquid is used to rapidly build up the velocity in each jet as a previously connected jet is cut off.

The operation is described in connection with FIG. 1, but the design of the distributor lends itself to installations where there are more than two sets of jet orifices. There are many other types of liquid distributors, which can be used to serve the functions described.

The periodicity of the jet pulses will vary with the nature of the machines used, and nature and orientation of the surface being treated. The pulse rate is determined by the rate at which the valves are diven, and this obviously can be controlled by use of a variable speed electric motor on shaft **17** or by control of the fluid pressure supply to the fluid pressure motor **12**, which drives valve **10**.

Various types of motors may be used to drive the valve **10**. Besides the reciprocating fluid pressure motor indicated diagrammatically at **12** or a simple rotary electric motor mentioned above, we may use a solenoid or a rotary cam or crank device for the slide valve and a rack and pinion with ratchet to convert the action of a reciprocating motor for drive of a slide valve.

What is claimed is:

1. An industrial process for power washing a manufactured metal article with pulsed liquid jet blasts, which comprises applying a substantially constant large volume flow of liquid at high pressure, repeatedly rapidly diverting this flow to and from a fixed jet orifice to create intermittent, sudden, high impact, pulses of high velocity, high energy, scrubbing jet blasts and directing said series of blasts against the surface area of the article to be treated, which blasts occur at a rate timed to permit at least partial drainage of the spent liquid blocking the area of treatment on said article during the periods between said blasts to permit said blast more effectively to wash said article.

2. A process as described in claim **1** which further comprises proportionally diverting said liquid flow between a plurality of fixed jet orifices, which includes said aforementioned orifice by smoothly increasing the liquid flowing into one set of said orifices by the same amount being increasingly diverted from another set, where such sets may comprise one or more said orifices, whereby water-hammer is avoided.

3. A process as described in claim **2** which further comprises diverting said liquid flow sequentially between individual ones of said orifices.

4. A process as described in claim **2** in which said jet blasts from said respective sets of orifices are directed against the article from different stationary points at different angles.

5. A process as described in claim **3** in which said jet blasts from said respective orifices are directed against the article from different stationary points at different angles.

6. An industrial process for surface treating an article with liquid jet pulsed blasts to alter its surface microstructure, the improvement which comprises supplying a

substantially constant large volume flow of liquid at high pressure, repeatedly rapidly diverting this flow smoothly to and from a fixed jet orifice to create intermittent pulses of high velocity, high energy, surface reforming jet blasts, directing said blasts against the surface area to be treated, causing said blast to occur at a rate timed to permit at least partial drainage of the spent liquid blocking the area of treatment on said article during the periods between said blasts to permit said blasts more effectively to surface treat said article, altering the surface microstructure of said article with surface reforming particles by having said liquid flow substantially free of particles and intermittently diverting the liquid flow to and from said fixed jet orifice at a point prior to where said liquid blast contacts said particles, whereby any apparatus used for such diversion remains free of abrasion from such particles.

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