Oct. 22, 1963 E. UMBRICHT 3,107,860

WASHING APPARATUS AND METHOD

Filed July 18, 1960

FIG. 4

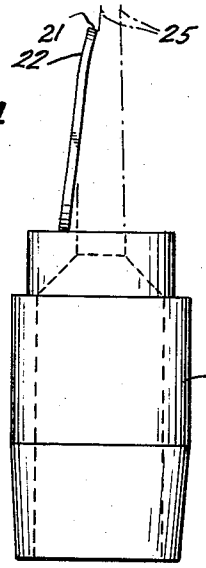


FIG. 1

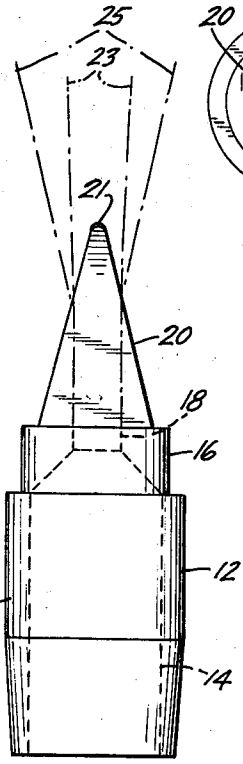


FIG. 2

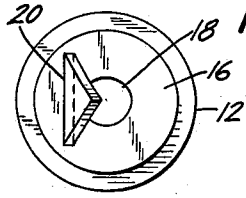
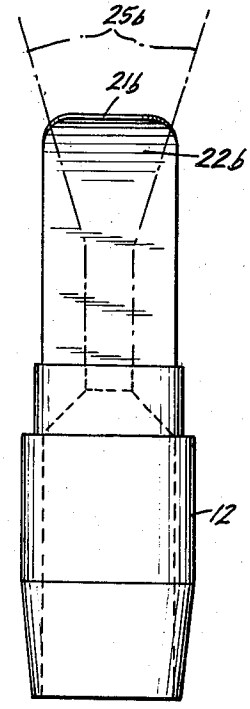


FIG. 3



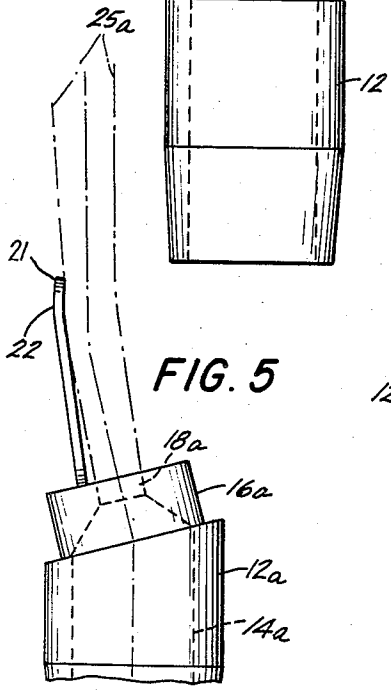


FIG. 5

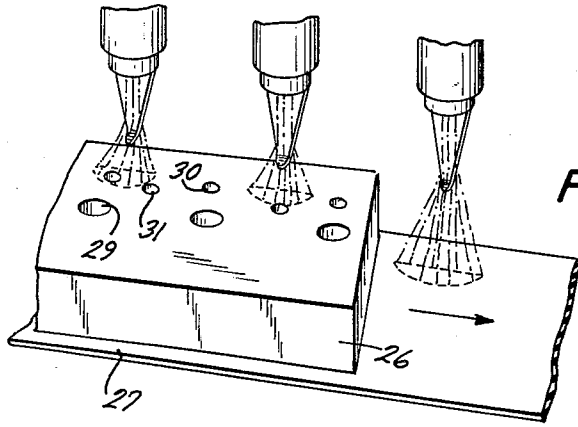


FIG. 6

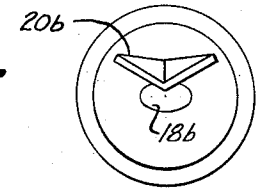


FIG. 7

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WASHING APPARATUS AND METHOD

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13 Claims. (Cl. 239—521)

This invention relates to a spray device for use in power washers and the like, and more particularly, relates to a device for converting a pressure stream of liquid into a jet, drops or globules of which are individually of substantial mass and, at least a substantial proportion of them, of high energy whereby they can impinge with effective force on a surface to be cleaned or otherwise treated.

In prior patents I have described apparatus for obtaining a more or less conical spray pattern of relatively high energy by interposing a stream-lined deflector into a high velocity jet of liquid. I have also previously disclosed forming a more or less flat, divergent, "fish-tail" spray by impinging such a high velocity stream against a flat surface extending across the jet at an acute angle, the jet being broken against the flat surface and broken up into drops which are ricocheted therefrom. In all such devices I have found that there is a substantial loss of kinetic energy due to the impingement on a stationary surface and a considerable amount of spattering breaks up the liquid into many fine droplets which lose energy by friction of passing through the air. I have now found that if instead of impinging the entire jet against a deflecting surface, I arrange the deflecting surface so that it encroaches on only a part of the jet stream, it tends to throw the deflected and spattered drops and droplets back into the remaining otherwise unobstructed part of the jet, and by virtue of the re-directed kinetic energy, the remaining portion of the stream is deflected with very limited further loss of kinetic energy.

In other words, my novel device forms a spray pattern of the desired form and direction by hydraulically disturbing a main portion of the bulk of the liquid while in a freely projected stream. This I do most conveniently and effectively by mechanically deflecting another portion of the same stream after it has left the orifice of the jet.

There are many occasions in which a manufactured part needs to be cleaned, e.g., by removal of grease, dirt, chips, cutting lubricants, molding sand, special coatings, etc. This is done most economically by means of high energy spraying or other surface treating with liquid; but often the surface configuration is such that not all of it can be conveniently brought into close proximity to a jet. For example, where a part must be turned over while exposed to the impingement of liquid, or where a recessed part must be cleaned, or where there are projections on the part which prevent its being brought close to the jet, the use of an ordinary jet from a round orifice is useful but ordinarily does not provide efficient and satisfactory action throughout. Comparison of the results from my novel spray, on the one hand, and from the use of older jets, such as the jets from simple round orifices, or the spray from a flared orifice or from an orifice with a deflector extending across the path of the jet, on the other hand, shows a marked improvement in retention of kinetic force of the projectile liquid and a much wider and more uniform treatment of the surface on which the jet impinges. This is particularly important where parts are passed through a broad ribbon spray pattern, where it is important that all parts be subjected to efficient action of the high energy drops of the liquid.

In such spray cleaning a high degree of force in the spray is necessary because of the brevity of time in which the full cleaning of each part must be accomplished,

especially in modern automatic power washers, and the importance of the force of the spray will be more evident when one remembers that some of the soil may be hardened and cemented to the surface by the drying of oils or cutting compounds or, e.g., in the case of castings, by the heat of the metal. Only a high energy impingement with a good cleaning solution can loosen such soil and remove it from the metal surface.

It is important, therefore, that as much as possible of the force generated from the pumping system be utilized in the impinging spray. The use of a deflector surface arranged at an acute angle to the axis of flow, and extending across the line of flow of the liquid a little beyond the orifice, has served to deflect and spread out the jet to a thin spray covering a ribbon of surface, but this change in form has in the past been at the expense of serious loss of force. Another means of spreading the liquid into a broad spray pattern has been to pass the liquid through a number of fine orifices each having a different direction so that combined they give the desired spread and angular pattern. This, however, has not proven satisfactory for industrial washer use because of the frequency of clogging of such fine orifices.

According to the present invention, large non-clogging jet orifices are used and the resulting heavy jet of liquid is broken and deflected into a spray pattern, as hereinafter set forth, but still retaining its high force.

According to my invention a high pressure stream established by pumping at high pressure through suitable piping is passed through a jet designed so that the liquid is ejected at high velocity as a substantially continuous stream. A short distance beyond the orifice of the jet a deflector blade extends into one side of this stream at an acute angle to its axis. This deflector blade causes the intercepted portion of the stream to be deflected by a few degrees toward the remainder of the stream. The resulting interference of the two streams causes, first, deflection of the remainder of the stream, and, secondly spreading the stream laterally into a "fish-tail" pattern, and to a substantial extent also breaks up the continuous stream into globules of substantial mass and high velocity (as distinguished from a fine spray or atomizing).

The orifice through which the high pressure liquid flows to make the free projected stream is ordinarily at least ⅛ inch in diameter and in various practical applications has been, for example, ⅛, 5/16, ⅜, ½, ¾ inch and larger, depending upon the application.

This relatively slight disturbance of a small portion of the liquid in the pre-flowing stream, just adequate to change the shape of the spray from a round, cylindrical or slightly divergent column of liquid to a broadened "fan" or "fish-tail" pattern retaining almost the full force with which it was emitted from the jet is achieved by a small deflector blade shaped so that it disturbs the column of liquid, but the disturbance is relatively slight, i.e., only a small portion of the liquid in the stream is disturbed, while the liquid in the bulk of the stream is deflected only by the dynamic effect of liquid deflected from the blade. This relatively slight disturbance of a small portion of the liquid is nevertheless adequate to change the shape of the stream from a column of liquid having substantially the cross-sectional shape of the orifice to a broadened pattern in which the bulk of the liquid is transmitted through space with almost the full force with which it was emitted from the jet.

In the accompanying drawing I have shown a preferred embodiment of my invention and various alternatives. These are selected and presented with a view to instructing others in the use of the invention and the principles thereof, in order that they may be enabled to adapt it and modify it in accordance with the requirements of any

particular use. These are not intended to be exhaustive or limiting of the invention in its broader aspect, but on the contrary to be illustrative and instructive.

In these drawings:

FIGURE 1 is a view in side elevation of a jet nozzle with deflector, and showing in phantom by short dash lines the bore of the nozzle through which the fluid passes and by longer dot and dash lines the outline of the stream, produced by the jet without the encroachment of the deflector blade, and by dot and dash lines the outline with such encroachment.

FIGURE 2 is a plan view of the end of a jet of the type shown in FIGURE 1.

FIGURE 3 is a view similar to FIGURE 1 but showing a different deflector blade.

FIGURE 4 is a view in side elevation taken from the right hand side of FIGURE 1 or FIGURE 3.

FIGURE 5 is a view similar to FIGURE 4 but showing an improved modification.

FIGURE 6 is a diagrammatic view representing a portion of a conveyor in a power washer, carrying a metal part to be washed and with a plurality of jet nozzles projecting high velocity jets of liquid against the part and into various cavities and/or recesses thereof which are to be cleaned.

FIGURE 7 is a view similar to FIGURE 2 showing an elliptical nozzle.

Referring first to FIGURES 1, 2 and 4, the jet there shown is intended to be fitted on the end of a pipeline carrying a cleaning liquid under high pressure from a suitable pump or pressure tank (not shown). This general type of apparatus has been known to the art heretofore and for example, is represented by apparatus shown in prior Patents No. 2,925,614, dated February 23, 1960; No. 2,832,461, dated April 29, 1958; No. 2,918,071, dated December 22, 1959; and No. 2,926,674, dated March 1, 1960.

The body **12** of the jet nozzle can be secured to the end of the piping system by welding, shrinking, threading or other suitable connection, advantageously one which leaves smooth internal passage **14** to maintain pressure and velocity of the flowing liquid.

On the end of the body **12** is secured, again by welding or threading, etc., an orifice member **16** having therein a tapered opening end registering at the inner end with the bore **14** and at its other end with an orifice **18**. Secured to the member **16** and spaced a little to one side of the orifice **18** is the deflector **20**, in this case shown as a triangular plate with its end **21** rounded on a small radius and with its tip portion curved at **22** slightly inward as shown in FIGURES 4 and 5.

The degree of encroachment of the tip **21** into the path of the projected stream, in the absence of the deflector **20** (indicated by the broken lines **23**) is important. For best results the tip **21** of the deflector **20** should be positioned on the central third of the diameter of the stream path indicated at **23**, i.e. at a position plus or minus 1/16 of the diameter from the central axis. The relative position of the tip in the stream determines the relative disturbance of the column and the breadth and shape of the resultant spray. To obtain the desired forceful spray, with a relatively concentrated pattern, it is best that this tip **21** be kept as far as possible from the projected axis of the column **23** of liquid emitted from the orifice, and on the same side of the axis on which the deflector **20** is mounted.

The angle of the deflector relative to the column of liquid is also important, as it is desired that the liquid should ricochet off this surface into the bulk of the stream so that the deflected liquid and the undeflected liquid in the bulk of the stream proceed with undiminished energy and in a direction which is the resultant of their respective inertias. With a wider angle between the axis of the stream and the encroaching tip **21** of the deflector, a broader spread of the stream will be obtained, but at the same time, a greater loss in energy will result.

A wider impingement spray pattern may also be obtained by greater disturbance in the flow of the emitted stream. Thus, extending the tip **21** into the stream to, or even beyond, the axis, will result in a wider distribution and a lesser energy of impingement on the article being cleaned. Another way of obtaining greater disturbance of the stream and therefore wider distribution pattern, is to use a broader deflector tip instead of the rather pointed tip shown in FIG. 1. This is illustrated in FIG. 3. In the examples shown in FIGS. 1 to 5, the spread of the stream is indicated diagrammatically by the dot-dash lines **25**.

Although I have shown the orifice **18** as circular, and ordinarily it would be made this way because of economy considerations in manufacturing, it can be made elliptical, as indicated in FIGURE 7, or other desired shape which may facilitate in forming a desired impingement pattern.

In FIG. 5 is shown a further modification of my invention wherein the jet body **12*a*** has its end cut off at an angle of 14°. With this design, it has been found possible to get much better cleaning in deep holes and recesses and especially this gives better control of the width of the jet stream and with higher force in the concentrated jet spray, but still gives a ribbon-like spray pattern. The angle between the axis of the internal passage **14** in the body **12*a*** of the jet and the axis of the orifice **18** is somewhat critical. As indicated above, 14° is the prescribed angle for the jet as shown; and in general, this angle should not be departed from by more than a few degrees. I have demonstrated that in this limited angular relation the high force liquid continues with a better regulated deflecting section of the stream, thus creating a controlled, wide but forceful stream of cleaning solution. Much less energy is lost in the flow of the liquid; hence a great improvement is experienced with removal of soil from deep recesses as for example, in engine blocks and other fabricated parts.

It will be noted in FIG. 5 that the combination of the deflection and limited turbulence produced in the stream by tilting of the orifice **18*a*** with respect to the bore **14*a*** and the encroachment of the deflector tip **21**, the stream continues beyond the deflector in a direction quite close to the original direction of the passage **14*a***. However, the stream is spread more in a lateral direction than in the direction toward and away from the deflector. If a still broader spray pattern is desired, a broader tip deflector such as that shown in FIG. 3 may be used with the tilted orifice design of FIG. 5.

The dimensions of the orifice and the internal bevel or slope between the bore of the body section **12** and the orifice **18** also influence the type of stream emitted and the limited spreading of the bulk of liquid. In one advantageous example corresponding to FIGURE 5, I have used a ½" diameter orifice, the orifice member **16** is 5/8" long and the bevel between the larger diameter of the bore **14*a*** and of the orifice **18*a*** extends for ¼" of its axial length. With a 3/8" diameter orifice, which is commonly used, I used an internal beveling extending from ¼" to 5/16", measured along the axis; and the total length of the orifice member measured along the axis was ½", thus leaving in the orifice proper a length of about 3/16". Such a jet produces a strong, forceful stream of liquid and an advantageous deflection with a now pointed deflector such as that of FIG. 1.

It should be noted that this type of jet is substantially free from tendency to clog, and therefore is highly advantageous for use in power washers. A large orifice and freedom from any part positioned so as to catch debris on the interior or exterior of the jet, results in this freedom from clogging which is very important in practical use.

It is within the scope of my invention to vary the dimensions, such as orifice size and size of the various com-

ponents to meet the requirements of the bulk liquid being expelled, to create a high degree of washing by impingement on the surface to be washed.

In another example according to FIGS. 1, 2 and 4, the orifice diameter was ½" and the length of the orifice member **16** was ½". The deflector member **20** was 1 9/16" long and ⅞" wide at its base, with the first 1¼" flat, i.e., lying in a single plane, and the last 5/16" at the tip **21** being curved at **22** on a 1 9/16" radius. The tip **21** was rounded on a ⅛" radius and the base of the deflector was spaced back from the circumference of the orifice 1/16". The tip **21** is spaced 1/32" from the extended axis of the orifice **18** and the bore **14**, toward the same side as the base of the deflector. The body **12** was made, in this instance, of 1" standard pipe and welded to the orifice member **16**.

In another example using the broader deflector of FIG. 3, the body **12** was, again, made of 1" standard pipe. The orifice member **16** in this case was ½" long with ⅜" orifice and the deflector in this case was 1⅞" long, and, again, secured at its base to the orifice member **16**, 1/16" beyond the periphery of the orifice and extended 1/32" beyond the extended axis of the orifice **16** and the bore **14** in the body. The end 13/16" at the tip **22***b* was curved on radius 2½".

In general, with the triangular deflector such as that of FIG. 1, advantageous dimensions are within the following, using the diameter of jet orifice as the unit of dimension "d". The position of the tip **21***b* to the extended axis is 0 to plus or minus ⅙ d. The spacing from the axis to the deflector at the point where the projection of the orifice intersects the deflector is ¼ d. to ½ d. The width of the deflector at its base is 1 d. to 4 d. The nearest spacing of the base to the axis of the orifice is ½ d. to 1 d. The length of the deflector is 1 d. to 8 d. The radius of curvature in the tip section **22** or **22***b* is 3 d. to 8 d. and the radius at which the tip **21** is rounded is ⅛ d. to ½ d. The stream is deflected at tip **21** in FIG. 4 by 5° to 10° from axis of orifice in direction away from the tip. The angle **25** in FIG. 1 of jet spread may be about 60°. With increased pressure on the liquid a wider spread of jet stream is obtained.

Referring to the type of jet shown in FIG. 3 with the blunt-end deflector, most advantageous dimensions are as follows, again using the diameter of the jet orifice "d." as the unit of measurement: The distance of the tip **21***b* from the extended axis of the orifice and bore minus ⅙ d. to plus ⅓ d., that is, ⅙ d. beyond the axis to ⅓ d. short of the axis. The distance from the nearest point at the base of the deflector to the periphery of the orifice ½ d. to 1 d. The width of the base 2 d. to 4 d. The length of the deflector 1 d. to 8 d., the portion of the deflector which is plane, i.e., before the start of the curvature, 0 to 4 d. Radius of curvature on the end portion **22***b*, 2 d. to infinity.

The stream hitting the broad-end deflector at tip **21***b* in FIG. 3 is deflected 5° to 15° from axis of orifice in direction away from the deflector. The angle **25***b* of jet spread in FIG. 3 ranges from 60° to 75°.

In general, for the best results one should minimize the area of contact of the deflector with the stream and the angle of deflection, i.e., between the contacting portion of the deflector and the axis of the stream.

In FIG. 6, I have illustrated diagrammatically one use of such jets for washing a casting such as a cylinder head or cylinder block. Here the casting **26** is shown being carried on a conveyor belt **27** for movement through a washing zone. The casting is shown as having holes or deep recesses **29**, **30** and **31** and the three jets shown are arranged so that each of these holes in turn comes under the impingement zone of one or more of the jets. It will be understood that the piping supplying liquid to the jets and the mechanism for carrying the articles to be washed and the housing for containing the spray, etc., may be in accordance with such equipment used in the prior art, e.g., as in the patents cited above.

I claim:

1. In a high pressure liquid jet washing nozzle of the character described for automatic power jet washing apparatus for directing a controlled jet of washing liquid in direct and high energy and velocity scrubbing impingement against a machine part to be scrubbed and washed for removal of tenacious soils therefrom, the combination which comprises a delivery conduit for conducting said washing liquid under high pressure to said nozzle, a jet orifice outlet on said nozzle for forming and ejecting a high pressure solid stream of said washing liquid at said high energy velocity, a deflector attached to said nozzle and having a deflecting tip spaced axially beyond said jet orifice outlet for contacting said ejected high pressure solid stream of liquid but only after said solid stream has been formed and ejected through said jet orifice outlet, said deflecting tip extending at an acute angle to the axis of said stream of liquid and into a portion only of said stream for deflecting one side only thereof into other portions of said stream laterally beyond said deflecting tip effecting separating of said other portions of said solid stream into high energy spray droplets by said deflected portion of said stream substantially in the absence of kinetic or velocity energy loss and without said other portions impinging on said deflecting tip.

2. A jet washing nozzle as recited in claim 1 in which the axis of said jet orifice outlet is tilted at an angle of about 15° from the axis of said delivery conduit, and in which said deflecting tip is disposed on that side of said nozzle toward which said orifice axis is tilted.

3. In a high pressure liquid jet washing nozzle of the character described for automatic power jet washing apparatus for directing a controlled jet of washing liquid in direct and high energy and velocity scrubbing impingement against a machine part to be scrubbed and washed for removal of tenacious soils therefrom, the combination which comprises a delivery conduit for conducting said washing liquid under high pressure to said nozzle, a jet orifice outlet on said nozzle for forming and ejecting a high pressure solid stream of said washing liquid at said high energy velocity, a deflector attached to said nozzle and having a deflecting tip spaced axially beyond said jet orifice outlet, said deflecting tip having a substantially flat area tangent to one side of said solid stream of liquid and extending partially thereinto at an acute angle beyond the point of tangency for deflecting a minor portion only of said stream into other undeflected portions thereof, said deflecting tip being disposed and configured at said one side of said solid stream to be completely out of contact with the preponderant portion of said stream as produced by said jet orifice outlet.

4. In a method of the character described for high pressure power jet washing of machine parts with high energy and velocity scrubbing impingement of a jet of washing liquid against said parts, the steps which comprise forming a high energy and velocity solid jet stream of washing liquid, directing said jet stream with high energy impingement against said machine part to be washed at relatively close proximity thereto for impingement of said jet stream before substantial dissipation of said high velocity and energy thereof, deflecting a portion only of said solid jet stream at one side thereof at an acute angle transversely into the remaining undeflected predominant portion thereof effecting separation of said solid jet stream into high energy spray droplets and substantially in the absence of dissipation of said high energy of said stream, said deflecting occurring at a point spaced toward said machine part from the point at which said solid jet stream is formed.

5. A spray device as defined in claim 1 in which the deflector is a resilient plate, whereby the force of the intruding jet causes an oscillation of the plate intruding

more or less to alternately spread and allow direct projection of the jet.

6. A spray device as defined in claim 1 in which said deflecting tip is petal-shaped with a narrowed end.

7. A spray device as defined in claim 1 in which said deflecting tip is petal-shaped with a pointed end.

8. A spray device as defined in claim 1 in which said deflecting tip is petal-shaped with a dihedral angle flaring out from the jet into which it intrudes.

9. A spray device as defined in claim 1 in which said deflecting tip ends in a rectangular edge near and transverse to the axis of the jet into which it intrudes.

10. A spray device as defined in claim 1 in which said deflecting tip intrudes into said jet to a point spaced from the extended axis of the orifice less than ⅛ the diameter of said orifice.

11. A spray device as defined in claim 7 in which the pointed end has a radius of curvature in its end equal to ⅛ to ½ the diameter of the orifice.

12. A spray device as defined in claim 1 in which the orifice is elliptical.

13. A spray device as defined in claim 1 in which the orifice is an elongated opening as viewed from the end.

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