Jan. 22, 1957 E. UMBRICHT 2,778,685

JET ASSEMBLY

Filed Feb. 2, 1953

FIG. 1.

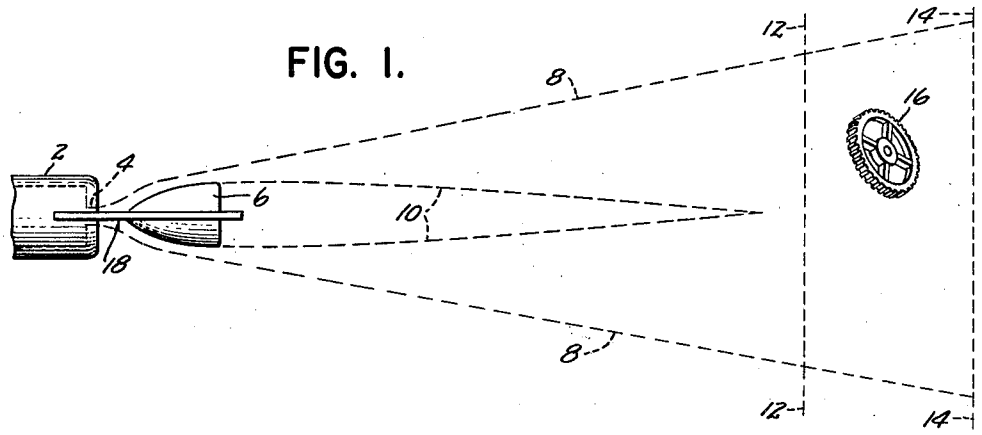


FIG. 2.

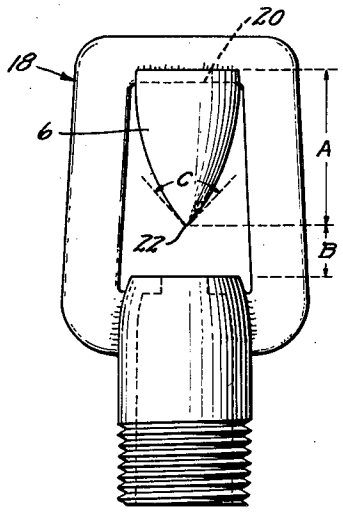


FIG. 3.

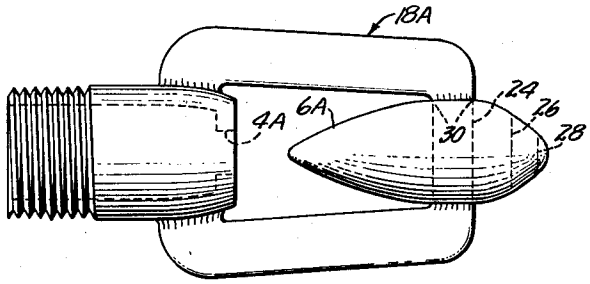
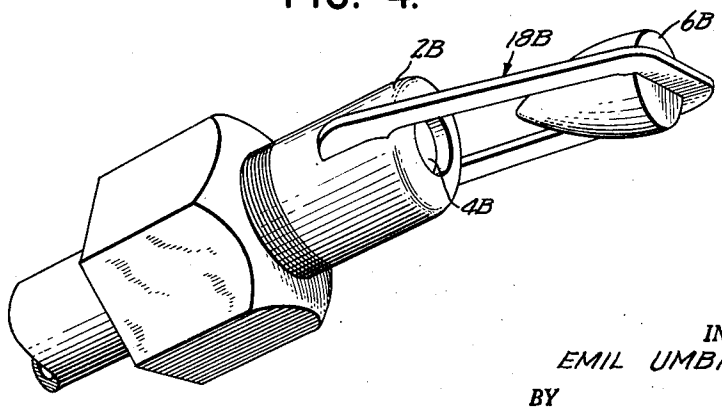


FIG. 4.



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JET ASSEMBLY

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12 Claims. (Cl. 299—121)

This invention relates to jet assemblies for use in power washers such as are used for cleaning metal. In such power washers, a jet of cleaning solution, for example water with chemical detergents, is forced at relatively high velocity over the surface of finished or semi-finished parts to clean the surfaces and prepare them for painting, assembly, or other treatment.

It is important that the cleaning solution strike the surface to be cleaned with sufficient velocity to remove the undesired surface film and also that the spray of liquid to be spread over a substantial cross-sectional area so that the entire surface will be cleaned efficiently. In practice, these two conditions are difficult to meet. If the cleaning solution is spread over a larger area by breaking a single jet into many small jets or causing it to form a spray, the velocity and force of the liquid may be reduced to such an extent that the cleaning action is ineffective. Moreover, the velocity and force of the liquid striking the surface may vary to a substantial extent over the cross-section of the spray, further reducing the effectiveness and efficiency of the cleaning operation. Prior arrangements which make use of a relatively large number of small orifices for ejecting the cleaning solution are undesirable because the orifices are easily clogged by solid material contained in the cleaning solution.

The present invention provides methods and apparatus for producing a diverging conical spray of cleaning solution which is propelled at high velocity and which has a large working zone in which the velocity and force of the liquid is substantially uniform over the cross-section.

In a preferred embodiment of the invention, a generally bullet-shaped director is supported in front of a relatively large opening with the nose of the director extending toward the center of the opening. The cleaning liquid is forced through the opening so that it strikes the director and is spread outwardly into a cone shape. Because of the shaped spray and position of the director, part of the liquid closes beyond the director to form a uniform distribution of the moving liquid spray. This arrangement produces a cleaning spray distributed uniformly over a relatively large cross-sectional area throughout which the liquid is propelled at high and substantially uniform velocity.

The director incorporated in the various embodiments of this invention is not to be confused with the many types of deflectors which have been positioned in front of orifices to change the direction of the stream or to break it up into a spray as for distributing water over a large area. Such spatter plates produce substantial amounts of very fine spray or mist and always cause a marked reduction in the linear velocity of the liquid.

The distinguishing characteristics of this invention together with other aspects and advantages of it will be in part pointed out in and in part apparent from the following description considered in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of a jet assembly embodying the invention in use to spray cleaning liquid over the surfaces of a gear wheel;

Figure 2 is a side elevational view of the jet assembly of Figure 1 showing the supporting arrangement for the director;

Figure 3 shows another embodiment of the invention having a different shaped director; and

Figure 4 is a perspective view of another embodiment in which the director is mounted at an angle to the axis of the pipe through which liquid flows to the jet assembly.

Figure 1 indicates the operation and manner of using a jet assembly embodying the invention. Cleaning solution, made up for example of water and a detergent, is supplied under pressure through a pipe **2** and is ejected through a relatively large orifice **4** formed in the end of the pipe **2**. A generally bullet-shaped director element **6** is positioned directly in front of the opening **4** and causes the water to be deflected outwardly as indicated by the broken lines **8** forming a cone-shaped spray. Beyond the end of the director **6**, part of the water is deflected inwardly, as along the broken lines **10**, to fill the center of the cone so that for a substantial distance, for example between the broken lines **12** and **14**, the water is uniformly distributed over the entire cross-sectional area, this spreading having been accomplished with minimum loss in velocity of the water. The parts to be cleaned, as illustrated by the gear **16**, are placed in a suitable position in the spray or are moved by conveyor means across the stream of cleaning liquid.

The bullet-shaped director **6** can be supported in any desired manner so long as the supporting members do not interfere materially with the flow of liquid or the formation of the spreading cone of liquid spray. In the embodiment of Figures 1 and 2, the director **6** is supported by a generally U-shaped bracket **18** formed of metal strip. The ends of the bracket **18** are welded or otherwise secured to and supported by the pipe **2** and the remaining portion of the bracket forms a closed loop to which the director **6** is secured, for example by welding the bracket **18** in a transverse groove, as at **20**, across the blunt end of the director. The metal strip is positioned edgewise with respect to the direction of the liquid stream so as to cause minimum interference with the flow. If desired, the edges of the bracket upon which the liquid impinges can be rounded or knife-edged to further reduce the effect of the bracket. It would be apparent that the manner of supporting the director is not critical to the invention so long as the supporting members do not cause excessive interference with the liquid stream. Thus, for example, one-half of the U-shaped bracket **18** may be omitted provided the bracket is formed of material sufficiently strong that the single arm will provide adequate mechanical support for the director. It is, of course, convenient for the director to be supported rigidly from the pipe through which the liquid is delivered to the orifice, but if desired it may be supported from an entirely separate structure so long as it is positioned properly with respect to the orifice **4**.

The shape of the director is critical only to the extent that the angle of incidence of the various parts of the stream of liquid from the orifice **4** on the surface of the director **6** should be less than the critical angle at which the liquid would be broken into a spray or mist of fine droplets with marked reduction in the velocity of the liquid.

Thus the tip **22** of the director **6** preferably is pointed, as shown in Figure 2, or rounded with a small radius of curvature, as shown in Figure 3. In one practical embodiment of the invention, the pipe **2** was one inch in diameter with a circular outlet orifice **4**, 0.44 inch in diameter. The director **6** had a maximum diameter of one

inch, an over-all length, indicated at A in Figure 2, of 1.5 inches, and was positioned symmetrically with respect to the liquid stream and the orifice 4. As shown in Figure 2, the director is so proportioned that when the distance A is 1.5 inches and the maximum diameter is one inch as in the practical embodiment mentioned above, the included angle between lines in a common plane extending between the tip of the director and oppositely disposed surface points at its maximum diameter is not significantly greater than thirty-seven degrees. The pointed tip 22 of the director was positioned 0.44 inch from the face of the orifice 4, as indicated by the dimension B. The convex surfaces of the director 6 had a constant radius of curvature of approximately two inches, arranged so that two lines on opposite sides of the director and tangent to its surface immediately adjacent the tip 22 form an angle, indicated at C, of approximately 80 degrees. All surfaces were smooth and polished so as to produce minimum turbulence in the flow of the liquid.

In general, the dimensions and shape of directors of the character described above will depend upon the size of the orifice 4, the position of the director, the velocity and characteristics of the cleaning liquid, and the area over which it is desired to spread the liquid.

For best results in most applications the director 6 should have a maximum mean diameter equal to 1½ to 2½ times the mean diameter of the orifice 4, and its length should be between 2½ and 3½ times the orifice diameter. The distance B from the tip 22 of the director 6 to the face of the orifice 4 should be at least equal to the diameter of the orifice and may be as much as several times this distance.

If desired, the tip of the director can be rounded, as indicated in the embodiment of Figure 3 provided the radius of curvature of the surface of this nose portion is not greater than one-half the diameter of the orifice opening. The remaining convex surface of the director can be of constant radius of curvature or the radius of curvature may vary along the length of the director, but in accordance with the foregoing limitations abrupt changes in the direction of the surface should be avoided and significant portions of the surface should not be at such abrupt angles to the direction of the impinging stream as would cause spattering or lateral dispersion of the stream. The surface of the director at its maximum diameter is tangent to a cylindrical surface whose axis is substantially parallel to the direction of flow of the liquid as it approaches the director. The director may have a relatively blunt end near this maximum diameter as shown in Figure 1 or the end of the director opposite the approaching stream may be tapered, conical, or bullet-shaped but should have an equally or more sharply converging configuration than the nose end of the director as shown in Figure 3. The director of Figure 3, can, if desired, be formed with an abrupt or blunt end at any point, as along any of the broken lines 24, 26, and 28 of Figure 3.

The director may have a portion of uniform diameter in the region of maximum diameter, for example as indicated at 30 in Figure 3. The length of this cylindrical surface portion 24 in the direction of the longitudinal axis of the director may be between zero (as in the embodiment of Figure 1) and a distance equal to the diameter of the orifice opening.

Figure 4 shows another embodiment of the invention in which the axis of the pipe 2B is at an angle to the longitudinal axis of the director 6B; this angle may be as much as forty-five degrees if desired. The director 6B, however, remains with its longitudinal axis parallel to the axis of the orifice 4B and parallel to direction of flow of liquid from the orifice 4B.

It will be clear also that any desired passageway may be employed to conduct the cleaning liquid to the jet assembly and to form it into a solid stream flowing toward the nose of the director. For example, one or more holes may be drilled in the side of a pipe carrying the cleaning liquid with a director positioned in front of each opening as described above. Each of the directors may be supported from the pipe by a strap type clamp formed of two members each having an arcuate clamping surface and arranged to engage opposite sides of the pipe. One of these members may be provided with a hole, in alignment with an opening in the pipe, which serves as the orifice. The two members may be clamped tightly around the pipe by bolts or other fastening devices, suitable sealing material being provided to prevent the cleaning liquid from leaking into any space between the pipe and the clamp member. The director may be supported from the pipe or from one of the clamp members, or by other means, it being apparent that the manner of support is not critical except as indicated by the limitations set forth herein.

It will be apparent that the particular descriptions set forth above are for the purposes of illustrating the principles of the invention so that others may adapt it to their particular circumstances of use. It will be apparent that certain details of the construction have been set forth only for the purpose of illustrating a working embodiment of the invention and not for the purpose of limitation, except as is apparent herefrom or from the following claims.

What is claimed is:

1. In a power washer for spraying cleaning liquid with high hydraulic force over surfaces to be cleaned, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, said director having a rounded tip portion with radius of curvature not significantly greater than a distance equal to one-half the mean diameter of said orifice, said director having a back portion of a diameter between 1.5 and 2.5 times the mean diameter of said orifice and means supporting said director in front of and spaced from said orifice with its tip in alignment with and facing toward said orifice.

2. In a power washer for spraying cleaning liquid with high hydraulic force over surfaces to be cleaned, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in a fixed position in front of and spaced from said orifice with its tip in alignment with and facing toward said orifice, said director having a rounded tip portion with radius of curvature not significantly greater than a distance equal to one-half the mean diameter of said orifice, the entire remaining surface of said director in the path of the liquid from said orifice having radius of curvature at least equal to twice the mean diameter of said orifice, and the maximum mean diameter of said director being between 1.5 and 2.5 times the mean diameter of said orifice.

3. In a power washer for spraying cleaning liquid with high hydraulic force over surfaces to be cleaned, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in a fixed position in front of and spaced from said orifice with its tip in alignment with and facing toward said orifice, said director being so proportioned that the included angle between lines in a common plane extending between the tip of said director and oppositely disposed surface points at its maximum diameter is not significantly greater than thirty-seven degrees.

4. In a power washer for distributing liquid spray, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in a fixed position in front of and spaced from said orifice

with its tip in alignment with and facing toward said orifice, the surface of said director at its maximum diameter being tangent to a direction substantially parallel to the direction of flow of said liquid as it leaves said orifice, the diameter of said director at its maximum diameter being between 1.5 and 2.5 times the mean diameter of said orifice.

5. In a power washer for spraying cleaning liquid with high hydraulic force over surfaces to be cleaned, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director each transverse cross-section of which is circular in outline, said director having a rounded tip portion with a radius of curvature not significantly greater than a distance equal to one-half the mean diameter of said orifice, and means rigidly supporting said director in a fixed position in front of and spaced from said orifice with its tip in alignment with and facing toward said orifice, the length of said director being between 2.5 and 3.5 times the mean diameter of said orifice.

6. In a power washer for distributing liquid spray uniformly over a substantial area, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in a fixed position in front of and spaced from said orifice with its tip facing toward said orifice, said director having a smooth surface with a tip portion in alignment with and pointed toward said orifice, said smooth surface having a radius of curvature at least equal to twice the mean diameter of said orifice and diverging at said tip portion at an angle lying between 60° and 90° so that a substantial Bernoulli effect is exerted on the liquid of said stream impinging on the surface of the director, a substantial portion of the liquid flowing along the surface of the director and being deflected inwardly after it leaves the director to form an expanding conical spray with substantially uniform distribution over its cross-section.

7. In a power washer for distributing liquid spray uniformly over a substantial area, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in front of and spaced from said orifice with its tip in alignment with and facing toward said orifice, the maximum diameter of said director being between 1.5 and 2.5 times the mean diameter of said orifice.

8. In a power washer for distributing liquid spray uniformly over a substantial area, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in a fixed position in front of and spaced from said orifice with its tip in alignment with and facing toward said orifice, the over-all length of said director being between 2.5 and 3.5 times the mean diameter of said orifice.

9. In a power washer for distributing liquid spray uniformly over a substantial area, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in a fixed position in front of and spaced from said orifice with its tip facing toward said orifice, the distance between said orifice and said tip being at least equal to the mean diameter of said orifice, tangents to opposite sides of the surface of said director near said tip defining enclosed angles between 60° and 90°.

10. In a power washer for spraying cleaning liquid with high hydraulic force over surfaces to be cleaned, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in a fixed position in front of and spaced from said orifice with its tip facing toward said orifice, said director being so shaped that every cross-section thereof in a plane perpendicular to the direction of flow of said liquid through said orifice is circular in outline and so that conical surfaces tangent to the surface of the director adjacent its tip will define enclosed angles of between 60 and 90 degrees.

11. In a power washer for spraying cleaning liquid with high hydraulic force over surfaces to be cleaned, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, a generally bullet-shaped director, and means supporting said director in a fixed position in front of and spaced from said orifice with its tip facing toward said orifice, the director having a ball shaped nose with radius of curvature not significantly greater than one-half the mean diameter of said orifice, the distance between the nose of the director and said orifice being at least equal to the mean diameter of said orifice, the surface of said director at its maximum diameter being tangent to a direction substantially parallel to the direction of flow of said liquid as it leaves said orifice.

12. In a power washer for distributing liquid spray, a jet assembly comprising a body having a passageway for conducting cleaning liquid and an orifice for ejecting the liquid in a substantially solid stream, the axis of said orifice being at an angle to said passageway less than 45°, a generally bullet-shaped director, means supporting said director in front of said orifice with its tip facing toward said orifice and spaced therefrom with its longitudinal axis parallel to the axis of the orifice, the portion of the surface of the director in the path of the fluid from said orifice being convex, and said director being so proportioned that the included angle between lines in a common plane extending between the tip of said director and oppositely disposed surface points at its maximum diameter is not significantly greater than thirty-seven degrees.

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