Dec. 4, 1962 L. OBIDNIAK 3,066,875

ADJUSTABLE LIQUID EJECTOR NOZZLE

Filed Sept. 15, 1958

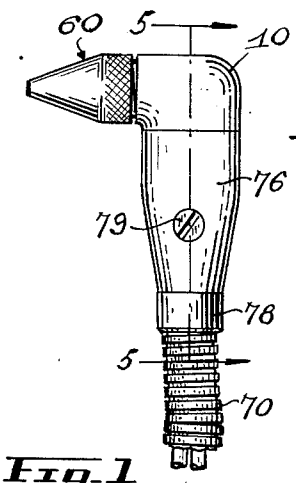


Fig. 1

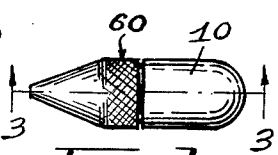
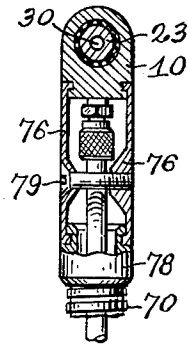


Fig. 2



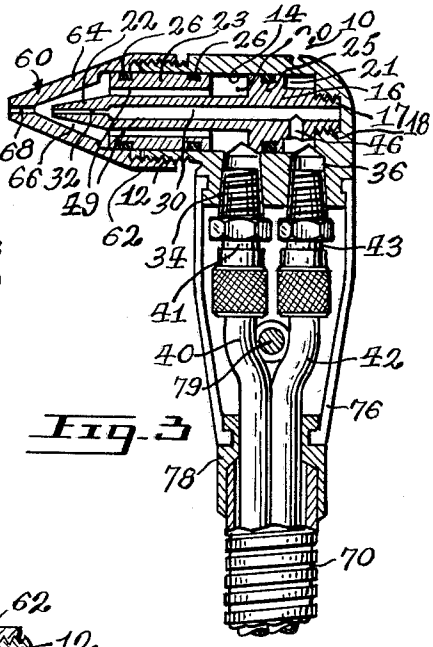


Fig. 3

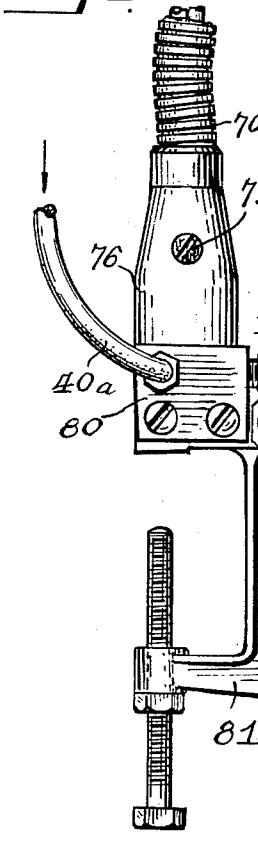


Fig. 5

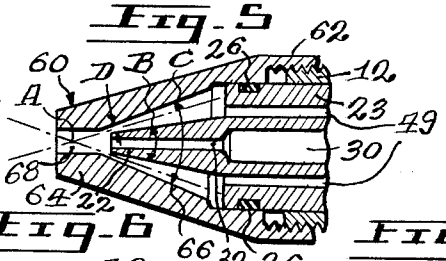
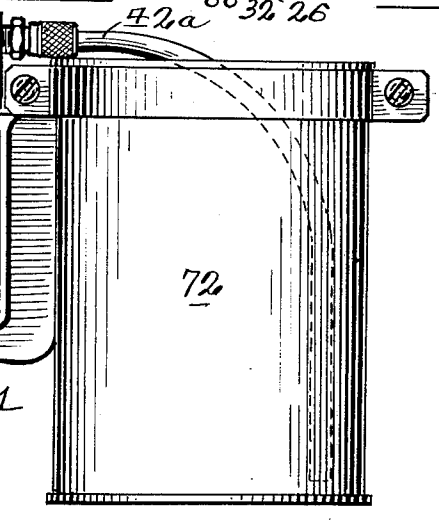


Fig. 6



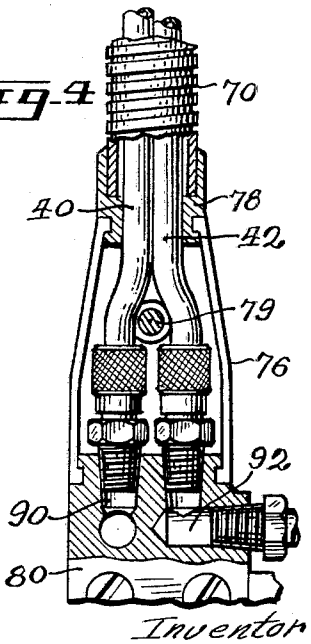


Fig. 4

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ADJUSTABLE LIQUID EJECTOR NOZZLE

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1 Claim. (Cl. 239—417)

The present invention relates to improvements in the construction of liquid ejector nozzles, and more particularly to improvements in nozzles of this type adapted to dispense a liquid spray by suction induced flow as opposed to direct pressure spraying of a pressurized liquid.

While the use of a stream of pressurized gas, compressed air for example, as a means of creating an aspirating effect in an ejector nozzle is well known in general, an effective simple way of controlling the flow of gas and/or liquid has not been provided in the prior art ejector nozzle constructions known to the applicant.

Usually, the pressurized gas is directed in a high velocity flow past the open end of a liquid delivery tube so as to create the aspirating effect drawing the liquid from the tube, and by the mixing of the liquid with the air creating an atomizing effect as it is ejected from the nozzle. In the most common form of such nozzle arrangements the air delivery or primary flow tube is disposed axially of the liquid delivery or secondary flow tube with a portion of the outer tube in advance of the inner primary flow tube serving as a mixing chamber. In this type of nozzle, the high velocity stream of pressurized air, since it is disposed along the axis of the nozzle, is in the axial centre of the mixing zone and tends to form a cone extending through the nozzle to which the liquid drawn from the surrounding liquid tube engages only by surface contact. Accordingly, the flow of liquid cannot possibly attain the speed of the pressurized gas stream and therefore complete and efficient mixing is not achieved. Adjustment of the degree of atomization is generally achieved by varying the size of the mixing chamber so as to theoretically vary the quantity of liquid withdrawn while maintaining the primary or pressurized air flow constant. This is not too satisfactory and while it can be improved by the addition of a further control, for example a separate valve, on the primary flow this of course complicates adjustment and adds to the cost of manufacture.

The present invention recognizes these disadvantages and aims to provide an improved ejector nozzle construction wherein the liquid to be dispensed is forced to pass directly into the high velocity primary air flow and accordingly is completely mixed with the air. The present nozzle construction includes means whereby by a single adjustment the discharge of liquid-air mixture can be controlled from the finest mist to the heaviest spray and further permits reversal of a portion of the primary air flow through the liquid delivery tube for cleaning purposes.

Accordingly, the invention is embodied in an ejector nozzle assembly including an ejector body having at least a forward portion of cylindrical formation and a liquid passage extending through the body with a terminal portion of the ejector body surrounding the liquid passage being of a reduced diameter relative to the remainder of the body and formed to constitute a conical liquid ejector tip. A hollow outer nozzle is adjustably mounted on the ejector body and includes a tapering conically-shaped forward portion which fits over and surrounds the liquid ejector tip in spaced relationship to provide an air chamber between the exterior of the tip and the interior of the nozzle. At least one recess is provided through the ejector body into the nozzle air chamber and an axial recess is provided in the forward end of the

outer nozzle portion which is disposed in axial alignment with the ejector body liquid passage.

In accordance with the present invention the interior of the nozzle portion surrounding the ejector tip is formed at an angle slightly greater than that of the exterior of the ejector tip so as to provide therebetween a conical air discharge passage converging from the air chamber to the outer nozzle discharge passage. The outer nozzle, as previously mentioned, is adjustably mounted on the ejector body, preferably by threaded engagement, so that by adjustment of the outer nozzle in the axial direction relative to the ejector body the dimensions of the conical air discharge passage can be varied from a fully open position providing a discharge capacity greater than that of the nozzle outlet passage to a fully closed position sealing off the air discharge passage in advance of the nozzle outlet passage.

Having thus generally described the nature of the invention, particular reference will be made to the accompanying drawing, showing by way of illustration a preferred embodiment, and in which:

FIGURE 1 is a view in side elevation of an ejector nozzle assembly constructed in accordance with the invention as it would appear when utilized in combination with a supply container of liquid, for example, a machine tool coolant.

FIGURE 2 is a top plan view of the ejector nozzle construction shown in FIGURE 1.

FIGURE 3 is an interior cross-sectional view of the construction shown in FIGURE 2 along the line 3—3.

FIGURE 4 is an enlarged detail view, partially in cross-section, to illustrate the connections of the liquid and air delivery conduit, leading from the supply tank shown to the ejector nozzle.

FIGURE 5 is a cross-sectional view of the construction shown in FIGURE 1 along the line 5—5.

FIGURE 6 is an enlarged detail view, in section, of the forward portion of the ejector nozzle construction of the invention to show the variance in angle between the interior walls of the outer nozzle and the exterior of the ejector tip more clearly.

With particular reference to FIGURES 2, 3, 5 and 6 of the drawings, a preferred construction of an ejector nozzle in accordance with the invention consists essentially of a main body 10 having a forward threaded extension 12 and a central recess 14 adapted to receive a generally cylindrical ejector body 16.

The ejector body 16 is shaped to provide inwardly extending annular recesses 20, 21 and a forward portion 22 of reduced diameter and conically tapering formation. The body portions 23, 25 of maximum diameter are provided with annular grooves adapted to accommodate sealing rings 26 and the tail end 17 of the body 16 is threaded, as shown most clearly in FIGURE 3, to threadably engage with a corresponding tapped opening 18 provided in the base of the recess 14. The ejector body 16 is bored axially to provide a liquid conducting passage 30 which is reduced in diameter, as indicated at 32, at the body forward portion 22 providing a restricted passage adapted to increase the velocity and measure the quantity of liquid drawn therethrough. In the construction shown the main body 10 is bored transversely of the axis of the recess 14 to provide ports 34, 36 leading into the annular recesses 20, 21 for the entrance of pressurized air and inducted liquid respectively. These are supplied through conduits 40, 42 through fittings 41, 43, as will be described in more detail later. A further trans-axial recess 46 extends through the lower portion of the annular recess 21 into the liquid passage 30 to complete the communication from the conduit 42 while the ejector body portion 23 is provided with borings 49 parallel to the main passage 30 and

leading from annular recess 20 to the front face of the body 16 to complete the communication from the conduit 40.

The main controlling element of the assembly is a hollow outer nozzle 60 shaped so as to have a first cylindrical portion 62 adapted to fit over and threadably engage the main body extension 12, and a tapering conical forward portion 64 adapted to fit over the ejector body tip 22 in spaced apart relationship forming therebetween a conically-shaped air passage 66, as shown most clearly in FIGURE 6. The nozzle portion 62 is axially recessed to provide an outlet passage 68 in concentric axial alignment with the ejector body passage 32, 30.

With reference to FIGURE 6, the principle of this arrangement is as follows. The pressurized fluid constituting the primary flow, for example compressed air delivered through the conduit 40, enters the ejector body recess 20, passes through the ejector body and enters the conical air passage 66. It should be noted that the exterior of the ejector tip is formed at converging angles B while the interior walls of the nozzle portion 64 are formed at a greater angle C, giving the air passage 66 the form of a tapered hollow cone with gradually converging side walls. This double-tapered or cone within a cone formation of the air passage 66 creates the best possible discharging conditions for the primary flow and makes the unique control afforded by the present invention possible. To continue, the primary flow of air passes through the passage 66 to the control section D and from the section D, having acquired high velocity, out of the nozzle outlet passage 68 to atmosphere. Accordingly, as previously explained, the form of the primary flow is a hollow cone with its apex A aligned with the axial centre line of the nozzle outlet passage 68. This form of discharge creates the desired maximum aspirating action and completely surrounds the conical ejector tip 22 causing liquid to be sucked up through the conduit 42 into the liquid passages 30 and from the passage 32 into and through the point A of the primary flow. It will be appreciated that every drop of the liquid in the secondary flow is pulled into the primary flow and intimately mixed in the outlet passage 68 prior to discharge. By this arrangement the two flows change their speed in the outlet passage 68 and acquire some intermediate speed which is a function of the two masses. Since no part of the secondary or induced flow can escape the mixing in the outlet passage without being affected by the primary discharging flow, an ideal condition is achieved in which the primary and secondary flows are physically forced to exchange their speeds.

As the nozzle 60 can be adjusted axially relative to the ejector tip 22 and parallel to the centre line of the nozzle assembly, the dimensions of the air passage at the section D can be increased or decreased. The axial movement of the nozzle 60 does not in any way affect the relationship of the angles B and C of the nozzle and ejector so that discharging conditions will remain unchanged. Accordingly, by displacement of the nozzle 60, with a primary flow of constant pressure, varying quantities of primary flow will be achieved and varying degrees of suction can be created and by such variation the mass of ejected liquid will automatically change in relative proportion.

For example, by retraction of the nozzle 60 to a point where the end of the ejector tip 22 is in actual contact with the tapering inner walls of the outer nozzle it will act as a valve and completely shut off the primary flow. In the absence of primary flow, of course, no suction is created and there is no discharge of secondary flow or liquid. Extension of the nozzle 60 from this position will gradually increase the dimensions of the conical air passage 66 at section D permitting flow of primary air and consequent aspiration and discharge of liquid.

A practical example of one preferred embodiment of the ejector nozzle of the invention is shown in FIGURE 1. In this arrangement the conduits 40, 42 extend through a flexible metal hose 70 to a connection with a liquid coolant supply tank 72 and air supply line 40*a*, through supporting block 80. The flexible metal hose 70 protects the conduits 40, 42 against physical damage and at the same time provides a flexible support for the ejector nozzle.

As is shown most clearly in FIGURES 3 and 5, the ejector nozzle assembly is connected to the end of the hose 70 by a split casing 76 having end flanges engaging the assembly body 10 and an end sleeve 78 provided on the hose 70. The portions of the casing 76 are held together by a screw 79, as shown in FIGURE 5. The other end of the hose 70 is similarly attached to a supporting block 80 mounted on a C-type clamp 81 suitable for attachment to a machine frame, for example. The block 80 is bored to provide a liquid conducting passage 90 and an air conducting passage 92 and the terminal ends of the conduits 40, 42 are connected to these passages by suitable fittings, as previously described. An extension conduit 42*a* is connected into the liquid conducting passage 92 and extends within the coolant tank 72, as indicated in FIGURE 1. An air supply conduit 40*a* is also connected into the passage 90 from a suitable source of compressed air.

As previously described, the action of the primary air flow delivered through the conduit 40 creates an aspirating effect on the conduit 42 drawing liquid up through the conduit 42*a* from the supply tank 72 and discharging it in an atomized spray of any desired liquid content. This is a further advantageous feature in the present construction which is particularly useful when the assembly is utilized for the spraying of machine tool coolant as shown, or similar liquids. The total cross-section of the air delivery borings 49 in the ejector body portion 23 is greater than the cross-section of the nozzle outlet discharge passage 68. As long as the cross-section D of the conical air discharge passage is adjusted so as to be smaller than that of the nozzle outlet passage 68 a pressure drop will occur and create the desired aspirating effect. However, if the nozzle 60 is advanced to the point where the section D is greater than that of the nozzle passage 68 there will be no pressure drop or expansion in the section D and the primary flow of air will be forced back through the passages 32, 30 of the ejector body 22, through the conduit 42 and into the supply tank 72. This reverse flushing serves two purposes: (*a*) the flushing of the ejector body and conduit 42 cleans the coolant tube and prevents possible clogging; and (*b*) the blowing in of air under pressure through the coolant stirs it up and tends to homogenize the suspension. All of the described effects are achieved easily and simply by the rotation of the nozzle 60 relative to the main body 10 without the necessity of providing supplementary valves or controls.

I claim:

An aspirator nozzle comprising an elongated body having an externally threaded extension at one end and an axial blind recess opening into said one end, said body including a pair of inlet ports spaced along said axial recess for respective connection to a source of liquid and pressurized fluid, an ejector body extending axially within said axial recess and terminally secured at one end at the end of said blind recess opposite said threaded extension, said ejector body including longitudinally spaced annular grooves each respectively communicating with one of said inlet ports, said ejector body including an axial liquid-receiving passage communicating with one of said annular grooves for receiving liquid therefrom, said axial liquid-receiving passage terminating in a reduced cross-section at the terminal end thereof, said ejector body including longitudinally spaced seal means circumposed about said body and isolating said annular grooves within said axial recess, said ejector body terminating in a frusto-conical tip portion, having a base disposed at an annular face, said ejector body including longitudinally extending fluid pres-

sure passage means opening into said annular face and communicating with said other annular groove, and a tubular nozzle element threadedly engaged on said threaded extension for free and ready manual longitudinal adjustment thereon, seal means interposed between said nozzle element and said ejector body, said nozzle element including an outlet passage in coaxial, spaced alignment with said reduced cross-section passage portion of said ejector body, said nozzle element including a frusto-conical internal chamber circumposed about said frusto-conical terminal tip portion of said ejector body, a projection of the frusto-conical chamber terminating at an imaginary apex intermediately of said outlet passage and at a greater angle than a projection of the outer surface of said frusto-conical tip portion, said nozzle element being retractable on said body whereby the terminal end of said ejector body will engage said internal chamber wall and no pressurized fluid will flow to cause aspiration of liquid from the axial passage of said ejector body, and said nozzle element being positionable in spaced relation from said ejector body tip portion a sufficient extent to cause a back pressure in said ejector body axial passage to keep the axial passage free of foreign matter and stir the liquid with which the axial passage normally communicates.

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