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[54] **ASPIRATING SPRAY HEAD**

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[21] Appl. No.: **245,677**

Related U.S. Application Data

[63] Continuation of Ser. No. 66,810, Aug. 25, 1970, abandoned.

[52] **U.S. Cl.** **239/434**

[51] **Int. Cl.** **B05b 7/04**

[58] **Field of Search** 239/434, 433, 431

[56] **References Cited**

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[57] **ABSTRACT**

In an aspirating spray head, fluid is introduced by way of an air inlet passage through one end of a larger diameter receiving passage which is open at its other end and liquid is introduced to the receiving passage by way of a liquid inlet passage which laterally opens into the receiving passage between its end. The end of the receiving passage through which the air inlet passage opens is defined by an abrupt shoulder which lies in a plane perpendicular to the receiving and air inlet passages, and the edge of the openings through which the air and liquid inlet passages open into the receiving passages are spaced from each other. When air is introduced into the receiving passage from the air inlet passage, liquid is aspirated through the liquid inlet passage and mized with the air in the receiving passage where the mixture is discharged therefrom as a spray. The ratio of the diameter of the receiving passage to the diameter of the air inlet passage is preferably between approximately 1.6 and 2.5 and the ratio of the distance between the openings of the liquid and air inlet passages to the diameter of the air inlet passage is preferably less than approximately 2.0.

6 Claims, 12 Drawing Figures

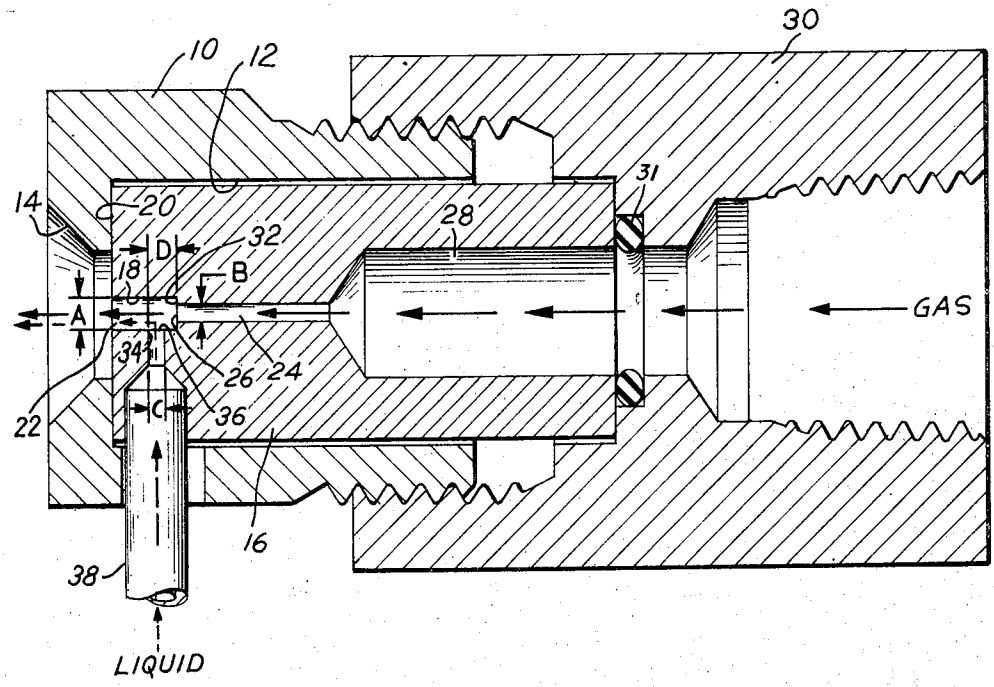
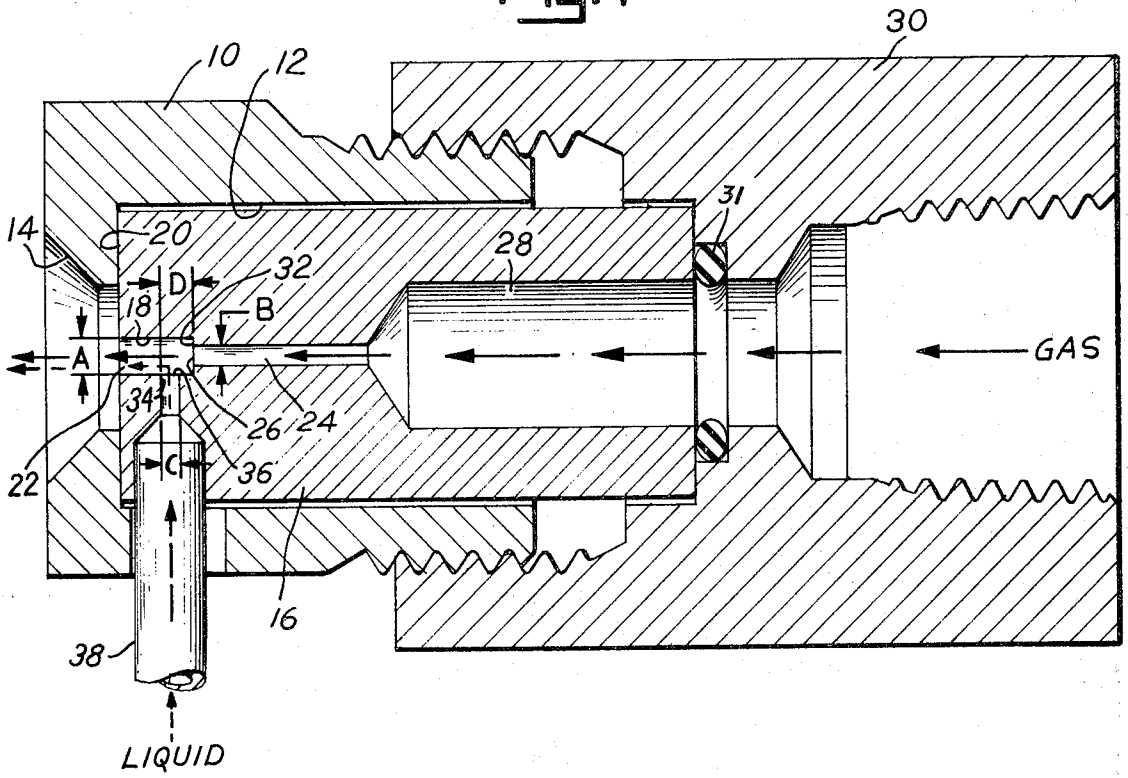


Fig. 1



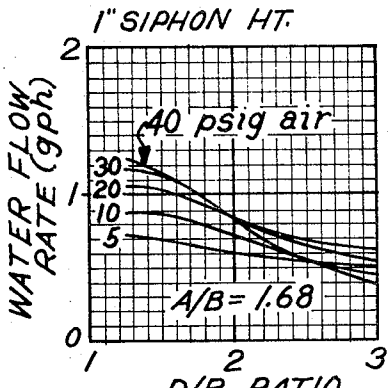


Fig. 2

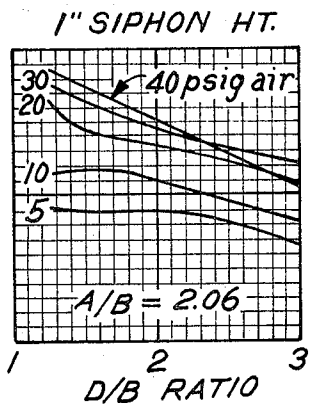


Fig. 3

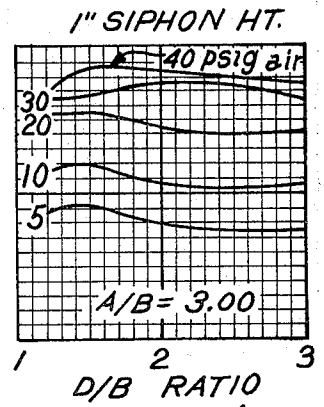


Fig. 4

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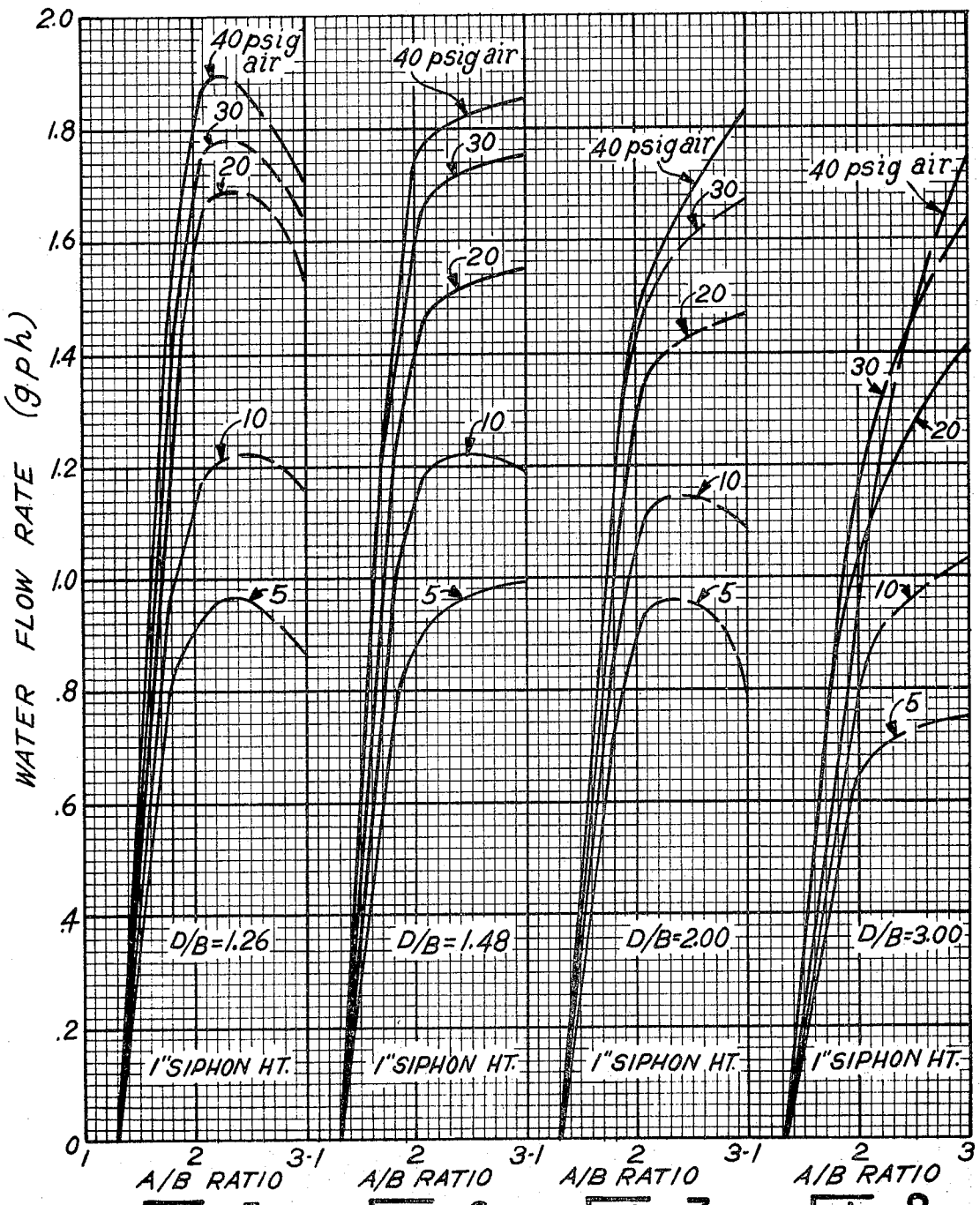


Fig. 5 Fig. 6 Fig. 7 Fig. 8

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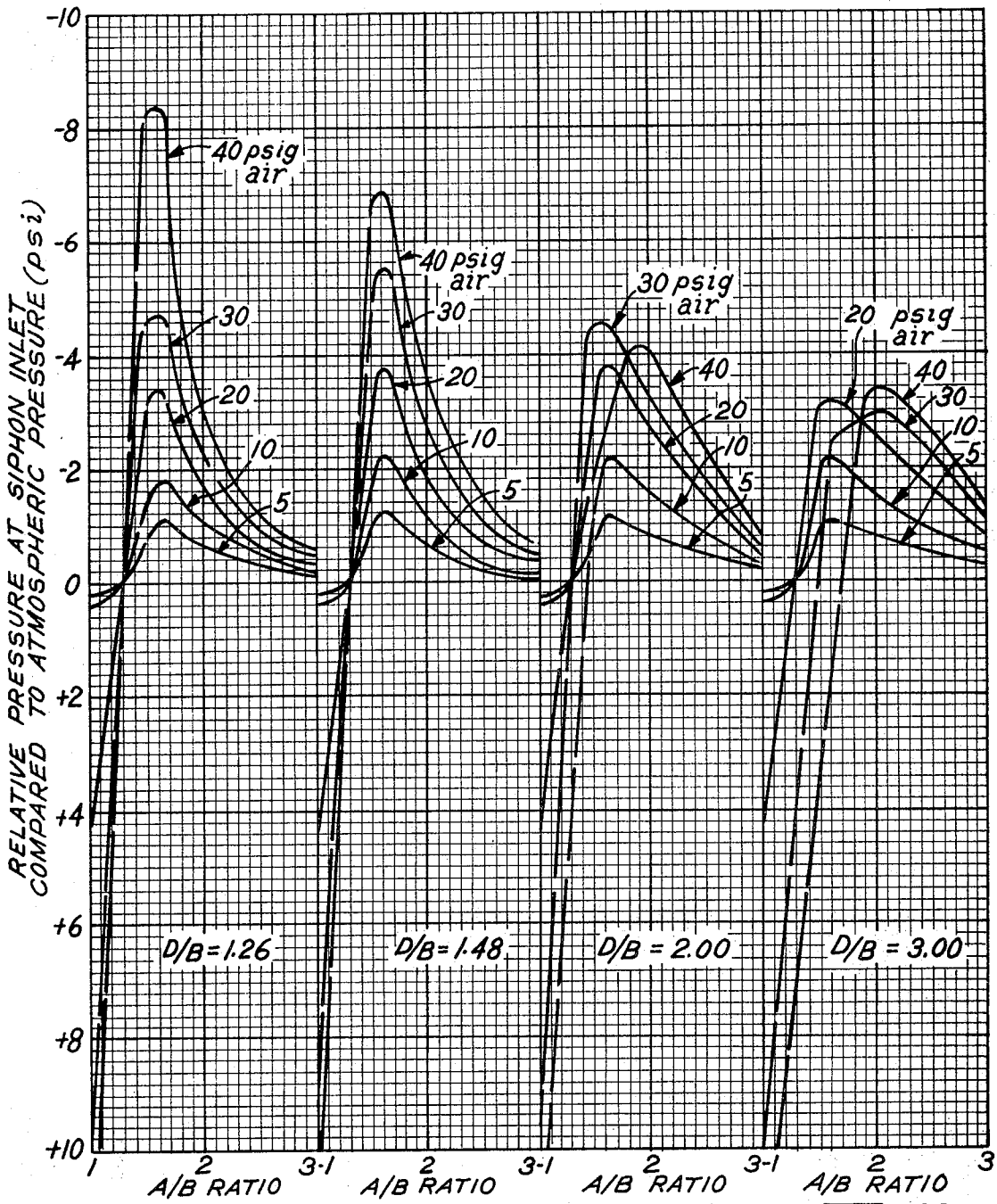


Fig. 9 Fig. 10 Fig. 11 Fig. 12

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ASPIRATING SPRAY HEAD

This is a continuation of application Ser. No. 66,810, filed Aug. 25, 1970, and now abandoned.

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a spray head and, more particularly to an aspirating spray head.

Aspirating spray heads are widely used for spraying various commodities such as insecticides, herbicides, hair spray, paint, etc. These aspirating spray heads generally employ a tapered Venturi in which air or other gaseous fluid is forced through a conveying/diverging tapered Venturi configuration and a low pressure region is formed at the location of the minimum diameter of the Venturi where the velocity of the air is the highest according to the well known Bernoulli theorem. A liquid inlet passage communicates with this small diameter throat and, since the pressure is reduced at the throat, liquid is drawn through the inlet passage and is mixed with the gas stream.

Such Venturi devices require precise sizing of the respective large inlet and small throat diameters and also require a uniform predetermined tapered transition between these areas. Moreover, since the transition between the throat and the large diameter portions of the Venturi is tapered, provision must be made during manufacture to form these tapered portions.

The aspirating spray head constructed in accordance with the principles of the invention obviates the need for such Venturi configurations and their attendant disadvantages. In the aspirating spray head constructed in accordance with the principles of the invention, tapered transition surfaces as well as the close tolerance dimensions which were required in Venturis are no longer necessary. Accordingly, manufacturing cost and effort are minimized in the spray head of the invention, and the spray head is capable of manufacture in a simple one piece moulding or by simple straight drilling operations. In the spray head constructed in accordance with the principles of the invention, the liquid stream is introduced into an expanding portion of the gas stream, rather than that portion of the stream which is at the highest velocity, and into a receiving passage which is larger in diameter, rather than smaller than the diameter of the gas inlet passage. Finally, I have discovered that the aspirating spray head constructed in accordance with the principles of the invention is particularly effective in use if the spray head is constructed in accordance with certain ratio relationships which will be described hereinafter.

In a principal aspect of the invention, an aspirating spray head includes a receiving passage which is open at one end and a second fluid inlet passage which communicates with the opposite end of the receiving passage and is adapted to deliver a flow of a first fluid to the receiving passage. The receiving passage is of a larger cross sectional dimension than the second passage and the end of the receiving passage at which the second inlet passage communicates defines a shoulder which is positioned in a plane which is perpendicular to the passages. A third inlet passage opens laterally into the receiving passage between its ends and is adapted to be connected to a source of a second fluid, whereby this second fluid is aspirated from the source by the flow of the first fluid into the receiving passage and the fluids are mixed in the receiving passage and discharged as a spray.

In another principal aspect of the invention, the ratio of the width of the receiving passage to the second inlet passage is in the range of approximately 1.6 and 2.5.

In another principal aspect of the invention, the edge of the opening of the third inlet passage where it opens into the receiving passage is spaced a predetermined distance from the opening of the second inlet passage into the receiving passage and the ratio of this distance to the width of the second inlet passage is less than approximately 2.0.

These and other objects, features and advantages of the present invention will become evident upon consideration of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

In the course of this detailed description, the drawings will frequently be referred to in which:

FIG. **1** is a cross sectioned elevation view of a preferred embodiment of aspirating spray head constructed in accordance with the principles of the invention;

FIGS. **2–4** are plots of water flow rate (gph) *v.* D/B ratio, where the A/B ratio is constant at 1.68, 2.06 and 3.00 respectively, A, B and D being shown in FIG. **1**;

FIGS. **5–8** are plots of water flow rate (gph) *v.* A/B ratio, where the D/B ratio is constant at 1.26, 1.48 2.00 and 3.00 respectively, and

FIGS. **9–12** are plots of the relative pressure at the siphon inlet compared to atmospheric pressure (psi) *v.* A/B ratio where the D/B ratio is constant at 1.26, 1.48, 2.00 and 3.00 respectively.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1**, a preferred embodiment of aspirating spray head constructed in accordance with the principles of the invention is shown which includes a nozzle body **10** having an elongated cylindrical chamber **12** therein which opens through one end of the body through a spray opening **14** and is open at the other end to receive a cylindrical passage insert **16.** A receiving passage **18,** having a given diameter A, is bored or moulded so as to extend axially into one end **20** of the insert partially along its length, the receiving passage **18** opening at **22** through the insert end. A second air inlet passage **24,** having a diameter B which is smaller than A, opens at **26** into the receiving passage **18** for the delivery of air or other suitable gas to the receiving passage. Passage **24** may communicate at its other end with the larger air passage **28,** if desired, which in turn, is adapted to be coupled in a conventional manner by way of a suitable coupling **30** and seal **31** to a source of pressurized air or other gaseous fluid (not shown).

The receiving passage **18** is preferably cylindrical in shape and the end of the receiving passage opposite its open end **22,** and in which opening **26** is defined, is formed as an abrupt shoulder **32** through which passage **24** opens. This shoulder **32** lies in a plane which is substantially perpendicular to the axes of passages **18** and **24.**

A third liquid inlet passage **34** opens at **36** laterally to the receiving passage **18** as shown in FIG. **1.** This passage **34** is adapted to be connected by way of a suitable conduit **38** to a source of liquid (not shown) which

is to be aspirated by and into the air stream which is introduced into the receiving passage through passage **24.**

In operation, air or other suitable gas, as shown by the solid arrows in FIG. **1,** is introduced through inlet passage **24** into the receiving passage **18.** Since the receiving passage is larger in diameter or width than the gas inlet passage **24,** this gas will abruptly expand and a reduction in the pressure in the receiving passage adjacent opening **36** will result. This reduction in pressure is quantitatively shown in FIGS. **9–12.** Since the pressure is reduced adjacent the opening **36** and the liquid source is usually at atmospheric pressure, liquid will be forced up through conduit **38** and the liquid inlet passage **34** and will be injected into the gas stream in the receiving passage where it will be mixed with the gas and will issue from the open end **22** of the receiving passage in the form of a spray mixture.

It will be noted that the transition between passages **18** and **24** is not tapered as in the case of a Venturi, but is an abrupt shoulder. Thus, both the expense as well as the complexity of manufacturing are substantially reduced and simplified over the type of aspirating spray head in which surfaces must be tapered, since all operations on the insert **16** may be performed by simple one piece moulding or straight drilling techniques. Moreover, the critical nature of small tolerance dimensions is minimized.

When practicing the above invention, it has been found that if certain dimensional ratio relationships are followed, the aspirating spray head of the invention will function extremely effectively and these ratios may be easily and inexpensively built into the spray head during manufacture. Where these dimensional ratios are departed from, either above or below, operation of the spray head of the invention will be somewhat impaired and the spray head may not function satisfactorily. The ratios which have been found to be important are the ratio of the width or diameter A of the receiving passage **18** to the width or diameter B of the air inlet passage **24** (A/B ratio) and the ratio of the distance D between the downstream edge of the opening **36** of the liquid inlet passage **34** where it opens into the receiving passage and the opening **26** of the air inlet passage **24** where it opens into passage **18** to the diameter B of the air inlet passage **24** (D/B ratio).

With reference first to the effect of the D/B ratio, several plots are shown in FIGS. **2–4** which show liquid flow curves for air pressures which vary between 5 and 40 psig and wherein the water flow rate, in gph, is plotted *v.* D/B ratios varying from 1.00 to 3.00. Each of these plots is for a siphon height of one inch and in FIG. **2** the A/B ratio is constant at 1.68, in FIG. **3** the A/B ratio is constant at 2.06 and in FIG. **4** the A/B ratio is constant at 3.00.

It will be noted when considering the plots in FIGS. **2–4,** that for any given A/B ratio, the water flow rate is the highest as the D/B ratio approaches 1.0 and the flow rate drops off as the D/B ratio is increased. It will be noted in FIGS. **2** and **3,** that the flow rate is substantially diminished when the D/B ratio exceeds 2.0. Although the curves in FIG. **4** do not show a marked variation in slope for D/B ratios between 1.0 and 3.00, D/B ratios in excess of 2.00 have been found to be impractical at low gas input pressures and at A/B ratios of 3.00, since the low pressure zone adjacent opening **36** becomes so weak that liquid cannot be lifted, in general, beyond the one inch siphon height of the various tests plotted in FIG. **4.** This loss of pressure differential where the A/B ratio is 3.00 is clearly shown in FIGS. **9–12.**

Thus, it has been found that the performance of the spray head is improved the nearer the opening **36** is positioned to opening **26** and shoulder **32** and, in no case except possibly only where very small siphon heights are contemplated, should the D/B ratio exceed 2.00.

Referring now to A/B ratio, in FIGS. **5–12** plots are shown of various curves for inlet air pressures of between 5 and 40 psig. In FIGS. **5–8** water flow rate, in gph, is plotted *v.* A/B ratios varying from 1.00 to 3.00. In FIGS. **9–12** the pressure drop, and more specifically, the relative pressure at opening **36** as compared to atmospheric pressure, in psi, is plotted *v.* A/B ratios which also vary between 1.00 and 3.00. In FIGS. **5–8** the siphon height is again 1 inch and in FIGS. **5** and **9** the the D/B ratio is constant at 1.26, in FIGS. **6** and **10** the D/B ratio is constant at 1.48, in FIGS. **7** and **11** the D/B ratio is constant at 2.00, and in FIGS. **8** and **12** the D/B ratio is constant at 3.00.

It will be seen when considering these plots in which the D/B ratio is held constant, when the A/B ratio is increased, both the water flow rate and the pressure differential in the receiving passage **18** for a given gas inlet pressure will markedly increase to a given maximum and then rapidly fall off as the A/B ratio is further increased. Thus, referring first to FIGS. **5–8,** the flow rate will reach a maximum when the A/B ratio is approximately in the range of between 2.0 and 2.5.

However, this 2.0 to 2.5 A/B ratio must be somewhat reduced where the siphon height is greater than 1 inch, the siphon height which is plotted in FIGS. **5–8,** since adequate relative pressure will not exist in the receiving passage **18** to lift the liquid over much greater heights. Referring to FIGS. **9–12** in which the relative pressure adjacent the opening **36** to atmospheric pressure is plotted *v.* the A/B ratio, it will be seen that this relative pressure reaches a maximum at an A/B ratio of approximately 1.68 and then rapidly decreases to a substantially lower value in the range of A/B ratios of 2.0 – 2.5. This relative pressure is directly related to the height to which the liquid may be siphoned. Thus, not only does this relative pressure substantially decrease at D/B ratios of over 2.00 as previously mentioned, but this pressure is also substantially decreased at A/B ratios of over 2.00 for a given inlet air pressure. By way of specific example, where the inlet air pressure is 5 psig, it is virtually impossible to aspirate liquids at a siphon height of much greater than one inch where both the A/B and D/B ratios exceed 2.00.

It has been found that the ratio of the diameter or width C of the liquid inlet passage **34** to the diameter of width B may be varied over a substantial range without adversely altering the performance of the spray heads of the invention. The tests plotted in FIGS. **2–12** were conducted at a C/B ratio of 1.26.

It should be understood that although the invention has been described as employing water as a liquid and air as a gas, the use of various other liquids and gases is contemplated. In fact, when considering the described invention, it will be appreciated that the invention may be employed as a vacuum pump wherein a gas is drawn through passage **34,** as a materials mixing device for mixing two different fluidized streams, or as a spray or mixing device for drawing a slurry or a pow-

dered solid mixture through passage **34**. Moreover, it is also contemplated that liquid rather than a gas may be passed through passage **24**. Also it will be understood that the passages may be of cross sections other than circular so long as the receiving passage is of a larger cross sectional dimension than the air inlet passage and the various ratio relationships set forth earlier obtain.

Finally it should be understood that the embodiment of the present invention which has been described is merely illustrative of one of the applications of the principles of the invention. Numerous modifications may be made by those skilled in the art without departing from the true spirit and scope of the invention.

What is claimed is

1. In an aspirating head,

a first receiving passage open at one end to discharge a stream from the head,

a second inlet passage opening through the opposite end of said first receiving passage and adapted to deliver a flow of a fluid to said receiving passage.

said receiving passage having a cross sectional dimension which is substantially constant over its length and in which the ratio of the width of the receiving passage to the width of said second inlet passage is in the range of approximately 1.6 to 2.5, said opposite end of said receiving passage defining a shoulder which is positioned in a plane which is perpendicular to said passages, and

a third inlet passage opening laterally into said receiving passage between said one end and said shoulder and in spaced relationship to said shoulder, said third inlet passage being adapted to be connected to a source of material at substantially atmospheric pressure, said passages being dimensioned and spaced from each other such that a pressure less than atmospheric pressure is present adjacent the opening of said third inlet passage when fluid is delivered through said second inlet passage, whereby said material is aspirated from the source by the flow of said fluid into said receiving passage and the fluid and material are mixed in the receiving passage and discharged therefrom.

2. In the aspirating head of claim **1** wherein the edge of the opening of said third inlet passage into said first receiving passage is spaced a predetermined distance from the opening of said second inlet passage into said receiving passage, and the ratio of said distance to the width of said second inlet passage is less than approximately 2.0.

3. In the aspirating head of claim **1** wherein the upper limit of said ratio is approximately 2.0.

4. In the aspirating head of claim **1** wherein said fluid is a gas and said material is a liquid.

5. In an aspirating spray head,

a receiving passage having a given diameter and open at one end to discharge spray from the device,

a gas inlet passage opening through the opposite end of said receiving passage and adapted to deliver a flow of gas to said receiving passage, the diameter of said gas inlet passage being smaller than said given diameter and the ratio of said given diameter to said last diameter being in the range of approximately 1.6 and 2.5, and

a liquid inlet passage opening laterally into said receiving passage and adapted to be connected to a source of liquid at substantially atomspheric pressure, the opening of said liquid inlet passage being spaced a predetermined distance from the opening of said gas inlet passage such that the ratio of said predetermined distance to the diameter of said gas inlet passage does not exceed approximately 2.0, and wherein said passages are dimensioned and spaced from each other such that a pressure less than atmospheric pressure is present adjacent the opening of said liquid inlet passage when gas is delivered through said gas inlet passage.

6. In the spray device of claim **5** wherein the upper limit of said first mentioned ratio is 2.0.

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