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B. C. BRAINARD

3,032,276

SPRAY HEAD

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2 Sheets-Sheet 1

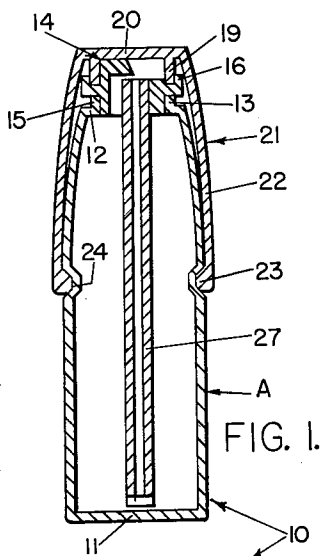


FIG. 1.

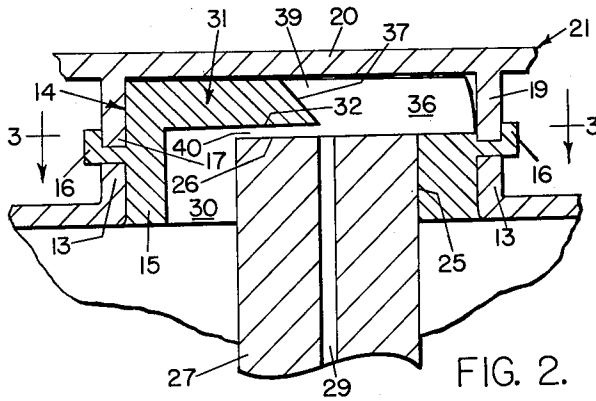


FIG. 2.

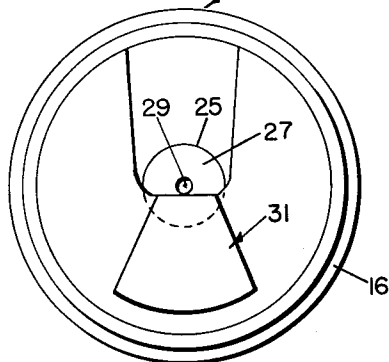


FIG. 4.

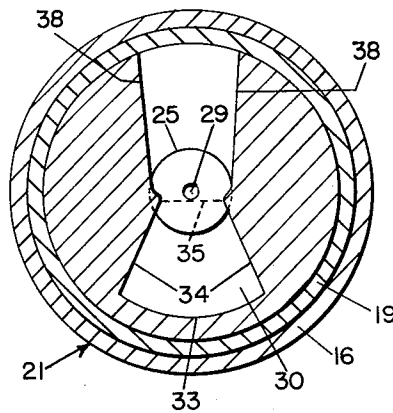


FIG. 3.

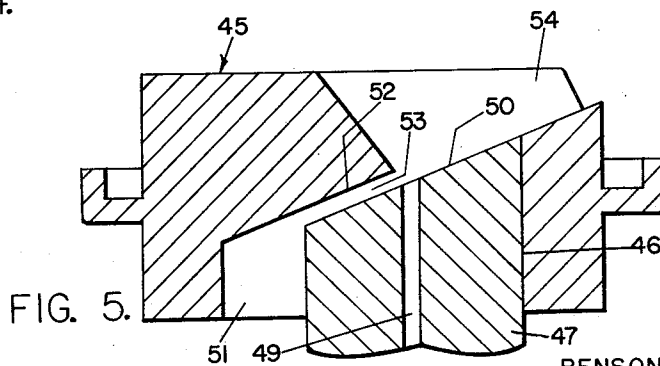


FIG. 5.

INVENTOR,
BENSON C. BRAINARD.

BY *Robert M. Dunning*
ATTORNEY

May 1, 1962

B. C. BRAINARD

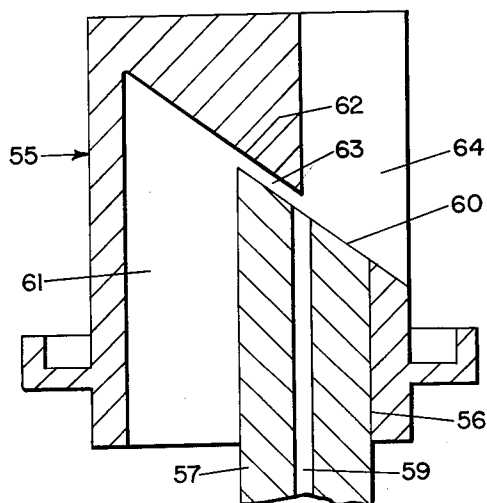
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FIG. 6.



INVENTOR;
BENSON C. BRAINARD.

BY *Robert M. Dunning*
ATTORNEY

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SPRAY HEAD

Benson C. Brainard, 14 E. Oaks Road, North Oaks,
St. Paul, Minn.

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This invention relates to an improvement in a directional spray head or nozzle for mixing gas and liquid and deals particularly with an improved structure which very effectively mixes the gas and liquid to produce a finely divided spray.

In the past the spray heads for combining gas and liquid have usually included a liquid passage and a gas passage which extend into a mixing chamber usually having a nozzle as an outlet. These previous devices have been subject to some difficulty. In the first place, in most instances the liquid does not immediately mix with the air passing through the nozzle, so that at the start of the spraying operation, only air is ejected. In others, droplets of liquid are entrained in the flow of air and when they are formed at the same pressure as air, surface tension tends to hold them in droplet form. These and other difficulties have been experienced in producing a spray head which produces a finely divided mist or spray and of a uniform character.

It is an object of the present invention to provide a liquid tube through which liquid is supplied and a generally parallel air passage through which air or gas is supplied. A cap or spray head body supports the tubular liquid supply member and incorporates an air passage. A transverse air or gas passage of small dimension extends partially over the end of the liquid tube to a point adjacent the wall of the bore of the tube. From this point, a spray outlet extends through the spray head, the spray outlet extending over a diametrically opposite part of the tube from the inlet passage and overlying the bore of the tube.

I have found that if a proper relationship is maintained between the height and width of the air inlet passage, the diameter and length of the tube bore of the liquid passage and the location of the end of the air passage, an extremely finely divided liquid spray may be produced. A wide variation from the desired proportions will greatly effect the efficiency of the spray. For example, if the air inlet passage extends any substantial distance over the end of the bore of the liquid tube, and when the spray head is used in conjunction with a squeeze bottle in which air reenters the bottle at the completion of the spraying operation, the reversely moving air travels at a relatively high velocity and ruptures the liquid surface at the upper extremity of the liquid tube and allows the liquid to drain down to the liquid level within the bottle. On the next spraying cycle, no liquid is mixed with the gas until the liquid has been forced through the tube to the upper end thereof. When the spraying liquid is forced into the pressurized portion of the air stream, the vaporization is incomplete as large drops of liquid have the tendency to interfere with the flow at the juncture of the air passage with the enlarged outlet passage. Accordingly droplets of liquid are entrained in the flow and are of the same pressure as the air so that surface tension tends to hold the droplets together. While turbulence breaks up some of the droplets, the spray is not nearly as fine as where the air inlet passage terminates in substantially right angular relation to the closest wall of the bore of the tube.

In the event the air passage terminates materially short of the nearest wall of the bore of the tube, the velocity of the air passing over the bore of the tube has materially dissipated and little or no vaporization takes place. Accordingly, it is a feature of the present invention to pro-

vide a construction of the type described in which the transverse air passage over the end of the liquid tube communicates with the discharge passage on a plane substantially even with the wall of the bore of the tube so that this air passage does not continue any material distance over the tube bore.

In the formation of the spray head, the height of the gas passage between the end of the liquid tube and the cap or head body should be approximately one-half the diameter of the bore of the tube. The width of the air passage at its juncture with the discharge passage is preferably about twenty times the diameter of the liquid tube bore. When the width of the air passage and its juncture with the discharge passage is widened, lower pressures are required to operate the spray and when the width of the air passage at this point is narrowed, higher pressures are required to operate the spray. Higher pressures and greater gas velocity at the air passage outlet are used with heavy liquids.

The length of the liquid tube also has a bearing on the efficiency of the spray head. The length of the liquid tube is preferably about 400 times the diameter of the bore of the tube. Variations in smoothness of the inside surface of the tube and variations in the diameter of the bore of the tube will also vary the length of the tube required. For lighter liquids with low surface tensions and low specific gravities, the tube length will be preferably more than 400 times the diameter of the bore and where higher surface tensions and higher specific gravities of liquids are to be sprayed, the tube should be of a length less than 400 times the diameter of the bore.

A feature of the present invention resides in the provision of a specific form of spray head which operates very effectively to produce a finely divided spray with no entrained droplets of enlarged size.

These and other objects and novel features of the present invention will be more clearly and fully set forth in the following specification and claims:

In the drawings forming a part of the specification:

FIGURE 1 is a vertical sectional view through a spray bottle and spray head showing a general arrangement of parts therein.

FIGURE 2 is an enlarged cross sectional view vertically through the spray head.

FIGURE 3 is the horizontal sectional view through the spray head, the position of the section being indicated by the line 3—3 of FIGURE 2.

FIGURE 4 is a top plan view of the spray head.

FIGURE 5 is a cross sectional view through a modified form of spray head.

FIGURE 6 is a cross sectional view through another modified form of construction of spray head.

The spray bottle is illustrated in general by the letter A and provides the most common manner of using the spray head although other types of supports may also be provided. The bottle A is disclosed as having a generally oval shaped body 10 having a closed lower end 11. The bottle is preferably formed of polyethylene plastic or other suitable resilient and flexible plastic and the walls of the bottle are sufficiently flexible so that the operator may press the walls inwardly to apply pressure to the liquid contents and the air overlying the contents. Equal pressure is thus supplied to both the air and the liquid to force the air and liquid through the outlet passage in a manner which will be later described more in detail.

The top 12 of the bottle is provided with a central opening therethrough which is encircled by an upwardly extending flange 13. The spray head is indicated in general by the numeral 14 and includes a cylindrical wall 15 about which the bottle flange 13 extends. The cylin-

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drical body portion 15 and flange 13 are preferably sealed in any suitable manner.

An outwardly projecting flange 16 is provided on the cylindrical portion 15 and is provided with a groove 17 in its upper surface which is designed to accommodate a ring shaped flange 19 extending downwardly from the top panel 20 of a cover or cap 21. The cap 21 is provided with downwardly extending peripheral walls 22 which fit snugly over the walls 10 of the squeeze bottle A at the upper end of these walls. An inwardly extending marginal flange 23 at the lower extremity of the cap walls 22 is designed to engage in a groove 24 in the flexible resilient walls 10 to hold the cap 21 in place.

It will be understood that the bottle construction described is only illustrative of a form of construction which may be used and the specific form of bottle or other spray head supports is not of particular importance in the present invention.

As indicated in FIGURES 2, 3 and 4 of the drawings, the spray head includes a cylindrical socket 25 extending into the bottom of the head, the axis of the socket being offset from the axis of the head but parallel thereto. The socket 25 terminates on the plane 26. The liquid tube 27 extends into the socket 25 and is anchored to the spray head. The tube 27 has a relatively small diameter liquid passage or bore 29 extending longitudinally therethrough.

A generally wedge shaped chamber 30 is provided in the undersurface of the head body 31, the upper surface of the wedge shaped chamber 30 being indicated at 32 which is on a level parallel to and spaced from the base 26 of the socket 25. The wedge shaped taper 30 is defined by an arcuate outer wall 33 and inwardly converging side walls 34 which intersect the socket 25. The ends of the side walls 34 terminate along an imaginary line 35 which extends along the nearest wall of the bore 29 of the tube 27.

An outlet passage 36 extends through the top of the spray head body 31, extending from the plane 26 of the socket 25 entirely through the top of the spray head. In the arrangement illustrated in FIGURE 2, the outlet passage 36 is defined by an upwardly and outwardly inclined wall 37 which includes a rounded rear wall portion 39 and substantially straight side wall portions 38 which may be parallel or may incline outwardly to some extent.

It will be noted from FIGURE 2 of the drawings that the upper end of the tube 27 extends adjacent the base of the socket 25 and the point of juncture B between the wall 37 of the outlet passage 36 adjoins the upper surface 32 of the air chamber 30 at a point directly above the wall of the bore 29 of the tube 27 so that the outlet passage 36 overlies the bore of the tube. This arrangement forms a generally transverse passage 40 between the upper end of the tube 27 and the upper surface 32 of the air chamber 30. The distance x between the upper end 26 of the tube 27 and the upper surface 30 of the passage 40 is substantially one-half of the diameter b of the tube bore 29.

From FIGURE 3 of the drawings it will be noted that the width c of the end of the transverse passage 40 is considerably wider than the bore b of the tube 27. While in the drawings the proportions must be altered in order that the various elements be shown, the width c in actual practice is preferably about twenty times the bore diameter b when the liquids sprayed are somewhat similar in specific gravity and in viscosity to water.

The height of the gas passage indicated by the letter x has been described as being preferably one-half b , the diameter of the bore 29, and the width of the passage 40 at its juncture with the outlet passage, and indicated by the letter c , is preferably about twenty times the dimension b . The height or length of the tube 27 is preferably 400 times the dimension b with specific gravities and surface tensions close to those of water. Variations in the smoothness of the inside surface of the tube, and

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variations in the diameter b of the bore 29 will vary the length of the tube required. For liquids which are lighter than water and which have low surface tension and specific gravity, the tube length e will normally be more than 400 times b . Where liquids with higher surface tensions and higher specific gravities are to be sprayed, or where the inside surface of the tube is somewhat rougher than usual, a shorter length of tube is preferably employed.

The dimension c may also be varied to change the operating pressure used within the bottle. When the passage 40 is widened, lower operating pressure may be used and such lower pressures may be used with liquids having low specific gravity and low surface tension. Narrowing the dimension c requires that higher pressures be used in the bottle and such are employed when spraying liquids having specific gravity and surface tensions above those of water.

The line of juncture between the transverse passage 40 and the outlet passage 36 has been designated by the letter d , and this line d is preferably directly over the point j where the wall of the bore 29 of the tube 27 reaches the end of the tube.

Preferably the line g does not vary from its disclosed position by more than 10% of the dimension b .

The angle i between the plane 26 and the wall 37 of the outlet passage 36 may be varied within wide limits. Effective results have been obtained when this angle was as small as 15° or as large as 165° . Thus the particular position of the wall 37 depends upon the extent to which the spray is to be combined.

The area of the air passage or air chamber 30 through which the air flows is also not particularly critical but should be, as a minimum, at least ten times the area of the passage 40 at its juncture with the discharge passage 36.

FIGURES 5 and 6 disclose variations in the head construction which may be employed if the spray is to be directed in an upward or downward direction. In this FIGURE the head 45 is provided with a socket 46 designed to accommodate a tube 47 having an axial bore 49 which has a diameter of b . The end 50 of the tube 47 which is on a plane at an angle to the axis of the tube of less than 90° .

An air chamber 51 is provided in the head adjoining the tube 47, the chamber 51 being preferably wedge shaped similarly to the chamber 30. The upper wall 52 of the chamber 51 is parallel to the tube end surface 50 and is spaced somewhat above the tapered socket 46 into which the tube 47 extends. A generally transverse air or gas passage 53 is provided between the end of the tube 47 and the surface 52, this air passage 53 communicating with the discharge passage 54 along a line d which is directly opposite the point j located at the juncture of the tube bore 49 and the end 50 of the tube. In other words, the line b is directly opposed to the wall of the bore at the end of the tube, as disclosed.

As in the previous structure, the height of the air passage 53 is equal to substantially one-half the diameter of the bore 49 or the dimension x is approximately one-half the dimension b . Also as previously described, the width of the air passage 53 is approximately twenty times the dimension b and may be varied as previously described.

FIGURE 6 of the drawings shows another modified form of construction. The spray head 55 is designed to spray a combination of gas and liquid in a downwardly inclined direction. The spray head 55 includes a cylindrical socket 56 designed to accommodate a tube 57 having a bore 59 having an internal diameter b . The upper end 60 of the tube is cut on a flat plane at an acute angle to the axis of the tube and the socket 56 is similarly shaped to accommodate the tube. An air passage 61 is provided in the head which is preferably wedge shaped and, like the head 51, the tube, air chamber, air passage and outlet chamber are all quite similar in plan. The upper surface 62 of the air chamber 61 is inclined into

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parallel relation with the base of the socket or with the plane 60 of the end of the tube 57 and provides an air or gas passage 63 having a height x which is approximately $\frac{1}{2}$ the dimension b . The discharge passage 64 communicates with the air or gas passage 63 along a line d which is in directly opposed relation to the point j which is in one side of the juncture of the bore 59 with the end surface 60 of the tube. The line b is at right angular relation from the point j with respect to the surface 60. The width of the transverse passage 63 at the point of juncture with the outlet passage 64 is approximately twenty times the dimension b . The spray head 55 is thus similar to the spray heads 31 and 45 with the main exception of the direction in which the spray is forced. Thus it will be seen that in each of the sprays, the point of greatest constriction of the transverse passage provided for gas or air adjoins the outlet passage along the line which is at right angular relation to the surface of the end of the tube and directly opposed to a point such as j where the wall of the tube meets the surface of the end of the tube. It will be also noted that in the arrangement illustrated the air may be forced over the end of the liquid opening either at right angles to the axis of the liquid tube or at a greater or lesser angle to the tube axis. The width of the transverse passage through which the air is forced may be varied to compensate for heavier or lighter liquids with greater or less surface tension, the lighter liquids permitting a wider passage requiring less pressure. The length of the liquid tube may also be regulated according to the specific gravity and surface tension of the liquid to be sprayed.

It is important that the bore b of the tube be sufficiently small in diameter so that the liquid in the tube is held substantially to the level of the end of the tube and surface tension of the liquid at the upper end of the tube tends to hold the tube filled. As a result, the spray bottle may be operated to pick up moisture virtually as soon as pressure is applied.

It is also important that at least most of the upper end of the liquid tube bore be exposed to the discharge passage so that air being drawn back into the bottle when the pressure on the walls of the bottle is discontinued may pass over the liquid in the tube before the movement of the air is accelerated to a point where the surface tension of the liquid within the bore of the tube is broken. In this way an extremely effective spray is provided.

In accordance with the patent statutes, I have described the principles of construction and operation of my improvement in spray heads, and while I have endeavored to set forth the best embodiment thereof, I desire to have it understood that changes may be made within the scope of the following claims without departing from the spirit of my invention.

I claim:

1. A directional spray head for gas and liquid including a head body, a liquid tube extending into said body and supported thereby, said tube having a bore extending in an axial direction therethrough, said liquid tube terminating on a substantially flat plane, a gas passage in said head defined by a wall substantially parallel to said flat plane and extending over a portion of the tube end to terminate in substantially opposed relation to the wall of the bore of the tube, said head body including an outlet passage of dimensions substantially greater than said gas passage overlying the tube bore and communicating with

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said gas passage and forming an enlarged continuation thereof.

2. The structure of claim 1 and in which the height of the gas passage between the plane of the end of the tube and the wall defining the top of the gas passage is approximately one-half the tube bore diameter.

3. The structure of claim 1 and in which the width of the gas passage is substantially twenty times the tube bore diameter.

4. The structure of claim 1 and in which the flat plane of the tube end is substantially normal to the axis of the tube.

5. The structure of claim 1 and in which the flat plane of the tube end is at an acute angle to the tube axis.

6. The structure of claim 5 and in which the flat plane of the tube inclines upwardly toward the outlet passage.

7. The structure of claim 3 in which the flat plane of the tube end inclines downwardly toward the tube axis.

8. A spray head including a head body having an upper surface and an under surface, a cylindrical socket in the under surface of said body, said socket terminating in a socket base, a gas chamber in the under surface of said head adjoining said socket, a liquid tube having a small diameter bore defined by walls and engaged in said socket, an outlet passage leading from the base of said socket laterally through said body, said outlet passage overlying the bore of said tube and terminating substantially along a line even with the wall of the bore, said head including a gas passage overlying a portion of the end of the tube and joining said outlet passage along said line, said gas passage connecting said gas chamber and said outlet passage.

9. The structure of claim 8 and in which the height of said gas passage is substantially equal to one-half the diameter of the bore, and the width of said passage is substantially greater than the height.

10. The structure of claim 9 and in which the width of said gas passages is in the nature of twenty times the bore diameter.

11. A directional spray head for gas and liquid including a body having an upper surface and an under surface, a socket in its under surface, a tube extending into said socket, said tube terminating on a substantially flat plane, and having a bore extending in an axial direction there-through, said body including a gas passage adjacent to, and generally parallel to said socket, said head including a transverse passage defined by a wall substantially parallel to the end of said tube extending from said gas passage over a portion of said tube and terminating adjoining the wall of the bore of the tube, and said body including an outlet passage of larger dimensions than said transverse passage and substantially diametrically opposed to said transverse passage and forming a continuation thereof, said outlet passage overlying the bore of the tube and communication with said transverse passage.

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