April 24, 1934. M. J. BROWN 1,956,143

METHOD AND APPARATUS FOR DISCHARGING AQUEOUS SOLUTIONS OF CARBON DIOXIDE

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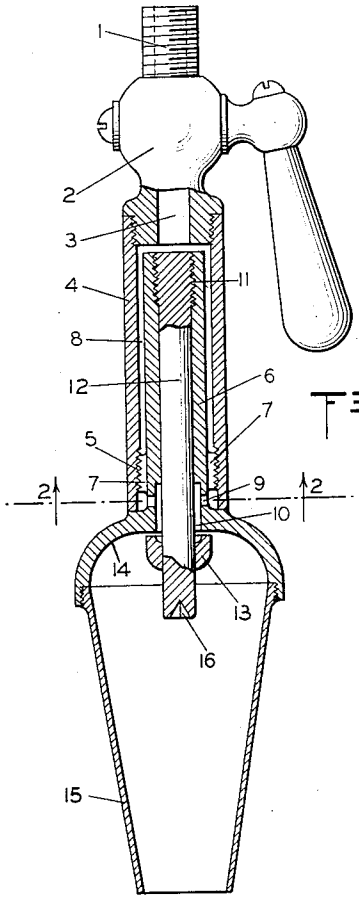


Fig. 1.

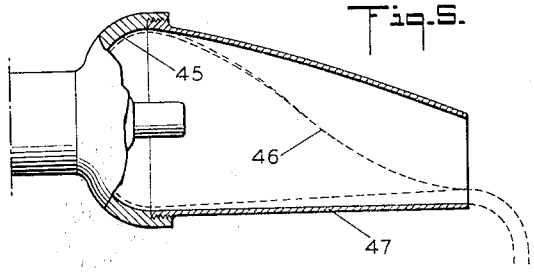


Fig. 5.

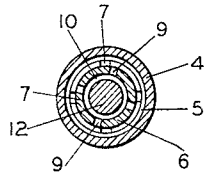


Fig. 2.

Fig. 3.

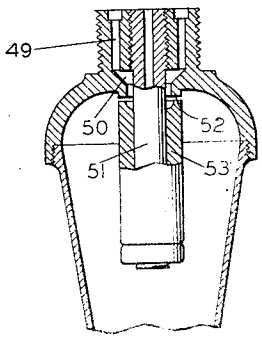


Fig. 6.

Fig. 4.

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METHOD AND APPARATUS FOR DISCHARGING AQUEOUS SOLUTIONS OF CARBON DIOXIDE

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23 Claims. (Cl. 225—24)

This invention relates to method and apparatus for discharging aqueous solutions of carbon dioxide, such as carbonated beverages, beer, etc., without excessive loss of carbon dioxide. Such charged liquids are always stored under pressure, and in order to retain a substantial amount of gas in the liquid after its discharge into a drinking vessel, from high pressure to atmospheric pressure, or a high pressure supply into a bottle at lower pressure, it has been necessary to charge the liquid with an excessive amount of gas in order to retain a small residue thereof in the liquid at the time it is drunk, or to hold the desired pressure in the bottle when capped.

I have discovered that the excessive loss of gas in going from high pressure in the pressure container to lower pressure in the bottle, or atmospheric pressure in the drinking vessel, is caused by excessive and unnecessary turbulence in the liquid during its fall in pressure due to faulty and improper design of the passages and the accessory fittings. By the method and apparatus of this invention such losses of gas due to unnecessary disturbance in discharging a carbonated liquid are avoided, and thereby liquid discharged according to this invention will retain twice as much or more gas as the same liquid discharged according to present procedure.

Water dissolves carbon dioxide in increasing proportions as the pressure goes up and the temperature goes down. Since both temperature and pressure can be controlled in closed vessels, it is possible to get into them solutions that are saturated under the conditions, and therefore not stable at atmospheric pressure and the same temperature. The unique merit of carbon dioxide in a beverage is the result of supersaturation and an inherent instability which gives a transient and characteristic effect on the tongue, throat and palate. Like the effect produced on the tongue, the supersaturation is transient at atmospheric pressure and is rendered more transient by increases of temperature. It has been observed that rising bubbles of carbon dioxide in a supersaturated solution of that gas in water are highly effective in removing the surplus of gas from the water. This is explained by the fact that at an interface between water and a gas phase consisting wholly or partly of carbon dioxide bubbles, equilibrium is reached almost instantaneously, but that equilibrium as to the whole body of liquid is reached very slowly because diffusion of carbon dioxide in the water away from or to the interface is relatively slow. Any action that renews or changes the phases at the interface, such as turbulence, tends to hasten the equilibrium for the whole mass. Briefly, the more turbulent a discharging stream is, the more quickly it loses its gas before being collected in the drinking vessel. I have studied all of the available carbonated water faucets in standard use at present, and find that in all of them without exception a turbulent effect is present in reducing the high velocity between the orifice from the valve and the annular nozzle or collector which directs the water at lower velocity into the receiving vessel.

When solutions at elevated pressures are to be used in beverages, the practical achievement desired is to bridge the gap of time, space and conditions of temperature and pressure from the moment the pressure is reduced, to the moment the supersaturated solution comes in contact with the tongue, palate and throat, so that during the gap there may be a minimum loss of gas from the liquid. This is not so much of a problem when opening a sealed bottle and pouring from the bottle, but the use of small containers is not always convenient or economical. In fact, much carbonated water cannot be used in this manner, but must be drawn in some quantities from large containers wherein the liquid is maintained at elevated pressure. When being drawn from such holders into drinking containers of usual size open, of course, to atmospheric pressure, there is a serious practical problem which has not yet been solved insofar as faucets are concerned. That problem is to remove the liquid at such rate that the receiving container is filled slowly enough to avoid agitation and yet fast enough for practical use; and at the same time to avoid development of high velocities of the liquid as it emerges from the zone of high pressure to the zone of atmospheric pressure. The same problem exists where liquid under high pressure is to be charged into a receptacle, such as a bottle, under lower pressure.

My invention pertains particularly to a process and equipment for partly neutralizing the deleterious results of the high velocity of the liquid as it emerges from a zone of high pressure to a zone of lower or atmospheric pressure.

After recognizing the high velocity as an effect to be reckoned with, I noted that all equipment with which I was familiar used some sort of disruptive impact to lower the velocity of the issuing liquid. In every case studied I found a turbulent discharge, and a strong tendency for the impact to produce spray or entrainment of gas, or both, with well-distributed large and small gas bubbles

in the liquid as a result. Although it is impossible to visually examine these devices in operation, the actual conditions prevailing therein may be imagined as a conglomeration of varying pressures, eddy currents and disruptive impacts, the result of which is the development of countless bubbles of gas, the interfacial exposure of which is great and therefore highly disruptive for maintaining the desired supersaturation.

My invention, which resulted from research and experimentation, is a process of accurately directing a thin stream of liquid which is traveling at high velocity, to establish contact between it and a surface, preferably polished, parallel or nearly parallel to the stream of liquid, and maintaining such contact until the velocity of the liquid is reduced to a reasonable speed by the braking action of the surface on the thin stream. Involved in such broad method is the prevention of eddies, spray, sharp angular impact with the surface, and sharp change of direction; and the use of high smoothness of braking surface in order not to produce the agitation which a rough surface would produce.

In carrying out my invention, the first essential is that the reduction of pressure should be complete in one very restricted part of the equipment and as nearly instantaneous as possible, that is, the desired reduction of pressure to or above atmospheric should take place over a very short length of flow and the drop in pressure should not be extended along the equipment more than necessary, because gas begins to be evolved as soon as the reduction of pressure begins. In other words, the reduction of pressure and the imparting of direction to the liquid should be in the same operation, precise, and nearly instantaneous. One lateral dimension of the stream, such as the thickness, must be quite small although the other may be relatively great. Practically this describes a thin film or sheet of water traveling at high velocity in a direction at right angles to these two dimensions.

Inasmuch as these dimensions are determined according to the time permitted in which to draw the desired volume of liquid, an on-and-off cock behind the thin film discharge is desirable, because after once setting the film thickness it will not ordinarily be changed or varied during the drawing of a drink.

Second, the liquid traveling at high velocity is picked up on a solid surface, preferably a sort of inclined plane. The liquid may cross an air gap to reach this surface, or as preferred, the surface is a continuation of one orifice surface. This should be an unobstructed surface, positioned almost or entirely parallel to the plane of travel of the water and correspondingly at right, or nearly right, angles to the smaller of the two dimensions mentioned above. In such an arrangement friction is established between the smooth solid surface and the rapidly moving thin film of liquid without splash or eddy currents, constituting the application of a smooth, relatively nonagitating brake to a thin liquid film of high velocity.

The shape of the braking surface is preferably concave so as to lead the liquid gently without sharply changing its direction, to the usual discharge nozzle or collector. The shape of the braking surface can vary widely from a flattened spheroid through paraboloid or ellipsoid shape to conical, but I have found the preferred form to be that shown herein where the orifice is formed on the one side of the thin film by a circumferential seat on a stem or core and the other overlapping surface is the beginning of the braking surface. This gives maximum divergence of stream. In the preferred form, the initial portion of the braking surface is flat, and thereafter curves gradually and merges into the collector after the velocity has been sufficiently reduced. Thereby the direction of the stream continues after leaving the orifice without being diverted laterally or thrown back on itself. Thus there is no formation of eddies, impacts or the like which cause rapid separation of gas from the liquid.

Third, the liquid having lost its velocity rapidly in contact with the smooth surface, is led to a convenient discharge point, such as through a nozzle or collector to a receptacle to be charged at lower pressure, or to the drinking glass at atmospheric pressure.

In the accompanying drawing, Fig. 1 is a longitudinal section showing a device embodying the invention;

Fig. 2 is a section on the line 2—2 of Fig. 1;

Fig. 3 is a section of a standard soda fountain faucet arm with my invention applied thereto;

Fig. 4 is a section on the line 4—4 of Fig. 3;

Fig. 5 shows a form for horizontal discharge; and

Fig. 6 shows a form in which the stream passes through an air gap between the orifice and the braking surface.

Referring to Fig. 1, 1 is a pipe to be connected to the tank of charged liquid, 2 is a cock of ordinary plug type which controls passage 3 leading from the plug. 4 is a tube threaded to the plug body as shown, having interior screw threads 5, to which is screwed tubular body 6 having its projecting screw thread slotted as at 7 to form water passages connecting the annular water space 8 with the holes 9 leading to orifice chamber 10. This chamber functions to quiet any turbulence and direct the flow to the orifice. The surfaces of these parts are made as smooth and straight as possible so as not to unnecessarily agitate the water in flowing therethrough at high pressure. Threaded into tubular body 6 by threads 11 is a rod 12 carrying adjacent its lower end an annular seat 13 having its upper surface accurately machined and smoothly finished, this annular discharge surface being preferably in a plane normal to the axis of rod 12. The surface could be at an angle to the axis of the rod, that is, conical, but the preferable form gives maximum divergence of the stream. Cooperating with and overlapping this discharge surface, and parallel thereto, is the upper orifice surface. In Fig. 1, this orifice surface is continuous with curved polished braking surface 14, which gradually merges into detachable conical collector 15 threaded to the base and resembling the usual nozzle on a soda fountain faucet.

Rod 12 contains an angular hole 16 in its end by which the orifice between 13 and 14 can be adjusted. It will be seen that a continuous annular orifice is thus provided without any obstruction which would cause eddies, or break or deflect the stream.

The device is designed according to the volume to be delivered in a given time with the orifice set at from around .001" to around .002", to give the desired rate of discharge without having the film of liquid too thick. Upon opening the cock 2 wide, the liquid flows through the orifice and over the braking surface at a predetermined rate. If the braking surface at the orifice is normal

to the axis and immediately adjacent thereto, it can be gradually changed from normal and continued into the smooth collector, as shown. There can be no impact between the surface and the liquid after the latter leaves the orifice because the surface is a continuation of the orifice. The liquid travels along the solid surface losing velocity rapidly and takes the turn easily without impact, splash, eddy currents or other disturbance, and then enters the collector wherein the liquid from all parts of the jet combines for delivery.

The following features should be noted in Fig. 1:

First, the cock does not control the rate of flow because if pressure reduction begins at the cock, gas will begin to escape at that point and thus result in deleterious and avoidable loss. The total pressure reduction is at the orifice and the liquid is continuously in contact with the braking surface from the time and place it enters the orifice without any air gaps, impacts, turbulence, or mixing of previously discharged liquid with freshly discharged liquid, and any one particle is not brought into contact with streams traveling in different directions or at different speeds. The thin stream provides easy escape of gas bubbles from the liquid without permitting them to entrain additional gas, maintaining relative solidity of the stream as a whole and hence maintaining more effective braking on the relatively solid thin stream. If the stream is relatively thick, rather than thin, the effective braking friction is reduced and there is a greater tendency to form gas bubbles with a reduced chance of escape from the body of the liquid.

After the velocity has been reduced to the desired rate, the form and surface of the collector becomes less material, although it is within the principle of this invention, if the collector for other purposes has obstructions, to so form it as not to cause significant agitation, but the principle of this invention must be followed of using a surface as a brake on liquid moving at high speed without causing splash, eddies or serious impact.

In Figs. 3 and 4, 20 represents a standard soda fountain faucet arm leading to a rotary valve 21 operated by handle 22 adapted to be connected either to port 23 or port 27. Port 23 leads to passage 24 in the valve body, and a central passage 25 in my attachment for discharging the usual needle stream through orifice 26. Port 27 in the valve body leads by passage 28 to annular passage 29 in the body 30 of my attachment. From passage 29 four or more holes 31 lead to orifice chamber 33. The rod 34 containing passage 25 is threaded into body 30 at 35, and the rod 34 is also threaded at 36 to receive a set nut 37 and threaded orifice seat member 38 having its upper end smoothly machined normal to the axis, as previously described, so as to overlie and cooperate with braking surface 40. This construction permits adjustment of the orifice. 41 is a collector having its inner surface merging smoothly with that of braking surface 40. For convenience in adjusting the thickness of the stream, the collector 41 is threaded on body 30 so as to be easily removed. In using this form of the invention, it is only necessary to detach the standard nozzle and collector now employed and replace mine, as shown in Fig. 3, with a great gain in results as will be shown.

This invention is well adapted for horizontal discharge as shown in Fig. 5, and in many instances will be preferred because of the low discharge velocity thus obtainable. In this form the stream is continuous on the braking surface 45 for some distance from the orifice, and then separates at the top while clinging to the surface, and merges at the bottom, the dotted lines 46 indicating roughly the edge of the stream. In using this form the bottom of the collector 47 should be slightly inclined for drainage.

Fig. 6 shows a modification of Fig. 3, but equally applicable to Fig. 1, in which the orifice and braking surfaces are discontinuous. That is, the stream on leaving the orifice traverses an air gap before striking the braking surface in a substantially parallel direction. In practice, the angle of the stream striking the braking surface in substantial parallelism should not be over 15°, so as not to cause splash, or disturbance of the desired smooth flow over the braking surface. In Fig. 6, 49 is the passage in the body leading to orifice chamber 50, with upper orifice seat 52 surrounding rod 51. 53 is an adjustable lower orifice seat member similar to 38. This construction will operate on the same general principles and with the same results as above explained in connection with Figs. 1 and 3.

Carbonated beverages are bottled from a source of liquid under high pressure into a bottle filled with air and the bottle is capped after permitting some bleeding off of the charging gas. This invention, as has heretofore been indicated, is applicable to such procedure in order to effect less loss of gas due to turbulence in going from the high pressure to the bottle pressure.

I give data from a few of many comparative tests made at the same time on the same charged water at the same temperature with standard commercial equipment and my equipment. The method followed was to draw a standard 250 cc. glass of water through the standard equipment, then stir it mechanically to collect the evolved gas, and then repeat with water drawn from the same tank through my equipment. In every case I recovered twice or more gas from water drawn through my equipment than from the same water drawn through standard equipment.

I used water at 15° C. containing carbon dioxide at 50 pounds per square inch and drew each glassful in 10 seconds. During an interval of 10 seconds immediately after, the glass of water was placed in the testing apparatus; stirring was then continued for 5 minutes at which time practically all gas was driven off that could be so removed. Using a standard soda fountain faucet with needle stream, 25 cc. of gas were recovered. Using the same faucet with slow stream, 100 cc. of gas were recovered. Using my equipment with slow stream, 300 cc. of gas were recovered. The excess gas in the water delivered through my equipment was very noticeable to the taste, and one could easily be told from the other on this account. It was also very noticeable in all the tests with my equipment that the water flowed into the glass with less turbulence, eddies, etc.

Where tests are given for comparison, they were all made within a few minutes of each other, and while the results varied from day to day, the comparative figures here given as between my method and the standard method are conservative and well within the averages of many tests made at various pressures.

It will be seen that this invention comprehends forming the thin film in contact with a braking surface or projecting the thin film across an air gap and contacting it at a low angle with the braking surface, whether the reduction in velocity be intermediate between a higher and a

lower pressure, or be from the higher pressure to atmospheric, there being in all cases a positive absolute pressure when the liquid has been discharged and its pressure lowered. It will also be seen that while the stream as a whole diverges from the orifice, the individual lineal elements of the stream are unidirectional in the line of discharge. Thereby one individual element of the stream does not strike or deflect another to produce impact, spray or eddies, nor does any individual element of the stream strike a surface at such angle as to produce impact, spray or eddy.

Various modifications and changes may be made in the details shown without departing from the scope of the appended claims.

I claim as my invention:

1. Method of discharging carbonated liquids to prolong the period of oversaturation at lowered pressure, consisting in smoothly flowing the liquid under pressure to an orifice, discharging the liquid in a thin diverging film between parallel surfaces, braking the film by maintaining it in further diverging contact with one of said surfaces, and collecting the liquid from a continuation of said braking surface.

2. Method of discharging carbonated liquids to retain an increased content of gas consisting in leading the liquid under pressure to a quieting orifice chamber, discharging the liquid from said chamber in a thin film at high velocity, and contacting the discharged liquid with a braking surface to reduce the velocity.

3. In carbonated liquid discharge apparatus, a supply pipe for liquid under pressure, an orifice chamber connected thereto for quieting the liquid, an orifice discharging the liquid in a thin film from said chamber, and a braking surface extending substantially parallel to the direction of discharge to receive and hold the stream in contact until its velocity is substantially reduced.

4. In carbonated liquid discharge apparatus, a supply pipe for liquid under pressure, an orifice chamber connected thereto for quieting the liquid, an orifice discharging the liquid in a thin film from said chamber across an air gap, and a braking surface extending substantially parallel to the direction of discharge to receive and hold the stream in contact until its velocity is substantially reduced.

5. In carbonated liquid discharge apparatus, a supply pipe for liquid under pressure, a seat and an overlapping substantially parallel surface forming a narrow orifice discharging a thin film at high velocity, and a braking surface extended in the direction of flow and holding the film in contact therewith until its velocity is substantially reduced.

6. In carbonated liquid discharge apparatus, a supply pipe for liquid under pressure, a seat and an overlapping surface forming a narrow orifice discharging a thin non-turbulent film at high velocity, means for adjusting the width of the orifice, and a braking surface extending in the direction of flow and holding the film in contact therewith until its velocity is substantially reduced.

7. In carbonated liquid discharge apparatus, a supply pipe for liquid under pressure, a seat and an overlapping braking surface forming a narrow orifice discharging a thin non-turbulent film at high velocity, the braking surface being extended in the direction of flow and holding the film in contact therewith until its velocity is substantially reduced, and means for discharging independently of said orifice an unobstructed stream.

8. An attachment for discharging carbonated liquid comprising a body having means at one end for connection to a valve, a channel in the end of said body to be supplied with liquid, the body having a longitudinal passage from said channel and an orifice chamber, an orifice, a concave braking surface surrounding said orifice, a cylindrical member carried by the body forming the inner wall of the orifice chamber, and a seat carried by said member constituting one surface of said orifice.

9. An attachment for discharging carbonated liquid comprising a body having means at one end for connection to a valve, a channel in the end of said body to be supplied with liquid, the body having a longitudinal passage from said channel and an orifice chamber, an orifice, a concave braking surface surrounding said orifice, a cylindrical member carried by the body forming the inner wall of the orifice chamber, a seat carried by said member constituting one surface of said orifice, and means for adjusting said seat to vary the width of the orifice.

10. An attachment for discharging carbonated liquid comprising a body having means at one end for connection to a valve, a channel in the end of said body to be supplied with liquid, the body having a longitudinal passage from said channel and an orifice chamber, an orifice, a concave braking surface surrounding said orifice, a cylindrical member carried by the body forming the inner wall of the orifice chamber, a seat carried by said member constituting one surface of said orifice, and a collector carried by said body having its inner surface constituting a continuation of said braking surface.

11. An attachment for discharging carbonated liquid comprising a body having means at one end for connection to a valve, a channel in the end of said body to be supplied with liquid, the body having a longitudinal passage from said channel and an orifice chamber, a concave braking surface formed on the end of the body surrounding the end of said orifice chamber, a cylindrical member carried by the body forming the inner wall of the orifice chamber, a seat carried by said member overlapping said braking surface to form an orifice, and a separate needle stream passage extending from end to end of the attachment.

12. In carbonated liquid discharge apparatus, means for discharging under pressure at high velocity, a thin film of liquid in non-agitated condition, and a non-agitating braking surface extending substantially parallel to the direction of discharge receiving and conducting such film to discharge at lower velocity.

13. Method of discharging carbonated liquids to prolong the period of over-saturation at lowered pressure, consisting in conducting the liqiud to an orifice from a source of liquid under high pressure, ejecting the liquid from said orifice in a thin film at high velocity, and contacting the film issuing from the said orifice with a braking surface extending substantially in the direction of the flow of liquid through said orifice.

14. Method of discharging carbonated liquids to prolong the period of over-saturation at lowered pressure, consisting in conducting the liquid to an orifice from a source of liquid under high pressure, ejecting the liquid from said orifice in a thin film at high velocity while releasing the liquid from substantially the pressure of said

source to a substantially lower pressure as it escapes from the orifice, and contacting the stream issuing from the orifice with a braking surface extending substantially in the direction of the flow of liquid through the orifice.

15. Method of discharging carbonated liquids to prolong the period of over-saturation at lowered pressure, consisting in forming a thin stream at high velocity and contacting said stream with a braking surface extending in the direction of flow, each particle of said stream moving in a single plane throughout the braking action.

16. Method of discharging carbonated liquids to prolong the period of over-saturation at lowered pressure, consisting in producing a film of rapidly moving liquid on a smooth braking surface under such conditions that substantially all reduction of pressure occurs in the orifice, and all causes that may produce obvious turbulence between the time of emergence from the orifice and the time when the film is formed are avoided.

17. Method of discharging carbonated liquids to prolong the period of over-saturation at lowered pressure, consisting in spreading rapidly moving liquid from an orifice as a film on a solid braking surface, and preventing turbulence producing impacts between solid surfaces and liquid, and liquid and liquid, from the time high velocity is developed until it is reduced to the desired extent.

18. Method of discharging carbonated liquids to prolong the period of over-saturation at lowered pressure, consisting in conducting the liquid to an unobstructed orifice from a source of liquid under high pressure, ejecting the liquid from said orifice in a thin film at high velocity, and contacting the film issuing from said orifice with an unobstructed braking surface extending substantially in the direction of the flow of liquid through said orifice.

19. Method of discharging carbonated liquids to prolong the period of over-saturation at lowered pressure, consisting in flowing liquid under pressure to a parallel walled orifice through a passage substantially suppressing turbulence in the liquid at the orifice, discharging the liquid in a film through the orifice onto a braking surface initially extending substantially in the direction of discharge, and maintaining contact of the film with the braking surface until the velocity has been reduced to a desired extent.

20. Method of discharging carbonated liquids to prolong the period of over-saturation at lowered pressure, consisting in simultaneously discharging the liquid in a thin film through an orifice with full pressure drop in the orifice and directing said film to establish non-turbulent contact with a braking surface until the velocity is substantially reduced.

21. In a carbonated liquid discharge apparatus, a supply passage for liquid under pressure, an orifice having less area than said passage for discharging a thin non-turbulent film at high velocity, and a braking surface extending substantially parallel to the direction of discharge to at least initially receive and hold the stream in contact until its velocity is substantially reduced.

22. In carbonated liquid discharge apparatus, a supply pipe for liquid under pressure, an orifice chamber connected thereto for quieting the liquid, an orifice discharging the liquid in a thin diverging non-turbulent film from said chamber, and a braking surface extending substantially parallel to the direction of discharge to receive and hold the stream in contact until its velocity is substantially reduced, each particle of said stream moving in a single plane throughout the braking action.

23. In carbonated liquid discharge apparatus, an orifice for discharging a thin film at high velocity, means for conducting liquid under pressure to said orifice, and a braking surface extending substantially parallel to the direction of discharge of the liquid through the orifice to receive and hold the stream in contact until its velocity is substantially reduced, the cross section of said orifice being less than the cross section of any section of said conducting means.

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