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METHOD FOR DISSOLVING GASES IN LIQUIDS

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Fig. 1

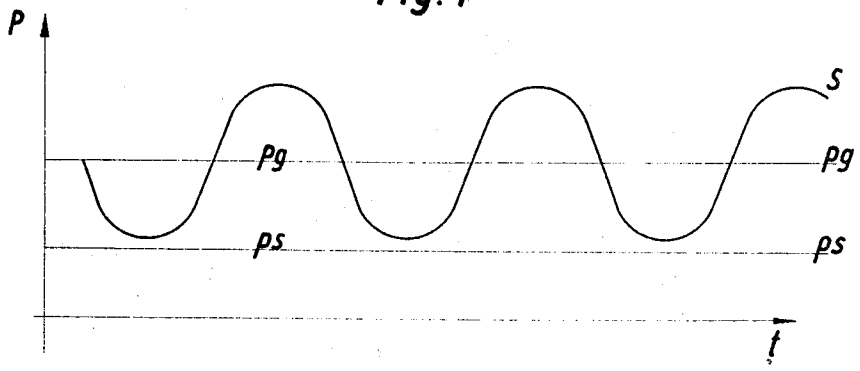
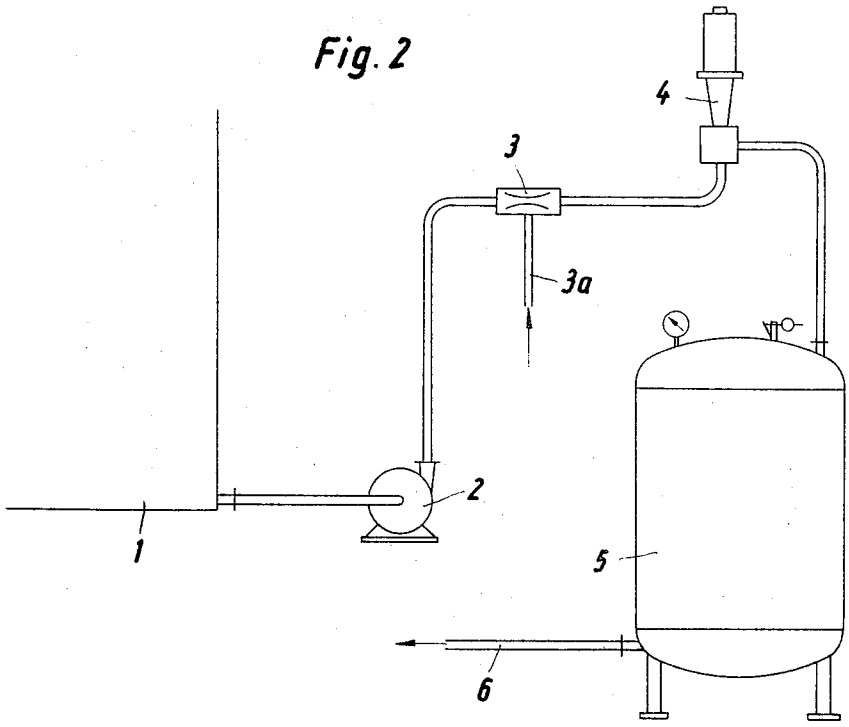


Fig. 2



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METHOD FOR DISSOLVING GASES IN LIQUIDS

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3 Claims. (Cl. 261—1)

The present invention relates to a method for dissolving gases in liquid and is particularly concerned with a method for producing gas impregnated beverages such as carbonated soft drinks, beer and the like.

It is an object of the present invention to provide a method for the quick dissolution of gas upon introduction of the same into a liquid.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present invention contemplates a method of dissolving a gas in a liquid comprising the steps of subjecting a liquid to a predetermined degree of superatmospheric pressure, introducing gas into the liquid while the time is under the predetermined pressure in an amount such that the predetermined pressure exceeds the saturation pressure required for maintaining the gas in solution, and subjecting the thus formed mixture of gas and liquid to vibrations of sonic character having an amplitude so chosen that the pressure drop corresponding to the negative portion of the amplitude is smaller than the difference between the predetermined pressure and the saturation pressure.

Thus, the present invention includes a method for dissolving gases in liquids, particularly for producing impregnated beverage such as soft drinks, i.e. carbon dioxide impregnated aqueous liquids for human consumption, and the like, according to which the mixture of liquid and gas bubbles formed by introducing gas into the liquid is subjected to sonic vibrations, generally, but not necessarily, ultrasonic vibrations, while the mixture of gas and liquid is maintained at an elevated pressure which is at least as high as the sum of the saturation pressure of the gas of the mixture in the liquid plus the pressure drop corresponding to the negative portion of the amplitude of the sonic or ultrasonic vibrations.

In other words, the liquid-gas mixture, while being subjected to the sonic or ultrasonic vibrations, will always be under a pressure which is at least as high and preferably somewhat higher than the saturation pressure of the gas in the liquid. This saturation pressure will will depend on the type of liquid, the type of gas, the temperature and the amount of gas per unit of liquid which is introduced into the latter and it is well within the skill of the art to determine this saturation pressure as well as the pressure drop corresponding to the negative portion of the amplitude of the vibrations of sonic character for any given operating conditions.

The essential elements of the device or arrangement for dissolving gas in a liquid in accordance with the present method are a conduit leading from a source of liquid, for instance, a storage tank to another storage tank in which the final product is maintained under the above described predetermined elevated pressure.

A pressure pump or the like is arranged in the conduit for the purpose of subjecting the liquid passing therethrough to a pressure which is sufficiently higher than the pressure required for maintaining the desired amount of gas in solution in the liquid so that when the liquid is subjected to vibrations of sonic character, the pressure drop corresponding to the negative portion of the amplitude of such vibrations will not suffice to reduce the

pressure of the liquid to below the saturation pressure required for maintaining the desired amount of gas in solution in the liquid.

The desired proportion of gas is then introduced into the thus pressurized liquid and will be partially dissolved therein and will partially form gas bubbles in the liquid.

The thus formed mixture of gas and liquid is then subjected to vibrations of sonic character which will serve the purpose of causing dissolution of the gas bubbles in the liquid provided that, in accordance with the present invention, at no time the pressure of the liquid is lowered or drops below the saturation pressure required for holding the desired amount of gas in solution in the liquid.

Vibrations of sonic character cause alternately an increase and a reduction in the pressure of the liquid which is subjected to such vibrations and it is essential according to the present invention that during the periods when the vibrations cause a decrease in the pressure of the liquid, nevertheless the residual pressure will be at least as high and preferably somewhat higher than the saturation pressure required for maintaining the entire amount of gas in solution in the liquid.

In the past, ultrasonic vibrations have been used for degassing liquids and it has been found that the speed of withdrawal of dissolved gas from liquids can be greatly increased by subjecting such gas containing liquids to ultrasonic vibrations. However, in such cases, at least during the pressure drop corresponding to the negative portion or amplitude of the ultrasonic vibrations, the residual pressure of the liquid will fall below the saturation pressure required for holding the gas dissolved in the gas preferably below atmospheric pressure.

In contrast thereto, according to the present invention, the pressure of the liquid-gas mixture will be at all times higher or at least as high as such saturation pressure and under these conditions which are to be maintained according to the present invention, it has been found that, surprisingly, vibrations of sonic character greatly facilitate the dissolution of the gas in the liquid.

Ultrasonic vibrations cause or generate pressure waves in liquids exposed thereto, which pressure waves comprise a positive component (pressure increase) and a negative component (decrease in pressure down to the tension stress or cohesion pressure between the molecules of the liquid). By applying a counterpressure against the negative amplitude of the sonic or ultrasonic vibrations, i.e. by increasing the outer pressure above the saturation pressure of the gas in the liquid, the degassing of the gas-containing liquid is slowed down. Upon further increasing such counterpressure, i.e. by maintaining a pressure equal to or greater than the sum total of the saturation pressure and the pressure drop corresponding to the negative portion of the amplitude of the sonic or ultrasonic wave, this effect, namely the degassing of the liquid, is reversed and the speed of dissolution of gas in the liquid is greatly increased. The total pressure, or the counterpressure which is to be applied during the sonic or ultrasonic treatment of the liquid-gas mixture will depend on the intensity of the ultrasonic or sonic waves and must be sufficiently high so that even during the negative component or portion of the amplitude of the vibrations, the total pressure to which the liquid-gas mixture is subjected will be greater than the saturation pressure required for maintaining the gas in solution in the liquid.

Experiments have shown that in many cases this result can be achieved by maintaining the gas-liquid mixture while the same is subjected to sonic or ultrasonic vibrations under an absolute pressure of between about three and six atmospheres.

Ultrasonic vibrations produced in the liquid do not differ basically from vibrations which may be produced

with audible wave lengths. It is therefore also possible to achieve the acceleration of the dissolution of gas in the liquid with vibrations within the audible range, for instance, by means of a 50 Hz. vibrator.

An optimum effect is achieved when the size of the gas bubbles is such that the resonant frequency of the body of gas contained therein is substantially equal to the frequency of the vibrations of sonic character applied to the liquid.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a schematic illustration of the pressure conditions in the liquid-gas mixture while the same is subjected to sonic or ultrasonic vibrations in accordance with the present invention, and

FIG. 2 is a schematic elevational view of an arrangement for dissolving gas in a liquid in accordance with the present invention, for instance, for dissolving carbon dioxide in beverages, i.e. aqueous liquids.

Referring now to FIG. 1, the saturation pressure, i.e. the pressure at which the desired amount of gas will remain dissolved in the liquid, is indicated by the line P*s*. The liquid, however, is subjected prior to introduction of the gas, and of course also prior to the subjecting of the liquid-gas mixture to vibrations of sonic character, to the higher pressure P*g* so that when the liquid is then subjected to the effect of the sonic or ultrasonic vibrations S, the minimum pressure will always be somewhat higher than the saturation pressure P*s*.

As illustrated in FIG. 2, the liquid, such as water or an aqueous liquid including for instance sugar and flavoring agent, is withdrawn from a container 1 and passes in the indicated sequence through a pressure pump 2, a gas-introducing device which includes a nozzle arrangement 3 and a gas conduit 3*a* for introducing a gas into the liquid in the form of finely sub-divided bubbles, then in contact with a conventional sonic vibrations generating device 4 into pressure container 5 and from there through conduit 6 to a filling station, for instance, a bottle-filling apparatus (not shown).

As described above, gas bubbles will be introduced at 3 into the liquid which is under a pressure which is higher than the pressure required for maintaining the amount of gas which has been introduced in solution, and dissolution of the thus introduced gas is accelerated by subjecting the liquid-gas mixture to the sonic or ultrasonic vibrasonic vibrations generated at 4, under the pressure conditions discussed further above.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of devices for dissolving a gas in a liquid differing from the types described above.

While the invention has been illustrated and described as embodied in an arrangement primarily intended for carbonating beverages, it is not intended to be limited

to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. Method of dissolving a gas in a liquid comprising the steps of subjecting a liquid to a predetermined degree of superatmospheric pressure; introducing gas into said liquid while the same is under said predetermined pressure in an amount such that said predetermined pressure exceeds the saturation pressure required for maintaining said gas in solution; and subjecting the thus formed mixture of gas and liquid to vibrations of sonic character having an amplitude so chosen that the pressure drop corresponding to the negative portion of said amplitude is smaller than the difference between said predetermined pressure and said saturation pressure.

2. Method of dissolving a gas in a liquid comprising the steps of subjecting a liquid to a predetermined degree of superatmospheric pressure; introducing gas into said liquid while the same is under said predetermined pressure in an amount such that said predetermined pressure exceeds the saturation pressure required for maintaining said gas in solution; and subjecting the thus formed mixture of gas and liquid to ultrasonic vibrations having an amplitude so chosen that the pressure drop corresponding to the negative portion of said amplitude is smaller than the difference between said predetermined pressure and said saturation pressure.

3. Method of dissolving a gas in a liquid comprising the steps of subjecting an aqueous liquid to a predetermined degree of superatmospheric pressure; introducing carbon dioxide gas into said aqueous liquid while the same is under said predetermined pressure in an amount such that said determined pressure exceeds the saturation pressure required for maintaining said carbon dioxide gas in solution; and subjecting the thus formed mixture of carbon dioxide gas and aqueous liquid to vibrations of sonic character having an amplitude so chosen that the pressure drop corresponding to the negative portion of said amplitude is smaller than the difference between said predetermined pressure and said saturation pressure.

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