United States Patent [19]

Kwok

[11] **3,777,746**

[45] **Dec. 11, 1973**

[54] **PULSATING DENTAL SYRINGE**

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[73] Assignee: **Edward V. Rippingille, Jr.**, Key Largo, Fla.

[22] Filed: **July 10, 1972**

[21] Appl. No.: **270,430**

Related U.S. Application Data

[62] Division of Ser. No. 124,905, March 16, 1971, Pat. No. 3,698,416.

[52] **U.S. Cl.** ..... **128/66**, 128/62 A

[51] **Int. Cl.** **A61h 9/00**

[58] **Field of Search** ..... 128/62 A, 66; 137/119, 103, 624.14

[56] **References Cited**

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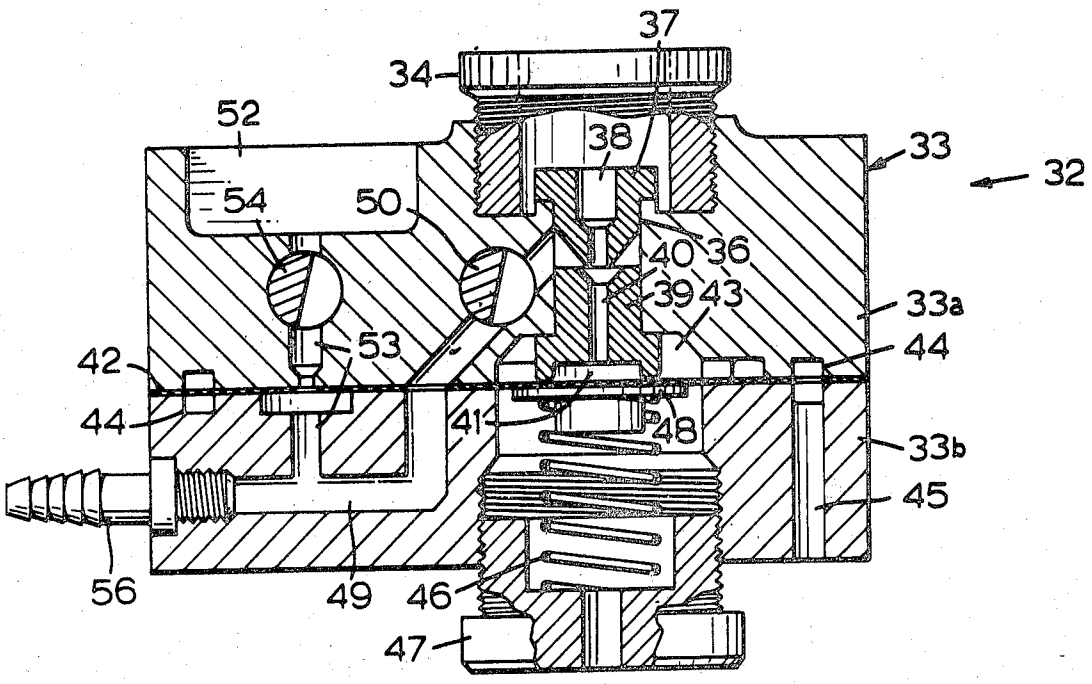
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Primary Examiner—Lawrence W. Trapp
Attorney—Clyde Chi Kai Kwok

[57] **ABSTRACT**

A pulsating dental syringe employing a fluid oscillator having a housing with a fluid inlet channel connected to a source of fluid under pressure, and first and second fluid outlet channels which communicate with the fluid inlet channel. A diaphragm is positioned so as to control the flow of fluid from the fluid inlet channel to the first fluid outlet channel. The second fluid outlet channel is connected to the fluid inlet channel upstream of the diaphragm, but the arrangement is such that the fluid flows through the first outlet channel when the diaphragm is in its open position. When the diaphragm is in its closed position, the fluid is diverted to the second outlet channel. The first outlet channel terminates in an end which is open to the atmosphere, and is dimensioned to produce an inertial effect in the fluid flowing through it. When the diaphragm moves to its closed position there is a momentary partial vacuum in the first outlet channel, which helps to hold the diaphragm firmly in its closed position. After the inertial effect has substantially dissipated, the force of the fluid against the diaphragm is sufficient to cause the diaphragm to return to its open position, whereupon the fluid resumes its flow through the first outlet channel.

6 Claims, 9 Drawing Figures



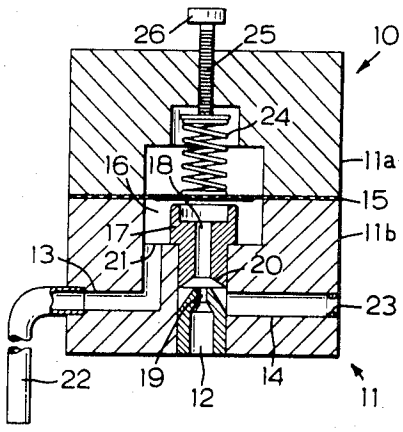


FIG. 1

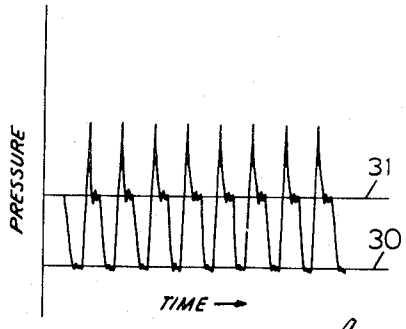


FIG. 2

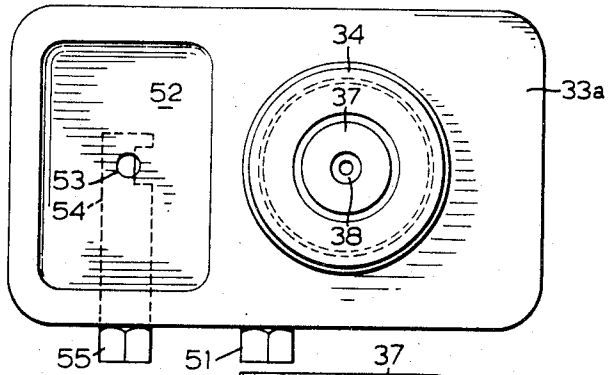


FIG. 3

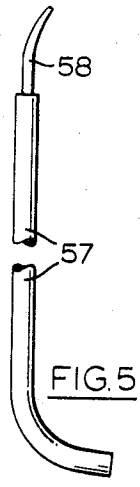


FIG. 5

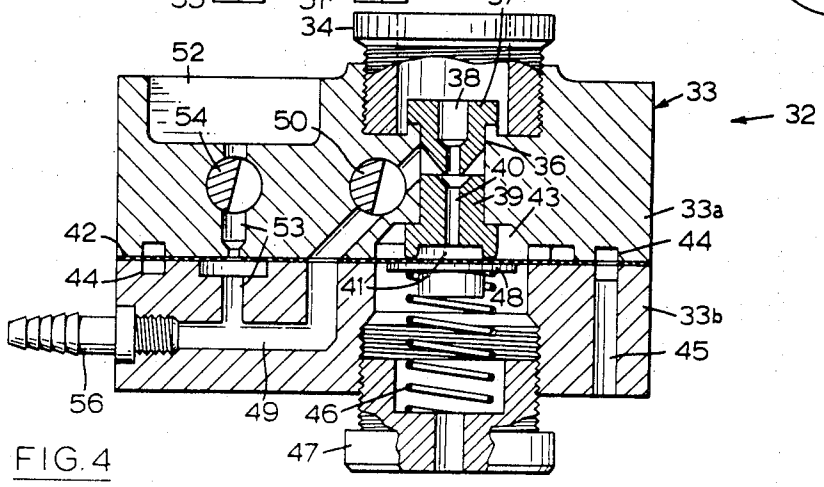


FIG. 4

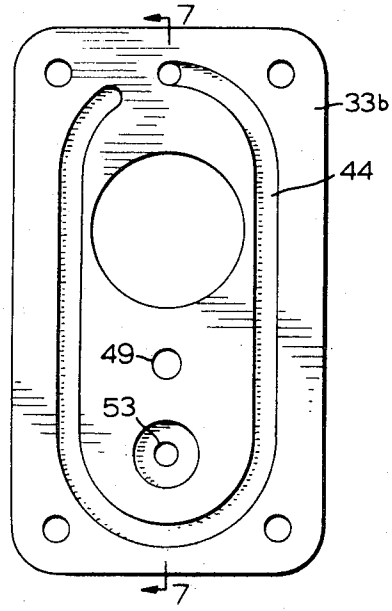


FIG. 6

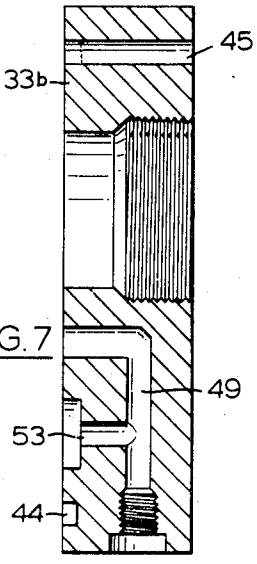


FIG. 7

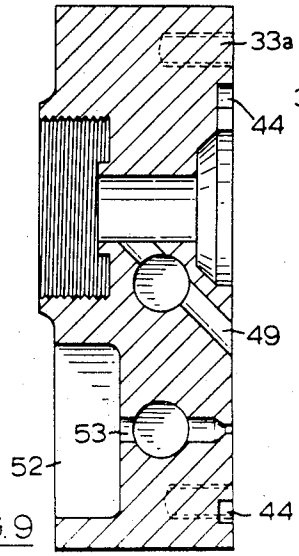


FIG. 9

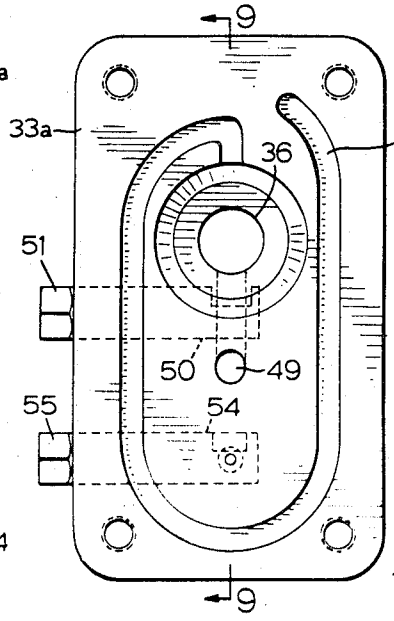


FIG. 8

PULSATING DENTAL SYRINGE

This application is a division of application No. 125,905 filed Mar. 16, 1971 entitled "FLUID OSCILLATOR AND PULSATING DENTAL SYRINGE EMPLOYING SAME" and now Pat. No. 3,698,416.

This invention relates to fluid oscillators capable of producing periodic pulsations in a fluid, and in particular to a pulsating dental syringe using the same.

Fluid oscillators have been developed which utilize fluid dynamic effects such as stream interaction and boundary layer control to provide a pulsating flow of fluid without any moving parts. In practice such devices generally must be constructed with fairly close tolerances in order to achieve satisfactory results, and the cost of such devices is generally quite high.

According to this invention, the inertial effect of a moving stream of fluid is utilized to control the operation of a valve such as a diaphragm, which is positioned in the fluid stream. A simple form of the invention includes a housing having a fluid inlet channel that is connected to a source of fluid under pressure, and first and second fluid outlet channels which communicate with the fluid inlet channel. A diaphragm is positioned so as to control the flow of fluid from the fluid inlet channel to the first fluid outlet channel. The second fluid outlet channel is connected to the fluid inlet channel upstream of the diaphragm, but the arrangement is such that the fluid flows through the first outlet channel when the diaphragm is in its open position. When the diaphragm is in its closed position, the fluid is diverted to the second outlet channel. The first outlet channel terminates in an end which is open to the atmosphere, and is dimensioned to produce an inertial effect in the fluid flowing through it. When the diaphragm moves to its closed position (the action is quite abrupt), there is a momentary partial vacuum in the first outlet channel, which helps to hold the diaphragm firmly in its closed position. After the inertial effect has substantially dissipated, the force of the fluid against the diaphragm is sufficient to cause the diaphragm to return to its open position, whereupon the fluid resumes its flow through the first outlet channel. The fluid inlet channel in the vicinity of its junction with the second outlet channel preferably is shaped to form a venturi. This causes a suction effect in the second outlet channel when fluid is flowing through the first outlet channel, and when the flow of fluid suddenly is diverted to the second outlet channel, a "water hammer" effect or instantaneous pressure rise is produced in the fluid flowing through the second outlet channel. The duration of this instantaneous pressure rise is quite short, and the pressure then drops to a level corresponding to the pressure of the source of fluid.

Fluid oscillators according to this invention are relatively simple to construct, and there is considerable leeway in the tolerances of the fluid passages. The increased intantaneous pressure produced by the present fluid oscillator makes the device particularly attractive for use in various kinds of cleaning appliances, such as dishwashers. Other applications include lawn sprinklers, pumps (e.g., for combating fires) and the like. In the following description a pulsating dental syringe is described in detail, as illustrative of a typical application for the fluid oscillator of the present invention.

In the drawings,

FIG. 1 is a somewhat diagrammatic sectional view of a fluid oscillator according to the invention,

FIG. 2 is a graph showing the pressure of fluid flowing through an outlet channel of the fluid oscillator as a function of time,

FIG. 3 is a plan view of a pulsating dental syringe utilizing a fluid oscillator according to the invention,

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 3,

FIG. 5 is a side view, partly broken away, of a nozzle with attached hose, for use with the pulsating dental syringe,

FIG. 6 is a plan view of the lower half of the housing of the pulsating dental syringe shown in FIG. 4,

FIG. 7 is a sectional view taken along the line 7—7 of FIG. 6,

FIG. 8 is a plan view showing the underside of the upper half of the housing shown in FIG. 2, and

FIG. 9 is a side sectional view taken along the line 9—9 of FIG. 8.

Referring to the drawings, and in particular to FIG. 1, a fluid oscillator is generally indicated by reference numeral 10, and it includes a housing 11 having an upper portion 11*a* and a lower portion 11*b*. The lower portion 11*b* of the housing 11 is formed with an inlet channel 12 which can be connected to a source of pressurized fluid, a first outlet channel 13 and a second outlet channel 14. Valve means 15 in the form of a thin flexible diaphragm is positioned between the upper portion 11*a* and lower portion 11*b* of the housing 11.

The upper portion 11*a* and the lower portion 11*b* of the housing 11 are each formed with a central bore which forms a chamber 16 when the upper portion 11*a* and the lower portion 11*b* of the housing 11 are attached to each other. An annular valve seat 17 is positioned in the chamber 16, and it has a central opening 18 which communicates with the inlet channel 12. The central part of the valve seat 17 is recessed as shown. The inlet channel 12 is formed with a throat 19 of reduced diameter to produce a pressure drop. Immediately upstream of the throat 19 is a conical recess 20 which joins the throat 19 with the opening 18 of the valve seat 17. The inner end of the first outlet channel 13 communicates with the chamber 16 at a junction 21, and a tube 22 of predetermined length is attached to and forms part of the outlet channel 13. The outer end of the tube 22 may be exposed to the atmosphere. The inner end of the second outlet channel 14 is joined at about right angles to the inlet channel 12 in the vicinity of the throat 19, and the outer end of the second outlet channel 14 may be formed with a constriction or load 23 to control the pressure of the fluid emerging from the second outlet channel 14.

The diaphragm 15 can be formed of any thin, resilient material capable of withstanding the maximum fluid pressure to which it is subjected. Typical materials include neoprene, rubber and like resilient materials. As will be explained in greater detail below, the diaphragm 15 is movable between an open position wherein there is a small gap between the diaphragm and the valve seat 17, so that fluid is permitted to flow past the valve seat 17 into the first outlet channel 13, and a closed position wherein the diaphragm 15 snugly engages the annular outer edge of the valve seat 17 and prevents fluid from flowing into the first outlet channel 13.

The diaphragm 15 is biased by a spring 24 which is positioned in the upper portion 11a of the housing 11, and which bears against a face of the diaphragm 15 opposite to the face which engages the valve seat 17. The tension in the spring 24 may be controlled by any suitable means, such as a screw 25 with a manually adjustable knob 26.

In operation, assuming the diaphragm is in the position shown in FIG. 1, fluid under pressure which enters the inlet channel 12 has an almost free path to the chamber 16 and is discharged through the first outlet channel 13 and the tube 22. Due to the venturi effect produced by the throat 19, a suction effect will occur in the second outlet channel 14. The force of the spring 24 exerted against the diaphragm 15 when the spring 24 is in its compressed condition is such as to cause the diaphragm 15 to commence moving towards the valve seat 17. As the distance between the diaphragm 15 and the valve seat 17 is reduced, the cross sectional flow area between the diaphragm 15 and the valve seat 17 is reduced, causing a decrease in the flow of fluid into the chamber 16, which results in a reduction in the pressure in the chamber 16. The reduction of pressure aids in drawing the diaphragm 15 towards the valve seat 17, and eventually the diaphragm 15 will snap onto the valve seat 17, thereby blocking the flow of fluid into the chamber 16. However, at the same time, movement of the whole column of fluid within the tube has been accelerated. As a result of the inertia of the fluid, the sudden closing of the diaphragm 15 cannot immediately stop the flow of fluid in the tube 22, and due to this inertial effect of the fluid in the tube 22 a partial vacuum (which may be quite strong in intensity) is formed in the chamber 16, thereby pulling the diaphragm 15 even more snugly against the valve seat 17. When the diaphragm 15 snaps onto the valve seat 17, the flow of fluid is suddenly directed into the second outlet channel 14, and the pressure in the second outlet channel 14 increases sharply from a very low pressure to an instantaneous pressure which may be considerably higher than the pressure of the fluid entering the inlet channel 12. The instantaneous pressure increase or transient has a relatively short period, and the pressure in the second outlet channel 14 then drops to a level which corresponds with the pressure of the fluid entering the inlet channel 12.

After a predetermined interval, which depends inter alia upon the volume of the portion of the chamber 16 between the valve seat 17 and the diaphragm 15 and the volume of the first outlet channel 13 and the tube 22, the rate of the spring 24 and the stiffness of the diaphragm 15, the inertial effect is substantially dissipated, and the pressure in the last-mentioned portion of the chamber 16 returns to ambient. When this occurs, the force of fluid exerted against the diaphragm 15 is greater than the force exerted on the opposite face of the diaphragm 15 by the now extended spring 24, which causes the diaphragm 15 to commence moving away from the valve 17 against the spring 24. When the diaphragm 15 begins to open, the flow of fluid entering the chamber 16 results in a further increase in the force exerted against the diaphragm 16, which further tends to urge the diaphragm 15 away from the valve seat 17. As a result, the pressure in the second outlet channel 14 drops suddenly to a level which may be less than ambient because the entire flow of the fluid is now directed through the first outlet channel 13 and the tube 22.

The dimensions of the second outlet channel 14 are not especially critical. The dimensions of the throat 19 and the conical recess 20 are such as to produce a maximum venturi effect consistent with a minimum pressure drop across the venturi. The load 23 in the second outlet channel 14 also may be varied as desired, in order to produce the required output pressure. The second outlet channel 14 may even be short circuited or closed by means of a device which is operated by water pressure, such as a fluid operated tooth brush.

The graph shown in FIG. 2 represents a number of cycles of operation of the fluid oscillator 10. Base line 30 represents ambient pressure, and base line 31 represents the supply pressure, i.e., the pressure of the fluid entering the inlet channel 12. The instantaneous pressure transients above the base line 31 are readily apparent in FIG. 2, and they represent the instantaneous increased pressure which exists in the second outlet channel 14 immediately after the diaphragm 15 snaps against the valve seat 17 and the fluid is directed into the second outlet channel 14. Immediately prior to the occurence of each transient, it will be noted that the pressure in the second outlet channel 14 is slightly below the base line 30, i.e., is slightly below ambient pressure.

The fluid oscillator described above may be used in a pulsating dental syringe, as will now be described. Referring to FIGS. 3–9, and in particular to FIGS. 3 and 4, a pulsating dental syringe is generally indicated by reference numeral 32, and it includes a housing 33 having an upper portion 33*a* and a lower portion 33*b*. The upper portion 33*a* of the housing 33 has a coupling 34 which is adapted to be attached to a faucet of the kind commonly used with bathroom sinks. Centrally located within the coupling 34 and positioned within a bore 36 of the upper portion 33*a* is an ejector 37. The ejector 37 is formed with a bore 38 which forms at its lower end a throat of relatively narrow cross section, to produce a venturi effect. A receiver 39 is positioned in the opposite end of the bore 36 and faces the lower end of the ejector 37; the upper end of the receiver 39 is formed with a conical depression, and it has a central bore 40 extending from one end to the other. As a result, water entering the upper portion 33a of the housing 33 passes through the ejector 37 and the receiver 39 and enters a cylindrical recess 41 formed in the lower end of the receiver 39.

A diaphragm 42 similar to the kind described above is positioned between the upper portion 33a and the lower portion 33b of the housing 33. The lower end of the receiver 39 is annular, and it constitutes a valve seat for engagement with the diaphragm 42.

The receiver 39 is positioned within a chamber 43 formed in the upper portion 33*a* of the housing 33. A first outlet channel 44 is connected at one end to the chamber 43, and as shown in FIGS. 6 and 8 the first outlet channel 44 is defined by recesses formed in the upper portion 33*a* and the lower portion 33*b* of the housing 33. No separate tube similar to the tube 22 of FIG. 1 is used in this embodiment, as the first outlet channel 44 is of a sufficient length to produce the desired inertial effect. The outer end of the first outlet channel 44 is connected to an opening 45 formed in the lower portion 33*b* of the housing 33, so that water flowing through the first outlet channel 44 may be dis-

charged to the drain. The first outlet channel 44 may comprise two turns, if necessary, by forming an opening in the diaphragm 15 to connect the recesses formed in the upper portion 33*a* and the lower portion 33*b* of the housing.

The diaphragm 42 is biased by means of a spring 46 the tension of which may be adjusted by means of a threaded nut 47. The inner end of the spring 46 bears against a disc 48 which is positioned between the spring 46 and the diaphragm 42.

A second outlet channel 49 is formed in the upper portion 33*a* and the lower portion 33*b* of the housing 33, and the inner end of the second outlet channel 49 communicates with the bore 36 in the vicinity of the lower end of the ejector 37. A valve 50 may be positioned within the second outlet channel 49 for controlling the flow of water through the second outlet channel 49, and the valve may be controlled by means of a knob 51 as shown in FIG. 3.

A reservoir 52 may be formed in the upper surface of the upper portion 33*a* of the housing 33, for containing mouthwash. The reservoir 52 is connected to the second outlet channel 49 by means of aligned openings 53 in the upper portion 33*a* and lower portion 33b of the housing 33, and a one-way valve 54 operable by a knob 55 is positioned in the opening 53 for controlling the flow of mouthwash from the reservoir 52 to the second outlet channel 49. A hose connector 56 is threadably connected at its inner end to the lower portion 33*b* of the housing 33, and it has a central opening which communicates with the second outlet channel 49. An elongated tube 57 can be attached at one end to the coupling 56, and the opposite end of the tube 57 has a nozzle 58 of the kind commonly provided with dental syringes of this kind. The nozzle has an orifice of a diameter capable of forming a stream of liquid at a small cross section, and the nozzle preferably is shaped to permit water passing through it to be directed against the teeth and gums for ejection of food particles and massaging gum tissue.

The operation of the fluid oscillator incorporated in the above-described dental syringe is identical to that of the embodiment of FIG. 1. In this case, however, as indicated previously no separate tube 22 is required in order to produce the inertial effect; the second outlet channel 44 is formed integrally with the upper portion 33*a* and lower portion 33*b* of the housing 33, thus providing a neat and compact arrangement.

Throughout the present specification, reference is made to the term "fluid." It is to be understood that the fluid oscillator of the present invention is intended to operate with fluids of sufficient density to achieve the required inertial effect. In particular, the fluid oscillator of the present invention is intended to operate at a relatively low frequency and to produce pulsations in a flow of liquid.

I claim:

1. A pulsating dental syringe comprising:

a housing having an inlet channel adapted to be connected to a source of water under pressure, and first and second outlet channels,

valve means positioned between said inlet channel and said first outlet channel for controlling the flow of water between said inlet channel and said first outlet channel and operable by water pressure alternately to open and to close and thereby respectively to permit and to prevent water from flowing through said first outlet channel, said second outlet channel being connected to said inlet channel upstream of said valve means, the water being caused to flow through said first outlet channel when said valve means is open, the flow of water being diverted to said second outlet channel when the water is prevented from flowing through said first outlet channel,

said first outlet channel being dimensioned to produce an inertial effect in the water flowing through it so that when said valve means is closed, a partial vacuum is produced in said first outlet channel, said valve means being adapted to open after said inertial effect has substantially dissipated and biased to return to its closed position after said valve means has reached its open position, said valve means being caused by said inertial effect to oscillate between its open and closed positions and thereby to produce pulsations of predetermined frequency,

and a nozzle coupled to the outlet of said second outlet channel, said nozzle having an orifice of a diameter capable of forming a stream of water of small cross section, said nozzle being adapted to permit water passing through it to be directed against the teeth and gums for the ejection of food particles and massaging gum tissue.

2. A pulsating dental syringe as claimed in claim 1 wherein there is a chamber connected to said inlet channel at a first junction, a valve seat in said chamber, said valve seat being positioned to divide said chamber into first and second portions, said first outlet channel being connected at one end to the second portion of said chamber and the opposite end of said first outlet channel being open to the atmosphere, said second outlet channel being connected to said inlet channel at a second junction that is upstream of said first junction, wherein said valve means includes a diaphragm positioned across the chamber and said valve seat and movable so that in its open position there is a gap between said diaphragm and said valve seat so that water is permitted to flow from said first chamber portion to said second chamber portion and in its closed position said diaphragm is held against said valve seat and water is prevented for flowing from said first chamber portion to said second chamber portion, said diaphragm having a first face that is opposite said valve seat and a second face that is opposite to said first face, and wherein a spring is positioned to apply a predetermined force against said second face of said diaphragm, the pressure in said second outlet channel being less than the pressure in said inlet channel when said diaphragm is in its open position.

3. A pulsating dental syringe as claimed in claim 2 wherein said spring is compressed when said diaphragm is in its open position and is extended when said diaphragm is in its closed position, the force of said spring exerted against said diaphragm when the spring is compressed being greater then the total force produced by the water pressure applied against said first diaphragm space, and the force of the spring exerted against said diaphragm when the spring is extended being less than the total force attributable to the water pressure applied against said first diaphragm face when said inertial effect has substantially dissipated as aforesaid.

4. A pulsating dental syringe as claimed in claim 2 wherein said inlet channel is shaped in the vicinity of

said second junction to produce a venturi effect in said second outlet channel when water is flowing through said first outlet channel.

5. A pulsating dental syringe as claimed in claim 3 wherein means is provided for adjusting the force of said spring.

6. A pulsating dental syringe as claimed in claim 2 wherein said chamber is cylindrical in shape, and wherein said valve seat is annular.

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