United States Patent

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[33] Great Britain
[31] 13536/67

[54] **HYDRAULIC TEETH CLEANER AND GUM MASSAGER**
2 Claims, 16 Drawing Figs.

[52] U.S. Cl. 128/66
[51] Int. Cl. A61h 9/00
[50] Field of Search 128/62, 66, 229, 24.1

[56] **References Cited**
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3,468,306 9/1969 Heitzman 128/66

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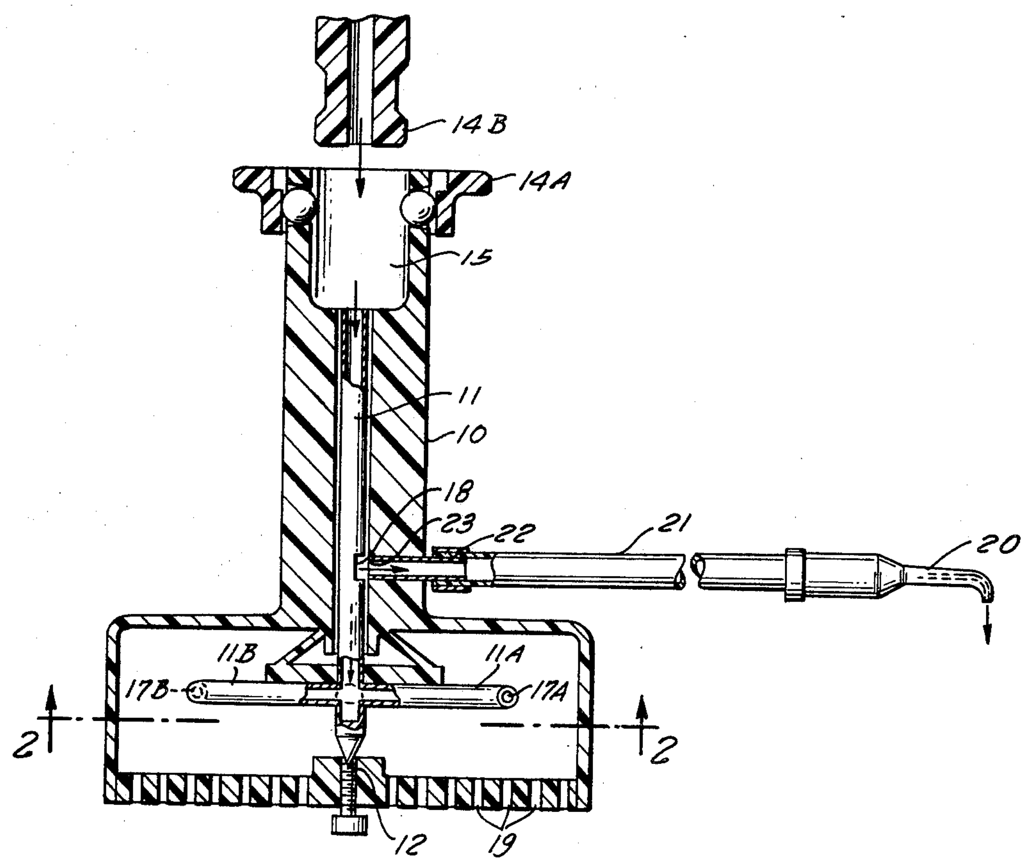
ABSTRACT: Oral hygiene apparatus connectable to and energizable by a pressurized water supply line to produce a pulsating stream of water, or water mixed with a secondary fluid, through a nozzle which is held in the mouth and directed at the gingivi and dental crevices for massaging and cleansing.



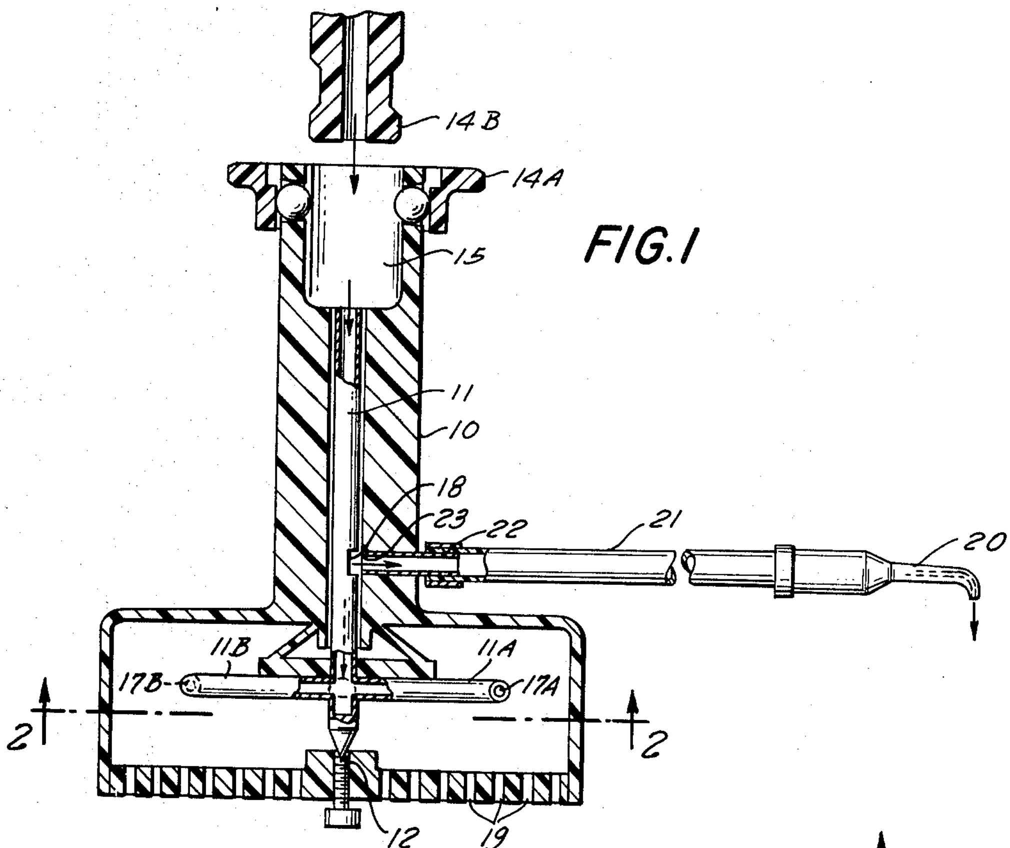


FIG.1

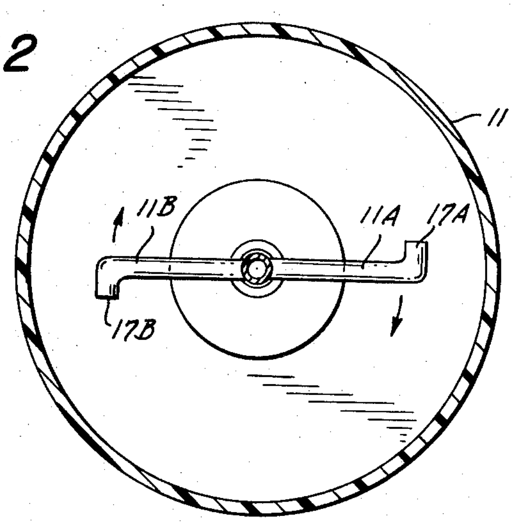


FIG.2

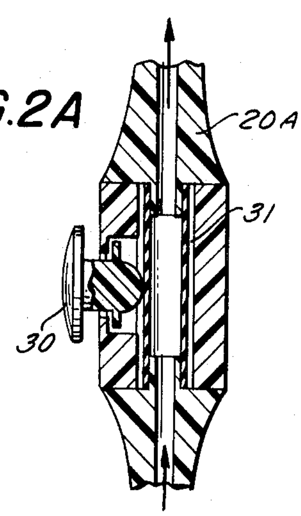


FIG.2A

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FIG.2B

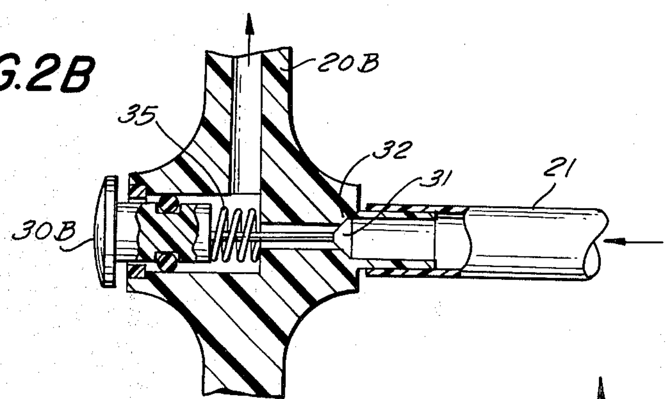

FIG.2C

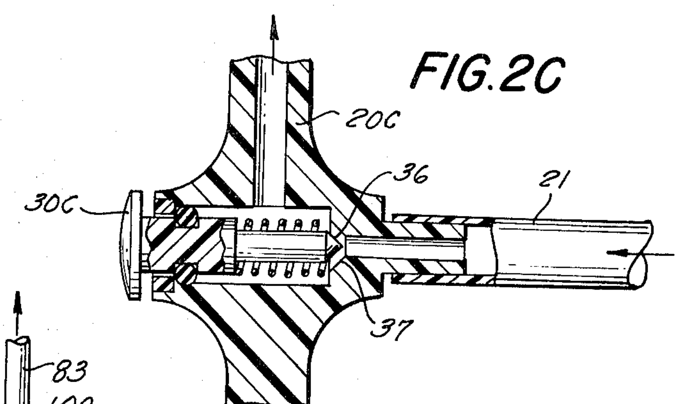

FIG.6

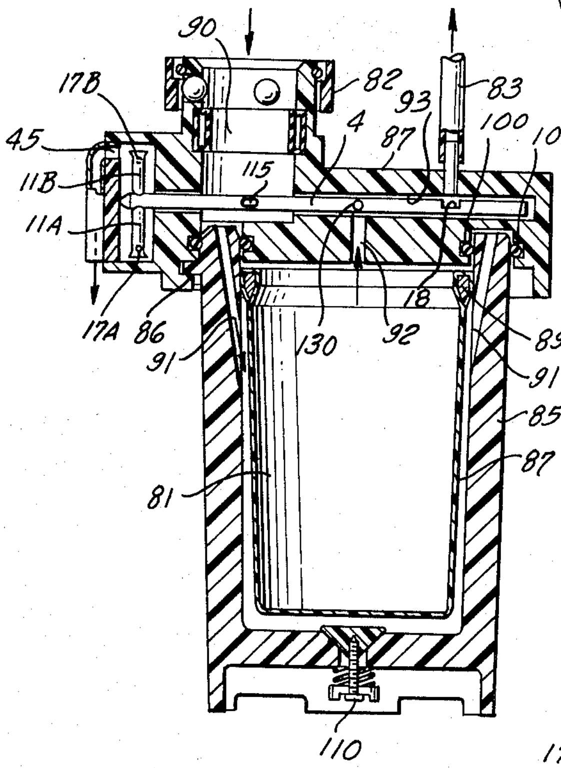

FIG.3

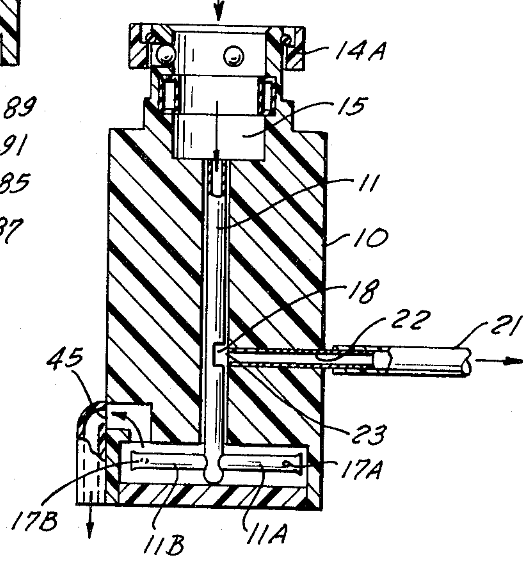

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FIG. 4

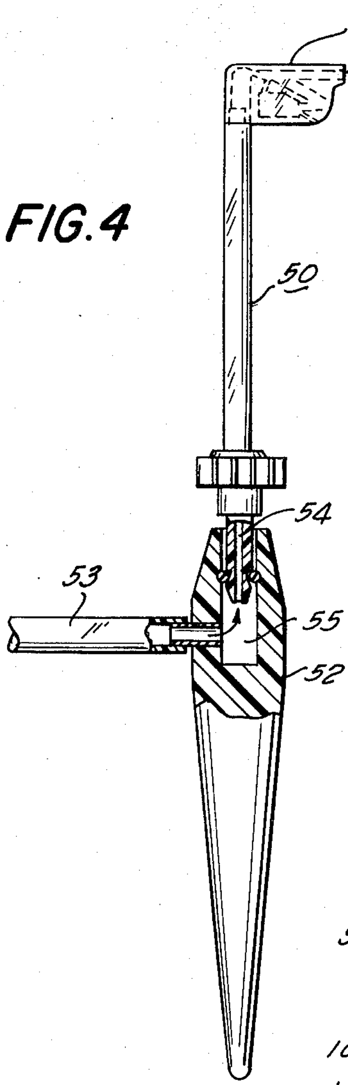
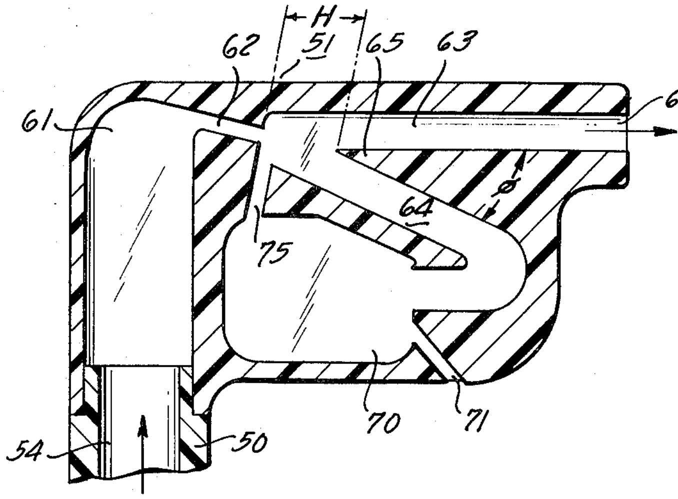


FIG. 4A



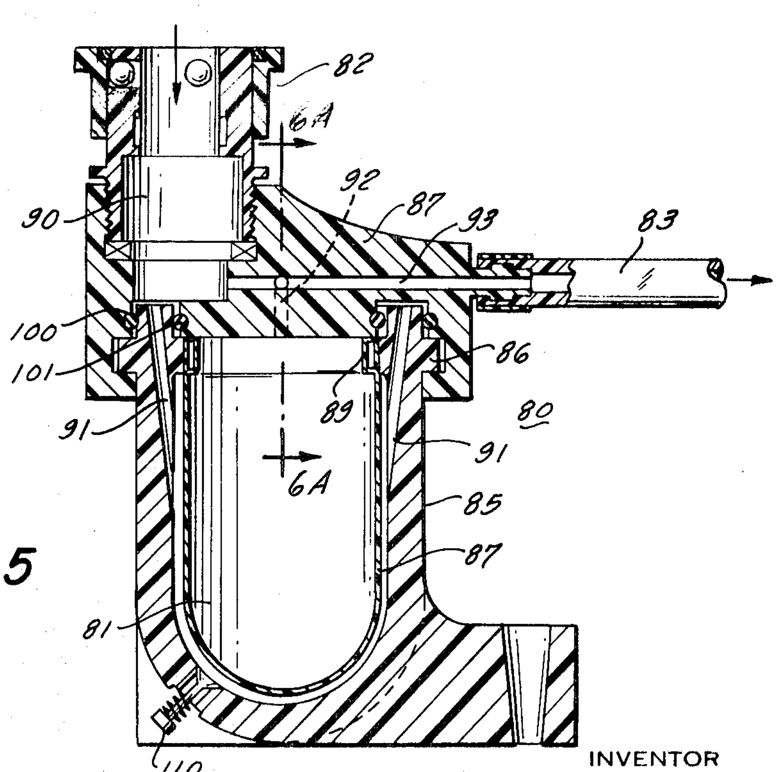


FIG. 5

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FIG.5A

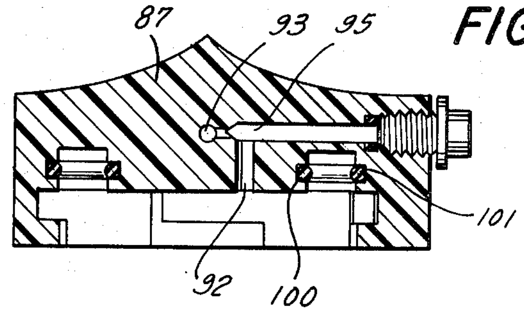


FIG.5B

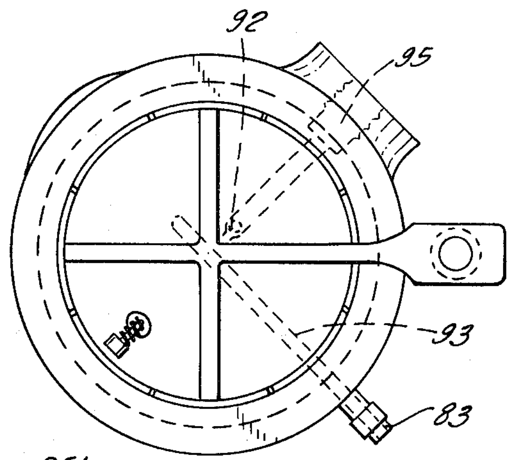


FIG.7

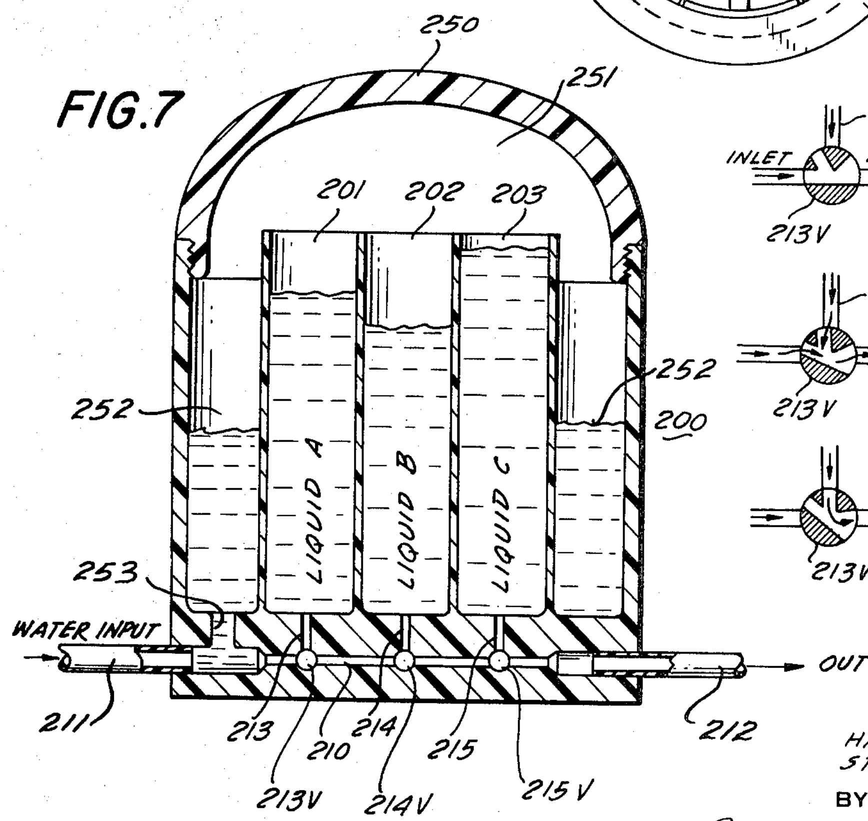


FIG.8A

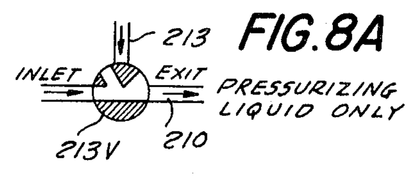


FIG.8B

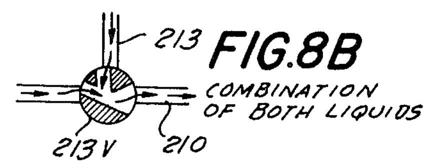
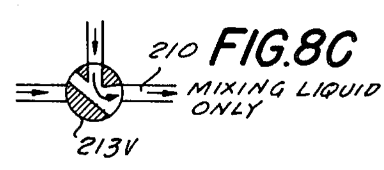


FIG.8C



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HYDRAULIC TEETH CLEANER AND GUM MASSAGER

RELATED APPLICATIONS

The present application is based on applicants' British provisional application Ser. No. 13,536 entitled "Hydraulic Teeth Cleaner and Gum Massager" filed on Mar. 22, 1967, the priority of which is hereby claimed.

BACKGROUND OF INVENTION

The present invention is concerned with providing improved apparatus for producing a pulsating jet of a liquid or mixed liquids for oral hygiene applications. A related though considerably more complex and costly device is described in U.S. Pat. No. 3,227,158 issued on Jan. 4, 1966 to J. N. Mattingly entitled "Method and Apparatus for Oral Hygiene." Such prior art apparatus requires an electrically driven reciprocating pump to produce a pulsating jet of water and accordingly is not only relatively expensive to manufacture but may present problems with respect to electrical shock hazard in the normally damp environment in which it is used.

SUMMARY OF THE INVENTION

The aforementioned problems are effectively eliminated in accordance with the present invention by the provision of a reliable, low-cost liquid-pulsing unit which is energized by the steady pressure of the water supply line to which it is connected, a portion of which supply is converted to a pulsating output directed through a relatively small nozzle to the user's mouth. In a first preferred embodiment, the desired pulsating output is generated by a valve core that is rotatably driven by the supply water to periodically interrupt flow to the output nozzle at the desired pulsation frequency (e.g. 500 pulses per minute).

In a second preferred embodiment, the desired pulsating liquid jet is generated by an extremely simple, compact and inexpensive fluidic oscillator which contains no moving mechanical components and is likewise energized solely by the pressure of the water supply line to which it is connected.

In accordance with a further aspect of the invention, means are provided for mixing controlled amounts of a secondary liquid (e.g. saline solution, mouthwash, etc.) with the primary liquid (e.g. water) that is supplied in pulsations to the output nozzle.

DESCRIPTION OF DRAWINGS

Operation of the invention will be explained in further detail in connection with the following descriptions of the accompanying drawings in which:

FIG. 1 is an elevation view (partially sectioned) of a preferred embodiment of apparatus for producing a pulsating liquid output through a nozzle;

FIG. 2 is a sectional bottom view, as indicated, of FIG. 1;

FIGS. 2A, 2B and 2C are enlarged sectional views of on-off controls that may be optionally used with the apparatus shown in FIGS. 1, 3 and 4;

FIG. 3 is a sectional elevation view showing apparatus similar to that in FIG. 1 but having liquid-damping means on the valve core drive;

FIG. 4 is an elevation view of a second embodiment wherein the pulsating output is generated by a fluidic oscillator;

FIG. 4A is an enlarged sectional view of the fluidic oscillator head of the apparatus shown in FIG. 4;

FIG. 5 is a sectional elevation view of apparatus for mixing a secondary liquid (e.g. mouthwash) with the pressurized primary liquid (e.g. water);

FIGS. 5A and 5B are sectional and plan views of FIG. 6 as indicated;

FIG. 6 is a sectional elevation view of apparatus which produces a pulsating output jet comprising a mixture of two liquids;

FIG. 7 is a sectional elevation view of apparatus for mixing any one or more of a plurality of different secondary liquids with a primary liquid input supplied under pressure; and

FIGS. 8A—8C are simplified schematics illustrating the operation of mixing vavles for the apparatus in FIG. 7.

DESCRIPTION OF PREFERRED EMBODIMENTS

A preferred embodiment of the invention shown in FIG. 1 comprises a rigid nonporous housing 10 containing and supporting a rotating valve core 11 pivotally supported at its lower end by adjustable thrust bearing 12. The housing is preferably adapted for quick connection to and disconnection from a liquid pressure source such as a household water faucet by a conventional quick-disconnect device having a female portion 14A attached to the housing and a male portion 14B attached to the faucet. As shown, the housing has a bore chamber 15 for receiving 14B and the pressurized input water from the faucet. Attached to and in communication with the hollow cylindrical vertical shaft of the valve core 11 are hollow radial turbine arms 11A and 11B which have at their extreme ends thrust orifices 17A and 17B. Water flow through arms 11A and 11B and the thrust orifices 17A and 17B is drained from the bottom of the housing through exahust ports 19 into an available sink disposed under the faucet. The wall of the valve core 11 also defines at least one valve orifice 18 which is provided to supply pulses of water through the output orifice of nozzle 20 via flexible tube 21, rigid coupling tube 22 and output port 23.

As illustrated, the diameter of 11 is preferably made slightly smaller than the journal bearing bore 10A to permit flow of a thin film of water between the surfaces for lubricating purposes.

The embodiment shown in FIG. 1 is prepared for operation by attaching the device to the faucet, and opening the faucet control to permit the pressurized water to flow into chamber 15. As the source pressure is the highest in the system, water is forced downwardly through the central hollow portion of 11 to the valve orifice 18 and the thrust orifices 17A and 17B. Flow of water through the orifices 17A and B at the ends of the radial turbine arms 11A and B produces reaction forces that are proportional in magnitude to the exit momentum of the flow. These forces provide a turning moment about the shaft axis and a resulting rotation of the valve orifice 18 past output port 23. The rotational operating speed is reached at the condition when the bearing friction and fluid drag moments are equal in magnitude to the driving moment. Rotation of 11 results in alternate opening and closing of the flow path through orifice 18 and port 23. This periodic valving action occurs with each revolution of valve core 11 and produces the desired pulsating water output to nozzle 20.

It will be appreciated by those skilled in the art that the shaft speed, and hence the output pulse repetition rate, can be controlled by changing the size of exit orifices 17A and 17B; small orifices producing lower momentum moment and lower speed and larger orifices larger moment and corresponding higher speeds.

Various embodiments of on-off switch controls that may be incorporated in the nozzle 20 are shown in FIGS. 2A—C. The embodiment shonw in FIG. 2A is a simple holdoff type which is operated by depressing button 30 to close the short section of flexible tubing (e.g. rubber or plastic) 31 through which the pulsating stream of water from 21 flows to nozzle 20. In a practical operating device, any of the control switches shown in FIGS. 2A—C may be molded into the plastic body of or a handle for nozzle 20.

The embodiment illustrated in FIG. 2B is of the holdon type and comprises a pushbutton 30B connected to a conical valve tip 31 that is urged into engagement with the walls of a mating conical valve seat 32 defined by the housing 20B. Valve tip 31 is urged into closed position as shown by bias spring 35 and flow of pulsating liquid from 21 to the output orifice of nozzle 20 is permitted only when button 30B is depressed.

The control valve shown in FIG. 2C is similar to that shown in FIG. 2B except that it is of the holdoff type and must be depressed to shut off flow of the pulsating water stream from 21 to the nozzle orifice. Pushbutton 30C is connected to a conical valve tip 36 which is adapted to mate with the wall of conical valve seat 37 to cutoff flow from 21 when 30C is depressed. Button 30C is biased to its open position by spring 38 as shown in the drawing.

In FIG. 3 of the drawings, there is illustrated a modified embodiment of the apparatus shown in FIG. 1 with like elements being identified by the same numerals. With the structural arrangement shown in FIG. 1, the frequency or pulse repetition rate of the output pulses can be controlled by adjusting the spring pressure on thrust bearing 12 which changes the rotational resistance of the valve core 11. In the embodiment shown in FIG. 3, the rotational velocity of 11 is held at a desired speed by submerging the arms 11A and 11B in a small reservoir of waste water from 17A and B that is discharged at an elevated water level through exhuast port 45 to assure that the rotating arms are continuously submerged for desired mechanical loading.

A second preferred embodiment of the present invention for producing a flow of pulsating water from a constant pressure water inlet, such as a faucet, is shown in FIGS. 4 and 4A. A small hand-held tip piece 50 having a pulser housing or head 51 (shown in enlarged section in FIG. 4A) is rotatably mounted on handle 52. The unit is connected to a faucet by a flexible rubber tube 53, or the like, and a pulsating water jet is produced at the output orifice 60 without use of any moving mechanical components. In the operation of this device, water is supplied to orifice 60 through tube 53, chamber 55, bore 54 of 50 and pulser housing 51. The pulsing operation of 51 will now be explained in further detail by reference to FIG. 4A. Water flow enters 61 which functions as an initial plenum or reservoir and then enters the restricted throat 62 from whence it is directed to the Y-section formed by an output port channel 63 and a feedback channel 64 separated by splitter 65. When the water flow exits throat 62 and strikes splitter 65, a low-pressure region is formed around the throat exit and portions of the liquid flow through both 63 and 64. The sudden expansion produces a reduced pressure region in 70 which is less than ambient and as a consequence air is drawn in through air channel 71 into mixing chamber 70 where it is mixed with the water. The resulting air-water mixture enters and flows through deflection channel 75 causing a major portion of the flow exiting 62 to be diverted or switched from 64 to 63. When the air-water mixutre in 70 is partially emptied, the flow from 62 again splits between 64 and 63 and the oscillating cycle repeats to provide repetitive output pulses of liquid through orifice 60.

The head 51, tip 50 and handle 52 may be molded from any plastic or other suitable material that is compatible with water or other liquids which it is designed to handle. The channels in 51 are fully enclosed except for the air intake 71 and the output orifice 60. The channel cross sections may be square, rectangular, circular etc. Typical dimensions for an operating head are as follows:

FIG. 5A Ref.	Round	Rectangular
60	0.06′ dia.	0.055″ × 0.055″
64	0.06″ ″	0.055″ × 0.055″
71	0.04″ ″	0.015″ × 0.055″
70	0.140″ ″	0.2″ × 0.055″
61	0.140″ ″	0.8″ dia.
75	0.040″ ″ ″	0.015″× × 0.055″
62	0.040″ ″	0.015″ × 0.055″

65 Separator angle $\theta = 24°$

Ratio H/G approx. 5

Ratio A/G approx. 3

Where:

H = distance from exit of 62 to splitter.

G = width of throat 62.

A = width of 60.

It should be understood that the embodiments of the pulsing generator according to FIGS. 1, 3 and 4 may be adjusted as desired to either provide discrete, spaced water pulses or water impulses superimposed upon a continuously flowing water stream. Referring to FIG. 1, for example, if the valve orifice 18 and output port 23 each extend less than 180° of the circumference of 11, the generated water pulses will be spaced. On the other hand, if the sum of the arcuate openings of 18 and 23 extend more than 360° of the circumference of 11, the flow in tube 21 and nozzle 20 will not be completely interrupted and the generated water pulses will be superimposed upon a continuously flowing water stream. Also, as explained hereinbefore, the water pulses issuing from the pulser shown in FIG. 4 are normally superimposed upon a constantly flowing water stream. If separate or distinct spaced water pulses are desired, then 100 percent of the flow issuing from throat 62 (when the flow from 75 is zero) can be directed into channel 64 instead of merely favoring channel 64. Subsequent flow in 75 will then pulse the flow into 63.

In accordance with a further aspect of the invention, apparatus is provided for mixing a substantially constant metered amount of a secondary fluid with the primary driving fluid to enchance the effectiveness and/or utility of the invention expecially for oral hygiene where the effect of a pulsating stream of water mixed with a known quantity of a secondary liquid (such as saline solution) directed against the teeth and gums is deemed beneficial to dental and gingival health. For this purpose a solution dispenser 80 is provided as shown in FIG. 5 which contains a chamber 81 that is filled with a desired saline solution or the like. Unit 80 is connected to a faucet by a conventional ball-type quick disconnect 82 and a pulser unit as shown in FIGS. 1, 3 or 4 is connected to tube 83 and the nozzle orifice directed toward the user's teeth and gums. The water faucet is turned on and the device is used in much the same manner as a toothbrush except that the nozzle orifice is not brought into direct contact with the surfaces of the teeth or gums so as to interrupt or block the pulsating output flow. The dispenser includes a rigid nonporous container 85 removably mounted such as by well-known bayonet or breech-type mounting lugs 86 to head section 87. Mounted inside 85 is a flexible inner liner 87 which is made of a thin material (such as rubber) that is compatible with the saline solution or other secondary liquid. The inner liner is mounted and supported by a stiff ring 89 that provides an interference fit with the inside walls of 85 to afford an effective seal between the pressurized water, supplied from the faucet through chamber 90 and ducts 91, and the secondary liquid contained inside the liner. Pressure supplied by the water through the ducts 91 forces the secondary liquid upwardly through metering duct 92 causing it to mix with water supplied through transfer duct 93 to output tube 83. The upper internal and external peripheral edges of 85 are sealed by O-rings 100, 101 to prevent leakage. At the bottom of 85, there is provided a spring-loaded plunger 110 which may be depressed after the device has been used to permit water to drain from the dispenser outer chamber. As shown in FIG. 5A, and 5B, an adjustable needle valve 95 is preferably provided to control the flow of secondary liquid from 92 into 93.

Liner 87 is preferably made from a material that is capable of being deformed by the external water pressure to the extent that the volume of the inner chamber can be reduced to essentially zero as the secondary fluid is discharged therefrom. It should then be capable of returning to essentially the original volume of the inner chamber when the water pressure is released and the liner inner chamber refilled with the secondary liquid. The inner liner material should be essentially nonporous since its purpose is to form a moveable barrier between the primary and secondary liquids that allows the water pressure to be transmitted to the secondary liquid forcing it out of the inner liner chamber through the metering valve.

If the primary liquid source has a constant pressure, then the flow rate of the secondary liquid can be regulated by the metering valve and held at any constant level compatible with the metering area, secondary liquid density and pressure differential of the primary liquid between the solution dispenser inlet and outlet, until the supply of secondary liquid in the inner chamber is exhausted. This results in a mixture of primary and secondary liquids which has a substantially constant weight percent of secondary fluid issuing from the solution dispenser.

If a constant weight ratio of secondary to primary liquids or fluids is not necessary or desireable in the mixture which is discharged from the solution dispenser to the nozzle assembly, then the inner liner can be omitted from the solution dispenser, as well as the secondary fluid metering device. Removing the inner liner allows the continuously flowing primary fluid to mix with the total volume of the secondary fluid, resulting in a continuously decreasing weight percentage of secondary fluid in the mixture issuing from the solution dispenser because the primary fluid continuously dilutes the secondary fluid inside the solution dispenser. Also, if the inner liner is removed, then a solid which is soluble to miscible with the primary fluid can be put into the solution dispenser to be mixed with the primary fluid. Since the initial quantity of solid is dissolving in a primary fluid of constant flow rate, the longer the primary fluid flows the smaller the amount of solid left in the solution container becomes. This results in a continuously decreasing weight percent of dissolved solid in the solution dispenser discharge fluid.

Referring to FIG. **6**, there is shown an embodiment of the present invention in which a pulser unit similar to that of FIG. **3** is mounted in the head or cap of a dispnser similar to that in FIG. **5** to provide a composite unit. Operation of the dispenser portion of the device shown in FIG. **6** is the same as that described above for FIG. **5** and accordingly the like components are identified by the same numerals. The rotating valve core **11** is pivotally mounted for rotation in the horizontal plane in transfer duct **93** of head **87** and water input for driving the valve core and supplying the output pulses is supplied from plenum chamber **90** through two oppositely disposed inlet ports **115** (only one shown) instead of through the end as in FIG. **1**. In other respects the drive operation is the same as that described for FIGS. **1** and **3** and therefore the descritption will not be repeated here.

Secondary liquid discharged from **81** through **92** flows around and through the clearance space between the wall of **93** and the outer surface of **11** where it mixes with water flow from chamber **90** and is discharged through tube **83** to a nozzle like that shown at **20** in FIG. **1**. Additional mixing of the secondary fluid discharged from **81** may be effected by the inclusion of a valve port **130** in **11** which produces a pulsating mixture of the fluids inside the rotating tube and a discharge of the mixture through valve opening **18** into output tube **83**. A needle valve may also be provided to control the flow of secondary fluid through **92** as described above and illustrated in FIGS. **5A** and **5B**.

A further embodiment of a solution dispenser provided by the invention is shown in FIG. **7**. The apparatus illustrated therein allows the selective mixing of a plurality of various liquids either separately or in combination. An important feature of this apparatus is that only one liquid need be pressurized (this will be referred to as the "pressurizing liquid"). The other liquids in the device derive their pressurization from the "pressurizing liquid." Another important aspect is that only one pressure chamber is necessary. The separate secondary liquid containers are located inside the pressure chamber and are not subjected to pressure differences across their walls. The dispenser apparatus includes an enclosing pressure chamber **200**, several smaller liquid containers **201, 202, 203** inside the pressure vessel, and a transfer duct **210** through the base of the pressure vessel which consists of an inlet **211**, an output **212** and connection ducts **213, 214** and **215** to the various chambers through metering valves **213V, 214V** and **215V**.

To operate the device the top **250** to the pressure vessel is removed and the separate liquid container chambers inside are filled with various secondary liquids A, B and C. The inlet is connected to some liquid that is pressurized such as a water faucet and the output is connected to a pulser unit as shown in FIGS. **1, 3** or **4**. As the pressurizing liquid is allowed to flow into the system, it will flow into the pressurizing chamber **252** via duct **253** and compress trapped air in the upper portion **251**, which will pressurize the liquids in the inner chambers **201—203**.

The liquids are induced to flow into **210** by a venturi effect at the valve locations. The valves **213V—215V** may be of the rotary type shown schematically in FIGS. **8A—C** which allow flow of pressurizing liquids only (See FIG. **8A**); liquid from a container only (See FIG. **8C**); or combinations of mixing liquid and pressurizing liquid as shown in FIG. **8B**.

The critical relation between volumes of the various chambers to insure that all the liquids can be expelled from an inner chamber is as follows:

$$V_2 = V_1 \frac{P_{\text{inlet}}}{P_{\text{atm}}}$$

where,

V_1 is the volume of the chambers **201—203** which hold the liquids;

V_2 is the volume of the chamber (**251** and **252**) which is vented to the pressurizing liquid;

P_{inlet} is the absolute pressure of the pressurizing liquid; and

P_{atm} is the absolute pressure of the atmospheric air trapped in the vessel prior to the introduction of the pressurizing liquid.

While preferred embodiments of the present invention have been described, it will be understood that various modifications may be made by those skilled in the art without departing from the scope of the invention as defined in the claims.

I claim:

1. Oral hygiene apparatus connectable to and energizable by a pressurized water supply line to produce an output stream of pulsating water through a nozzle, said apparatus comrising:
   a. a support housing defining a passage having an input for receiving pressurized water from a supply line, an output port for delivering a pulsating flow of water and an exhaust port;
   b. a valve core pivotally mounted in said passage and rotatably driven by the pressurized water, said core comprising a hollow shaft having one open end for receiving pressurized water and at least one dependent radial arm having a thrust orifice with a water passageway connected to the hollow water passage of said shaft, and a valve orifice disposed in the wall of said shaft for supplying pulses of water to said output port;
   c. means for mechanically loading said rotating valve core; and
   d. a nozzle having an orifice connnected to said output port.

2. Oral hygiene apparatus connectable to and energizable by a pressurized water supply line to produce an output stream of pulsating water through a nozzle, said apparatus comprising:
   a. a support housing defining a passage having an input for receiving pressurized water from a supply line, an output port for delivering a pulsating flow of water and an exhaust port;
   b. a valve core pivotally mounted in said passage and rotatably driven by the pressurized water, said core comprising a hollow shaft having one open end for receiving pressurized water and at least one dependent radial arm having a thrust orifice with a water passageway connected to the hollow water passage of said shaft, and a valve orifice disposed in the wall of said shaft for supplying pulses of water to said output port;
   c. means for submerging a portion of the rotating valve core in a reservoir of water to mechanically load and thereby regulate the rotational speed of said valve core; and
   d. a nozzle having an orifice connected to said output port.