United States Patent

Ryckman, Jr.

[15] **3,703,170**

[45] **Nov. 21, 1972**

[54] **ORAL HYGIENE APPARATUS**

[72] Inventor: **William D. Ryckman, Jr.**, Asheboro, N.C.

[73] Assignee: **General Electric Company**

[22] Filed: **March 4, 1971**

[21] Appl. No.: **120,828**

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

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

[58] **Field of Search** ..... 128/62 A, 66, 230, 234, 235

[56] **References Cited**

UNITED STATES PATENTS

3,405,710	10/1968	Kovach	128/66
3,547,110	12/1970	Balamuth	128/66
3,195,537	7/1965	Blasi	128/62 A
2,308,974	1/1943	Harper	128/66 UX
3,511,229	5/1970	Romo	128/52
1,846,595	2/1932	Hertzberg	128/66 UX

FOREIGN PATENTS OR APPLICATIONS

1,202,627	7/1959	France

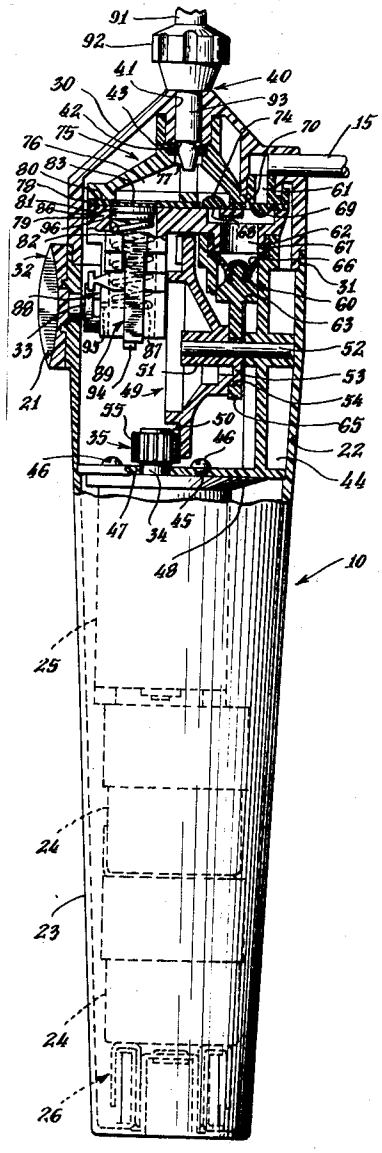
Primary Examiner—Lawrence W. Trapp

Attorney—Lawrence R. Kempton, Leonard J. Platt and Frederick P. Weidner

[57] **ABSTRACT**

Oral hygiene apparatus of the variable pressure pulsed liquid jet type that includes a hand-held unit and a liquid reservoir which may be separate or incorporated in the hand-held unit. The unit contains an electric motor, electrical energy supply means, a pulsating pump and a pressure regulator that is adjustable within set limits to control the maximum peak liquid output pressure and expels liquid equal to the liquid displacement of the pump regardless of the adjusted maximum peak liquid output pressure.

17 Claims, 6 Drawing Figures



PATENTED NOV 21 1972

3,703,170

SHEET 1 OF 3

Fig. 2

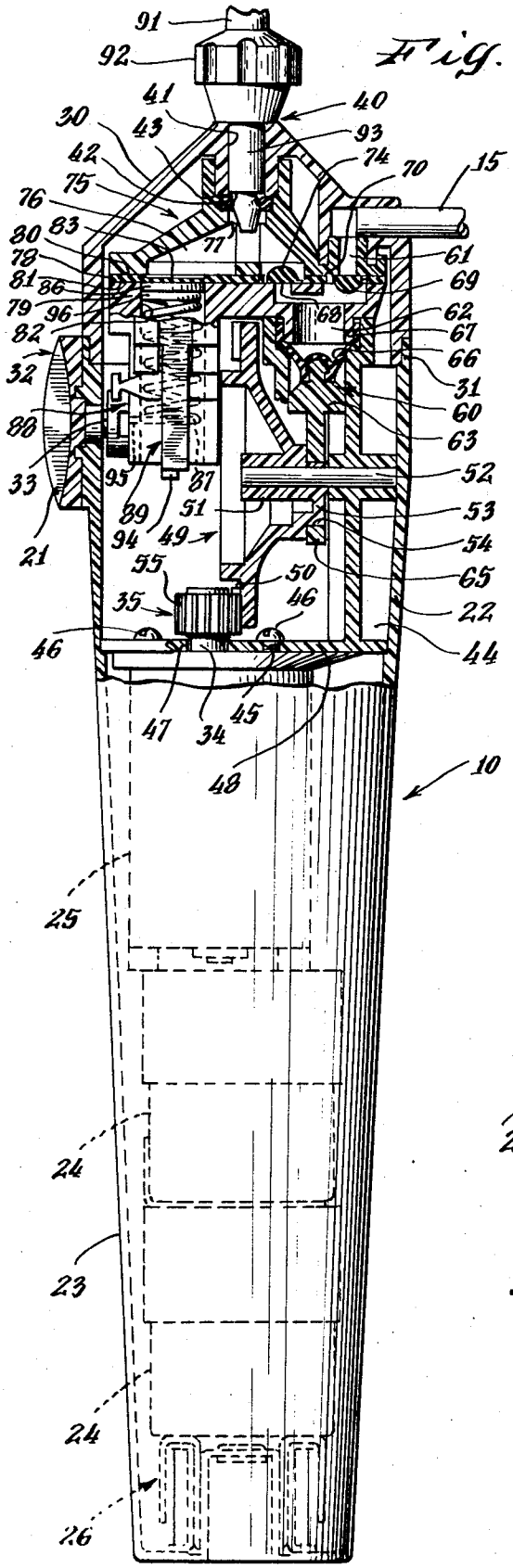


Fig. 1

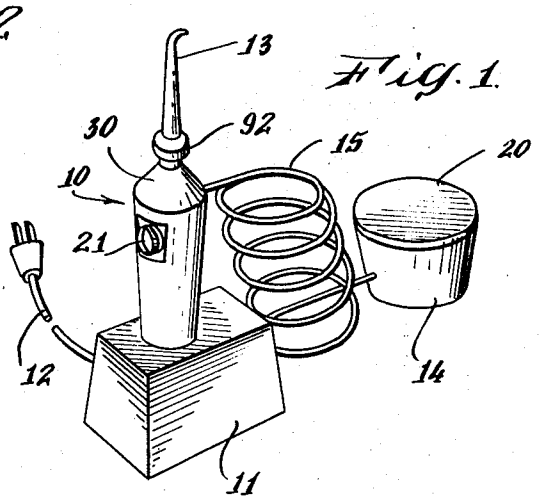
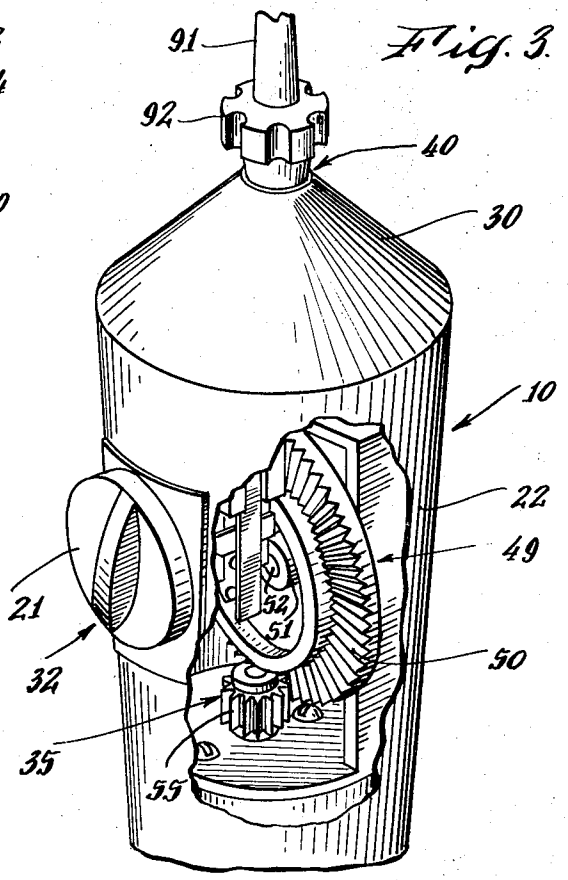


Fig. 3



INVENTOR.
William D. Ryckman, Jr.

BY
Frederick O. Meissner Jr.
ATTORNEY.

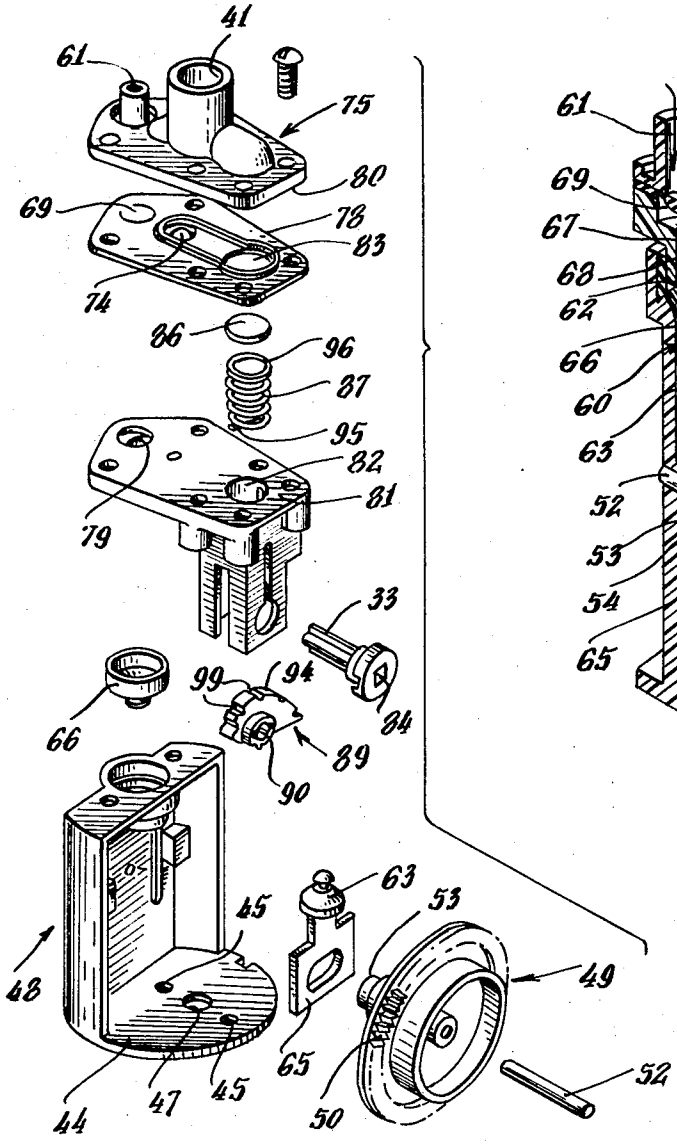


Fig. 5.

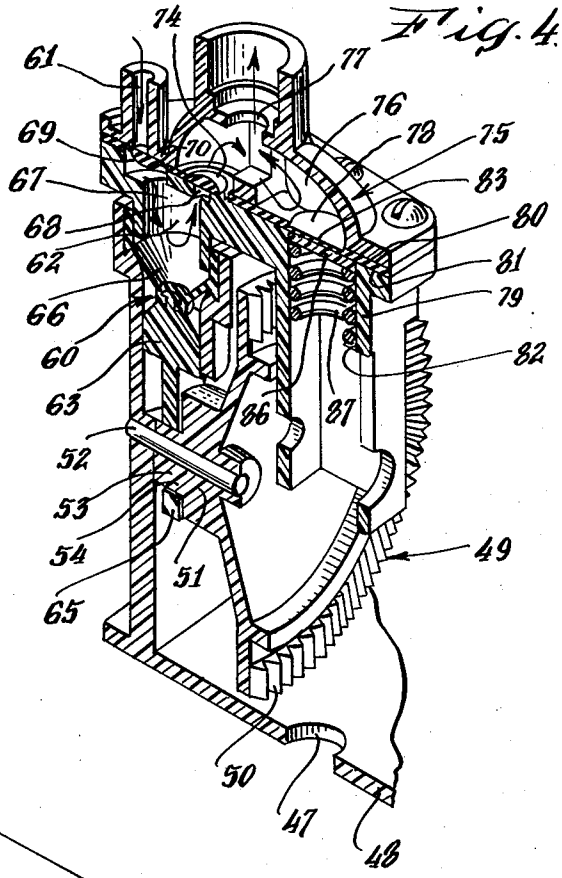


Fig. 4.

INVENTOR
William D. Ryckman, Jr.

BY
Frederick A. Weidner, Jr.
ATTORNEY.

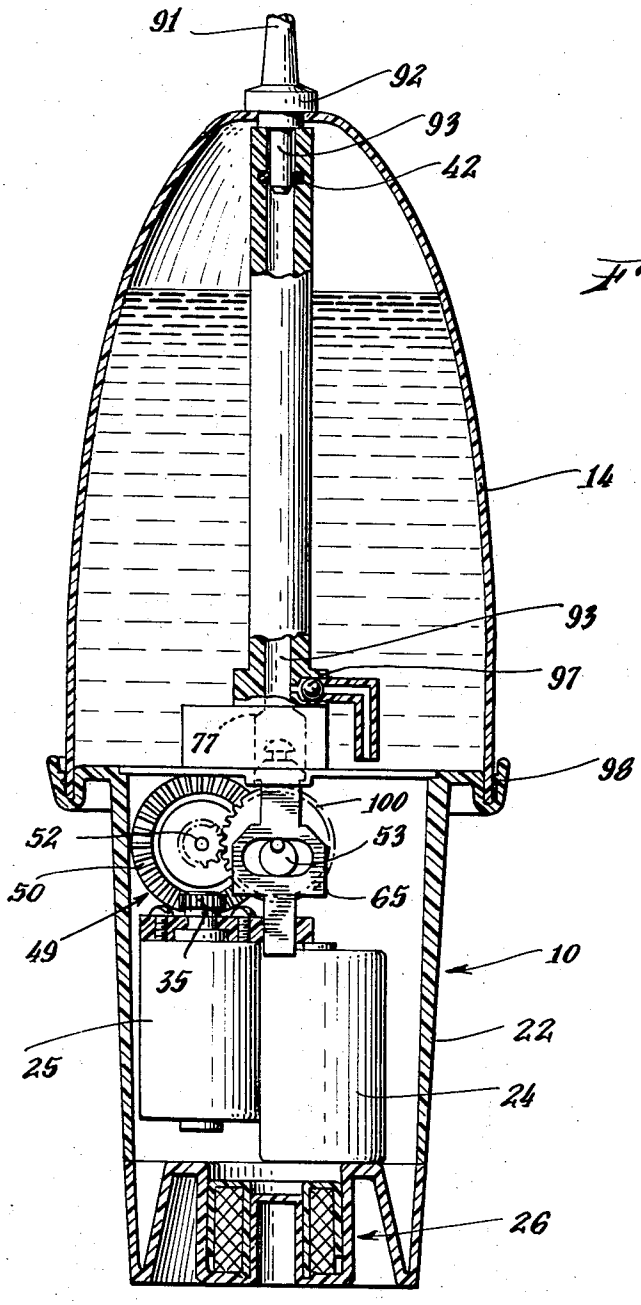


Fig. 6.

INVENTOR
William D. Ryckman, Jr.

BY
Frederick O. Weidner Jr.
ATTORNEY.

ORAL HYGIENE APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to oral hygiene apparatus of the liquid jet type used for cleaning teeth and massaging the gum tissues.

Oral hygiene apparatus for producing a small jet of liquid discharged at substantial velocity may be used for cleaning the teeth and gums. The method of cleaning teeth by a jet of liquid is particularly beneficial for users who have intricate or fragile dental braces or appliances. One form of apparatus for practicing this method of cleaning the teeth and gums includes a reciprocating pump driven by an electric motor. To produce the jet of pulsating liquid, a piston within a pump cylinder applies pressure during its forward stroke to liquid drawn into the pump cylinder during the rearward stroke. The pump is normally provided with a means for the user to adjust the amount of liquid pressure discharged.

Oral hygiene apparatus of this type may have its own reservoir for supplying the liquid used in the apparatus system. The reservoir is filled with the desired liquid, such as water or an oral cleansing solution, and placed in such a manner that it communicates with the pump so that the liquid may be introduced into the pump cylinder during the rearward stroke of the piston. During the forward or pressure applying stroke of the piston, the liquid leaves the pump cylinder under pressure by means of a conduit which carries the pulsating jet of water to a hand nozzle for discharge into the mouth. Such apparatus normally is designed and manufactured so that the peak liquid output pressure can be adjusted by the user within the range of 20 to 90 psi. Heretofore, the liquid output pressure was controlled within a pressure range by adjusting the inlet valve that introduces liquid into the pump chamber to permit a controlled amount of liquid to backflow into the inlet during the pressure applying stroke of the piston. Pressure regulation by backflow inherently produces loss of energy within such apparatus and from the standpoint of power required to operate the pump, pressure regulation by such a means is inefficient.

Oral hygiene apparatus of the type described above and used heretofore are rather heavy and bulky. While being used they must be placed on a counter or other level support with the power cord plugged into some convenient wall receptacle for supplying electrical current to the motor that drives the pump. Oral hygiene apparatus of this type also have a hand-held nozzle connected through rather rigid conduit means to the pump within the apparatus housing. Such apparatus, therefore, needs to be used conveniently close to a wall receptacle, it must be supported on a firm level surface, and operated near a sink for disposal of the discharged liquid. Many bathrooms where such oral hygiene apparatus are commonly used do not afford such readily available conveniences. Moreover, from the standpoint of convenience for the user, elimination of the power cord, being able to hold the oral hygiene apparatus comfortable in the hand, and elimination of the rigid, hard to manipulate, conduit from the pump to the nozzle would be advantageous.

By my invention, there is provided an improved oral hygiene apparatus that accomplishes these advantages and overcomes the disadvantages of prior oral hygiene apparatus as pointed out above.

SUMMARY OF THE INVENTION

In accordance with this invention, there is provided oral hygiene apparatus that includes a hand-held unit containing an electric motor, a means of supplying electrical energy to the motor, a pulsating pump drivenly connected to the motor for pressurizing the liquid, and a pressure regulator that receives pressurized liquid from the pump which is manually adjustable by the user from outside the hand-held unit to control the maximum peak liquid output pressure expelled from the hand-held unit. The regulator is constructed so that it expells an amount of liquid equal to the displacement of the pump regardless of the adjusted output pressure. The oral hygiene apparatus also includes a liquid reservoir for supplying liquid to the pump, which reservoir may be included as part of the hand-held unit or it may be a separate reservoir connected to the pump through a liquid transfer conduit. The liquid is expelled from the hand-held unit through a nozzle tip and the user may direct the expelled liquid by manipulating the hand-held unit as desired.

It is an object of this invention to provide an improved oral hygiene apparatus that produces a high velocity liquid jet for cleaning the teeth and gums.

It is also an object of this invention to provide oral hygiene apparatus that produces a high velocity liquid jet for cleaning the teeth and gums which may be hand-held.

It is another object of this invention to provide oral hygiene apparatus that produces a high velocity liquid jet for cleaning the teeth and gums that is hand-held, self-contained, and battery operated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of one embodiment of my oral hygiene apparatus including a hand-held unit, reservoir and battery recharging unit.

FIG. 2 is a partially-sectioned side-elevation view of the hand-held unit of my oral hygiene apparatus.

FIG. 3 is a perspective view of the hand-held unit of my oral hygiene apparatus with a broken-away portion.

FIG. 4 is a partially sectioned perspective view of the pump and adjustable pressure regulator.

FIG. 5 is an exploded view of the pump and adjustable pressure regulator.

FIG. 6 is an alternate embodiment of my hand-held oral hygiene apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, the apparatus illustrated in FIG. 1 is one embodiment of my invention and comprises a hand-held, battery operated unit **10** seated in a base **11** containing a battery recharging device. An electric cord **12** is provided for plugging into an electrical outlet and operating the battery recharging unit. The hand-held unit **10** has a nozzle **13** rotatably secured to the top of the unit which is utilized for discharging liquid from the unit **10** into the user's mouth. A rotatable control knob **21** accessible to the user from outside the hand-held unit is provided for turning the unit on and off and regulating the liquid output pressure. In this embodiment of my oral hygiene apparatus a separate liquid containing reservoir **14** is connected to the unit **10** through transfer conduit **15**.

The reservoir 14 may have a cap 20 as a convenience to prevent the liquid from spilling out of the reservoir during use. To operate the oral hygiene apparatus shown in FIG. 1, the user places liquid into the reservoir and holds the reservoir in one hand. The unit 10 is removed from the base 11 and held in the other hand. By rotating the control knob 21 the unit is turned on and liquid is pumped, as will be described in detail later, from the reservoir through conduit 15 into unit 10 and discharged from unit 10 through nozzle 13 for the oral cleaning operation.

With reference to FIG. 2, the internal arrangement of components of the hand-held unit 10 is shown. The hand-held unit comprises a generally cylindrically shaped housing or casing 22 which is divided into two portions for convenient manufacturing assembly. The casing 22 is preferably formed of an electrically insulating plastic material which is relatively strong and lightweight. The rear or power portion 23 of the casing contains two suitable rechargeable batteries 24, shown schematically, which are adapted to energize a low voltage direct current motor 25 also contained in the power portion 23 of the casing but forward of the batteries. The electric motor drives the liquid pumping mechanism, as will be described more fully later. At the base or extreme rear of unit 10 is a battery recharging component 26 that is accepted in the recharging base 11 shown in FIG. 1 that contains a battery recharging device. In the embodiment shown, the battery recharging is done inductively with a primary transformer coil located in the base 11 and the secondary transformer coil, which is part of recharging component 26, in the power unit 10. With base 11 plugged into a wall outlet and the power unit placed in base 11 there is inductive coupling between the primary and secondary coil which through appropriate electrical connections recharges the batteries. In this type of oral hygiene apparatus an inductive recharging arrangement is particularly advantageous as there are no exposed electrical contacts. While one battery may be used I have found that it is preferable to use two rechargeable batteries, particularly of the nickel-cadmium type, as they function efficiently over a long period of time. While the preferred embodiment uses batteries as the source of electrical energy for the motor the hand-held unit could instead be energized by a low power transformer. Such a transformer would, however, be more inconvenient as it would require an electric cord from the transformer in the base to the hand-held unit. Suitable supporting means are arranged within the power portion 23 of the casing to maintain the batteries, motor, and recharging component in their proper positions after assembly. The forward portion of the hand-held unit 10 contains the pump, adjustable pressure regulator and discharge nozzle for the oral hygiene apparatus all of which will be described in detail subsequently.

After assembly of the various components in the hand-held unit 10 the two casing portions, rear portion 23 and front portion 30, are suitably joined at circumferential lap joint 31 as by ultrasonic welding. Energization of electric motor 25 is controlled by one position of the switch assembly 32 which includes control knob 21, accessible from outside the casing for manual operation. By manually rotating control knob 21 about the axis of stem 33 the necessary electrical connections are made within the switch assembly to energize the motor thereby causing motor shaft 34 to rotate, which has attached thereto pinion gear 35. With motor 25 secured in place within the casing the motor shaft 34 and pinion gear 35 are rotated substantially coincidental with the longitudinal axis of hand-held unit 10.

At the front or right-hand end of unit 10 is an outlet coupling arrangement 40 for receiving individual removable and rotatable nozzle tips 13. The coupling arrangement consists of a cylindrical aperture 41 through the front portion 30 of the casing with an internal fitment that will allow rotational movement of the nozzle tip 13 but still function as a liquid seal. In this case the fitment consists of an O-ring 42 secured in place within casing 22 which cooperates with channel 43 formed in the end of the nozzle tip to provide a liquid seal. The nozzle tip 13 may be removed by pulling it outwardly from the hand-held unit 10 and replaced by pushing it inwardly with sufficient force to overcome the sealing engagement of the O-ring. Normally, several nozzle tips are supplied so that the users, such as a family, may each have one for their personal use.

The pumping and regulator mechanism contained within the front end of hand-held unit 10 will now be described with particular reference to FIGS. 2 – 5. The orientation of electric motor 25 within hand-held unit 10 and securing it in place is achieved by screws 46 extending through holes 45 in support frame 48 and into the motor frame. Motor shaft 34 projects through a hole 47 in the bottom 44 of support frame 48 and has attached to it pinion gear 35. Face gear assembly 49 is rotatably secured to support frame 48 so that its gear teeth 50 engage the gear teeth 55 of pinion gear 35. The face gear assembly 49 has a hub 51 through which is inserted pin 52. Pin 52 is fixed to support frame 48 in any suitable manner and is positioned substantially at a right angle to the longitudinal axis of the hand-held unit 10. As can be seen in the drawings, the face gear is dished and opens sidewardly in the direction of the switch assembly 32. Integrally formed with hub 51 and opposite the dished portion is a cam element 53 having an eccentric cam surface 54. Upon rotation of the face gear assembly about its central axis on pin 52, cam element 53 will correspondingly rotate about pin 52. The face gear assembly may be formed from suitable plastic material and can be molded in one piece.

In close proximity to the face gear assembly and also secured in place within the hand-held unit 10 is a pulsating pump assembly 60 of the reciprocating piston driven diaphragm type. The liquid for pressurization by the pump enters the pump assembly 60 from reservoir 14 through conduit 15 which is attached to an inlet port 61 leading into the pump chamber 62. The pump chamber of the preferred embodiment of the oral hygiene apparatus is cylindrically shaped and has within it a reciprocating diaphragm 66 driven by reciprocating piston 63 joined to yoke 65 that is in driven connection with cam 53. The elastomeric flexible rolling-type diaphragm 66 attached to the forward end of piston 63 is secured to wall 67 of the pump chamber in such a manner that the volume of pump chamber 62 varies with the reciprocating movement of piston 63. In operation, when the piston of the pump assembly is moved rearwardly within the pump chamber liquid is

drawn into the pump chamber through inlet port **61** and fills the chamber. During the forward movement of the piston, the volume of the pump chamber is decreased and correspondingly the liquid within the pump chamber has pressure applied to it and forces the liquid to leave the pump chamber through outlet port **68**. It will be noted that inlet port **61** has a check valve **69**, in the form of a flapper, which allows the liquid to pass from the inlet port **61** into pump chamber **62** during the rearward movement of piston **63** but during the forward movement of the piston when the liquid in the pump chamber is pressurized, check valve **69** closes by abutting a shoulder **70** thereby effectively sealing inlet port **61** to prevent liquid from the pump chamber to pass back out through the inlet port. Outlet port **68** is also provided with a check valve **74** in the form of a flapper that opens to allow the liquid to pass from pump chamber **62** during the forward movement of piston **63** but closes during the rearward movement of the piston when liquid is being drawn into the pump chamber from reservoir **14**. Such a pump arrangement produces an intermittent or pulsating liquid jet under considerable pressure. The preferred embodiment of my oral hygiene apparatus is constructed so that the frequency rate of the liquid pulsations produced by this system will be around 2,000 per minute. A reciprocating pump as described above produces individual intermittent pulses of liquid with the pressure of each pulse caused by the forward or pressure applying movement of the piston when plotted against time taking the form of a bell-shaped curve. The pressure curve starts at zero pressure and increases to a peak pressure level at the top of the bell-shaped curve then decreases back to zero pressure. During the rearward movement of the piston liquid is drawn into the pump chamber therefore no pressure is applied to the liquid during this time interval hence the intermittent nature of the discharged liquid.

After the liquid is pressurized it leaves pump chamber **62** via outlet port **68** through check valve **74** and passes to the adjustable pressure regulator assembly **75**. The regulator assembly includes a walled chamber **76** the internal dimensions of which may vary depending upon the requirements of the liquid pressurization system. Outlet port **68** of the pump chamber and the inlet port of regulator chamber **76** are common in the preferred embodiment of the oral hygiene apparatus. Walled chamber **76** has a constantly open outlet port **77** through which the pressurized liquid is expelled. One wall of chamber **76** is formed of a flexible diaphragm **78**, preferably a flexible elastomeric diaphragm, which is capable of moving to vary the volume of chamber **76**. The drawings all show the flexible elastomeric type diaphragm. Regulator diaphragm **78** may be secured in place by a hollow clamping sleeve **79** having a clamping face **81**. Regulator chamber **76** also has a clamping face **80** so that the peripheral margin of regulator diaphragm **78** around the bore **82** is clamped tightly between the faces **80** and **81**. This arrangement allows the central portion **83** of diaphragm **78** to move back-and-forth by expanding and contracting to thereby vary the volume of chamber **76**. The cylindrical hollow clamping sleeve **79** has positioned within its bore **82** a rigid back-up disc **86** that abuts diaphragm **78** in central portion **83**. The disc **86** is circular in shape and slightly smaller in diameter than the inside diameter of bore **82** so that it can move back-and-forth therein. Also retained within bore **82** of clamping sleeve **79** is a force exerting means in the form of coil spring **87**, one end **96** of which abuts disc **86**. Behind spring **87** is a manually adjustable control assembly **88** that is utilized to adjust and control the amount of compression of spring **87**. The control assembly **88** includes a rotatable cam element **89** having an eccentric cam surface **94** which engages the end **95** of coil spring **87**. Cam element **89** is connected through key hole **90** to stem means **33** which in turn is connected via key hole **84** to control knob **21** accessible to the user from outside casing **22**. By rotating knob **21** cam element **89** is thereby rotated and eccentric cam surface **94** functions to vary the length of coil spring **87** and correspondingly the amount of compression of coil spring **87**. If desired, various pressure settings may be calibrated by putting notches **99** in the eccentric cam surface. These notches cooperate with end **95** of coil spring **87** to indicate the pressure setting but can be overridden by simply turning knob **21**.

The pressure regulator operates as follows. Liquid is intermittently being pumped under pressure by the pump assembly **60** and delivered to the regulator chamber **76** through the common or combined pump chamber outlet and regulator chamber inlet **68**. If the pressure of the liquid introduced into the regulator chamber is below the maximum peak pressure for which the regulator is adjusted the volume of regulator chamber **76** will remain the same and the pressurized liquid will be expelled from the chamber via outlet port **77**. However, should the incoming pressurized liquid have a peak pressure higher than the maximum adjusted level, the pressure of the liquid introduced into chamber **76** will force diaphragm **86** to expand outwardly of the chamber and correspondingly move disc **86** rearward and compress coil spring **87** between cam element **89** and disc **86**. The chamber **76** is thereby increased in volume. When the pressure of the liquid coming into regulator chamber **76** from the pump drops off to below the selected maximum peak pressure level spring **87** will tend to expand and exert force through disc **86** to the diaphragm to force the diaphragm back to its normal position causing the liquid stored in the previously expanded chamber to be expelled from the chamber at the selected maximum peak pressure level for a short time. In this manner the regulator operates to chop off the peak of the pressure to the selected adjusted maximum level and store the energy as well as the liquid within the expanded chamber until the proper maximum pressure level is achieved. The total flow of liquid expelled from outlet port **77** of the regulator chamber is always the full displacement capability of the pump yet the maximum peak output pressure can be selectively controlled. By incorporating such a pressure regulator in the liquid pressurization system of the oral hygiene apparatus there is negligible energy loss within the apparatus compared to the case when the backflow means of control is used. I have, therefore, been able to increase the efficiency of the pressurization system used in oral hygiene apparatus with consequent savings in motor size, less electric power requirements, lighter weight materials and smaller overall size as compared to heretofore known oral hygiene apparatus.

As mentioned previously, the forward end of hand-held unit **10** is equipped with an outlet coupling **40** for receiving rotatable nozzle **13**. Nozzle **13** has an inlet section **91** that extends from the forward end of casing **22** to outlet port **77** of regulator chamber **76**. With such a connection the liquid may leave the chamber under pressure through inlet section **91** and tip portion **92** of nozzle **13** for ultimate discharge for the oral cleaning operation. Nozzle **13** is usually equipped with a collar **93** to facilitate finger rotation of the nozzle **13** while the oral hygiene apparatus is being used.

In my oral hygiene apparatus, the batteries will be recharged by placing unit **10** in base **11** and keeping cord **12** plugged into an electrical outlet for providing electric current to the charging unit. For the oral cleaning operation, reservoir **14** is filled with liquid then control knob **21** of switch assembly **32** turned from the "off" position to the "on" position thereby energizing electric motor **25**. The "on" position is also the low pressure position so that the motor is always energized initially at the low pressure setting. If higher pressure is desired control knob **21** is rotated until the desired level is reached. The motor through a gear train including pinion gear **35** and face gear assembly **49** causes face gear cam **53** to rotate with eccentric cam surface **54** driving piston **63** in a reciprocating motion through yoke **65**. The liquid flow path through the pump and pressure regulator is shown by arrows in FIG. **4**. During rearward movement of the piston, liquid from reservoir **14** is drawn into pump chamber **62** through check valve **69**. The piston during its forward movement applies pressure to the liquid through rolling diaphragm **66** which closes check valve **69** and forces the liquid through outlet port **68** into regulator chamber **76**. The regulator functions as described above to control the maximum peak output pressure of the fluid discharged from the apparatus. When use of the oral hygiene apparatus is to be discontinued, the user rotates the control knob to the "off" position to de-energize the motor. By so doing, cam element **89** is rotated and the compression on spring **87** is decreased to a minimum so that the adjusted pressure is at its lowest level.

Several advantages are achieved by the particular construction and arrangement of the pump and pressure regulator assembly. The regulator diaphragm **78**, inlet flapper valve **69**, and outlet flapper valve **74** may all be formed in one piece of elastomeric sheet material. Moreover, the elastomeric sheet also functions as a liquid sealing gasket between the various components to keep liquid from leaking into the mechanical and electrical parts of the apparatus where it could detrimentally affect operation of the apparatus. It should also be noted that by using an elastomeric rolling diaphragm **66** in the pump and the one piece elastomeric sheet that contains diaphragm **78**, flapper valves **69** and **74**, the liquid passing through the hand-held unit **10** never comes into contact with any corrosion or abrasion sensitive parts. This is particularly significant in the case of moving parts as the liquid can be a carrier of corrosive materials and abrasive particles that would otherwise cause wear and shorten the life of the apparatus.

Another important advantage resulting from the construction of the pump and pressure regulator is that there is provided greater efficiency regarding electrical power requirements, which is particularly significant in the case of batteries being used as the power source in the oral hygiene apparatus. The voltage output of batteries varies with state of charge which will in turn cause the power output of the motor to vary resulting in a corresponding variation of the pressure applied to the liquid by the motor driven pump. If the voltage decreases, which is common when batteries are being used, the output pressure from the pump decreases. In oral hygiene apparatus it is desirable to limit the adjustment range of the maximum peak output pressure, usually from 20 to 90 psi. During manufacture the adjustment is calibrated and set so that the maximum peak output pressure (90 psi) is the highest attainable adjustable level. In previous oral hygiene apparatus wherein the liquid output pressure was regulated by backflow, should there be a drop in voltage to the motor the pressure could not be adjusted high enough to compensate for the drop in voltage and corresponding loss of power and consequently the maximum liquid pressure level (90 psi) could not be attained. In my apparatus the peak output pressure is not affected by moderate voltage changes. By using this type of pressure regulator the maximum peak pressure level is still maintained at the desired level (90 psi) because the regulator functions to chop off the excess peak pressure, store the liquid and energy then subsequently release it. Moreover, since in my system liquid output pressure is not regulated by backflow there is little energy loss so that the apparatus can be operated efficiently with a smaller capacity motor and with battery power if desired.

FIG. **6** shows an alternate embodiment of my oral hygiene apparatus wherein the reservoir **14** is incorporated in with the hand-held unit **10**. The pump (partly shown), adjustable regulator (not shown), electric motor, batteries, charging unit (not shown), electrical switching (not shown), etc., described in the embodiment in FIGS. **1 – 5** are also used in this embodiment and function in the same manner and are substantially the same in construction as described in the embodiment shown in FIGS. **1 – 5**. In the embodiment shown in FIG. **6** the batteries and motor are positioned side-by-side and an additional driven gear **100** has been added for construction convenience. Since the reservoir **14** of the oral hygiene apparatus shown in FIG. **6** is carried as a part of the hand-held unit **10**, the liquid transfer conduit **15** between the reservoir **14** and hand-held unit **10** may be eliminated. Valving means such as a ball check valve **97** is provided to introduce liquid from the integral reservoir **14** directly into the pump chamber. In this embodiment outlet port **77** has an extended passageway **93** for transferring the liquid from the regulator to the nozzle **13**. The reservoir **14** may be filled with liquid, placed on the hand-held unit **10**, which is provided with a circumferential liquid seal **98**, and then operated as described previously in connection with the embodiment of FIGS. **1 – 5**.

While there has been shown and described particular embodiments of the present invention, it will be apparent to those skilled in the art that various changes and modifications may be made without departing from the invention in its broader aspects, and it is, therefore, contemplated in the appended claims to cover all such changes and modifications that fall within the true spirit and scope of the present invention.

I claim:

1. Oral hygiene apparatus comprising:
a. a liquid reservoir,
b. a hand-held unit including
aa. an electric motor,
bb. means to supply electrical energy to said motor,
cc. a pulsating pump in driven connection with said motor for pressurizing liquid, and
dd. a pressure regulator that receives pressurized liquid from the pump, said regulator having means being adjustable within set limits to control the maximum peak liquid output pressure within those limits and expelling liquid from the hand-held unit equal to the liquid displacement of the pump regardless of the adjusted maximum peak liquid output pressure.

2. The oral hygiene apparatus of claim 1 wherein the liquid reservoir is separate from the hand-held unit and a transfer conduit delivers the liquid from the reservoir to the pump.

3. The oral hygiene apparatus of claim 1 wherein the means to supply electrical energy to said motor is a battery.

4. The oral hygiene apparatus of claim 3 wherein the battery is rechargeable.

5. The oral hygiene apparatus of claim 1 wherein the pump means is a pump assembly having a chamber, an inlet port and an outlet port for said chamber, and a reciprocating piston driven diaphragm for applying pressure to liquid in said pump chamber.

6. Oral hygiene apparatus comprising:
a. a liquid reservoir,
b. a hand-held power and pumping unit including a casing, said casing having a liquid inlet, an outlet, and containing
aa. an electric motor,
bb. means to supply electrical energy to said motor,
cc. a pulsating pump in driven connection with said motor for pressurizing liquid, said pump having a chamber, an inlet port in communication with the casing inlet and an outlet port,
dd. a pressure regulator that receives pressurized liquid from the pump, said regulator having means being adjustable within set limits to control the maximum peak liquid output pressure within those limits and expelling liquid from the hand-held unit equal to the liquid displacement of the pump regardless of the adjusted maximum peak liquid output pressure, and
c. transfer means for delivering liquid from the reservoir to the casing inlet.

7. Oral hygiene apparatus comprising:
a. a liquid reservoir,
b. a unit including
aa. an electric motor
bb. means to supply electrical energy to said motor,
cc. pump means in driven connection with said motor for pressurizing liquid,
dd. a pressure regulator receiving pressurized liquid from the pump comprising;
i. a housing,
ii. a walled chamber within the housing,
iii. a flexible diaphragm bounding a portion of the chamber to vary the volume of said chamber,
iv. means exerting force against the diaphragm outside said chamber,
v. adjustable control means to vary the amount of force exerted by said force exerting means against the diaphragm,
vi. an inlet to admit pressurized liquid into the chamber, and
vii. a constantly open outlet through which pressurized liquid is expelled from the chamber.

8. The oral hygiene apparatus of claim 7 wherein the means to supply electrical energy to said motor is a battery.

9. The oral hygiene apparatus of claim 8 wherein the battery is rechargeable.

10. The oral hygiene apparatus of claim 9 wherein a separate battery recharger is provided.

11. The oral hygiene apparatus of claim 10 wherein the battery recharger is of the inductive type.

12. The oral hygiene apparatus of claim 7 wherein the liquid reservoir is separate from the hand-held unit and transfer means delivers the liquid from the reservoir to the pump.

13. An oral hygiene apparatus comprising:
a. a liquid reservoir,
b. a hand-held power and pumping unit containing
aa. an electric motor
bb. a rechargeable battery to supply electrical energy to the motor,
cc. a pulsating pump in driven connection with said motor for pressurizing liquid, said pump having a chamber, a reciprocating piston, an inlet port in liquid communication with said reservoir and having a flapper-type check valve, and an outlet port,
dd. a pressure regulator that receives pressurized liquid from the pump comprising;
i. a housing
ii. a walled chamber within the housing,
iii. a flexible diaphragm bounding a portion of the chamber to vary the volume of said chamber,
iv. means exerting force against the diaphragm outside said chamber,
v. adjustable control means to vary the amount of force exerted by the force exerting means against the diaphragm,
vi. an inlet with a flapper-type check valve to admit pressurized liquid into the chamber, and
vii. a constantly open outlet through which pressurized liquid is expelled from the chamber, and
c. a battery recharging unit.

14. The oral hygiene apparatus of claim 13 wherein the regulator diaphragm is a flexible elastomeric diaphragm.

15. The oral hygiene apparatus of claim 14 wherein the regulator diaphragm, and flapper type check valves are formed in a one-piece sheet of elastomeric material.

16. The oral hygiene apparatus of claim 15 wherein the reciprocating piston operates an elastomeric flexible rolling-type diaphragm to change the volume of the pump chamber.

17. The oral hygiene apparatus of claim 13 wherein the means exerting force against the regulator diaphragm outside said chamber is a coil spring.

* * * * *