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Oral irrigator

Abstract

An oral irrigator includes a drive assembly, a pump assembly, and a flexible membrane seal. The drive assembly is received within a housing. The pump assembly is positioned at least partially within a pump chamber. The pump assembly includes a piston and a connecting rod coupled to the drive assembly, the connecting rod movable between first and second positions through operation of the drive assembly. The flexible membrane seal extends from an interior surface of the pump chamber to the connecting rod to fluidly seal an open end of the pump chamber. The flexible membrane seal deforms from a first orientation to a second orientation as the connecting rod moves from the first position to the second position.

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5349896	12/1993	Delaney, III	92/103SD	F04B 43/0054
D351892	12/1993	Wolf et al.	N/A	N/A
5360338	12/1993	Waggoner	N/A	N/A

5368548	12/1993	Jousson	N/A	N/A
5370534	12/1993	Wolf et al.	N/A	N/A
D354168	12/1994	Hartwein	N/A	N/A
D354559	12/1994	Knute	N/A	N/A
5378149	12/1994	Stropko	N/A	N/A
5380201	12/1994	Kawata	N/A	N/A
D356864	12/1994	Woog	N/A	N/A
5399089	12/1994	Eichman et al.	N/A	N/A
D358883	12/1994	Vos	N/A	N/A
5456672	12/1994	Diederich et al.	N/A	N/A
5465445	12/1994	Yeh	N/A	N/A
5467495	12/1994	Boland et al.	N/A	N/A
5468148	12/1994	Ricks	N/A	N/A
5470305	12/1994	Arnett et al.	N/A	N/A
5474450	12/1994	Chronister	N/A	N/A
5474451	12/1994	Dalrymple et al.	N/A	N/A
5476379	12/1994	Disel	N/A	N/A
5484281	12/1995	Renow	601/165	A61C 17/032
5487877	12/1995	Choi	N/A	N/A
5490779	12/1995	Malmin	N/A	N/A
5505916	12/1995	Berry, Jr.	N/A	N/A
D369656	12/1995	Vos	N/A	N/A
D370125	12/1995	Craft et al.	N/A	N/A
5525058	12/1995	Gallant et al.	N/A	N/A
5526841	12/1995	Detsch et al.	N/A	N/A
5540587	12/1995	Malmin	N/A	N/A
5547374	12/1995	Coleman	N/A	N/A
D373631	12/1995	Maeda et al.	N/A	N/A
5554014	12/1995	Becker	N/A	N/A
5554025	12/1995	Kinsel	N/A	N/A
5556001	12/1995	Weissman et al.	N/A	N/A
5564629	12/1995	Weissman et al.	N/A	N/A
D376893	12/1995	Gornet	N/A	N/A
D377091	12/1995	Scott, Sr.	N/A	N/A
5613259	12/1996	Craft et al.	N/A	N/A
5616028	12/1996	Hafele et al.	N/A	N/A
5626472	12/1996	Pennetta	N/A	N/A
5634391	12/1996	Eady	92/99	F16J 3/02
5634791	12/1996	Matsuura	433/88	A61C 17/0202
5636987	12/1996	Serfaty	N/A	N/A
5640735	12/1996	Manning	N/A	N/A
D382407	12/1996	Craft et al.	N/A	N/A
5653591	12/1996	Loge	N/A	N/A
5659995	12/1996	Hoffman	N/A	N/A
5667483	12/1996	Santos	N/A	N/A
D386576	12/1996	Wang et al.	N/A	N/A
5683192	12/1996	Kilfoil	N/A	N/A
5685829	12/1996	Allen	N/A	N/A
5685851	12/1996	Murphy et al.	N/A	N/A
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D388613	12/1997	Stutzer et al.	N/A	N/A

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5709545	12/1997	Johnston et al.	N/A	N/A
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5716007	12/1997	Nottingham et al.	N/A	N/A
5718668	12/1997	Arnett et al.	N/A	N/A
5743169	12/1997	Yamada	92/99	B29C 45/14467
5746595	12/1997	Ford	N/A	N/A
5749726	12/1997	Kinsel	N/A	N/A
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5779471	12/1997	Tseng et al.	N/A	N/A
5779654	12/1997	Foley et al.	N/A	N/A
5795153	12/1997	Rechmann	N/A	N/A
5796325	12/1997	Lundell et al.	N/A	N/A
5833065	12/1997	Burgess	N/A	N/A
5836030	12/1997	Hazeu et al.	N/A	N/A
D402744	12/1997	Zuege	N/A	N/A
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5876201	12/1998	Wilson et al.	N/A	N/A
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5934902	12/1998	Abahusayn	N/A	N/A
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5993402	12/1998	Sauer	601/162	A61C 17/02
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6039180	12/1999	Grant	N/A	N/A
6041462	12/1999	Marques	N/A	N/A
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D424181	12/1999	Caplow	N/A	N/A
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D437049	12/2000	Hartwein	N/A	N/A
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6200134	12/2000	Kovac	N/A	N/A
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6293792	12/2000	Hanson	N/A	N/A
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D455203	12/2001	Jones	N/A	N/A
6363565	12/2001	Paffrath	N/A	N/A
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D495143	12/2003	Berde	N/A	N/A
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6783004	12/2003	Rinner	N/A	N/A
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D553980	12/2006	VerWeyst	N/A	N/A
7276035	12/2006	Lu	N/A	N/A
7314456	12/2007	Shaw	N/A	N/A
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D565713	12/2007	Gao	N/A	N/A

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D588262	12/2008	Pukall	N/A	N/A
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D590492	12/2008	Powell	N/A	N/A
D592748	12/2008	Boulton	N/A	N/A
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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of U.S. Non-Provisional patent application Ser. No. 16/877,081, filed May 18, 2020, which is a continuation of U.S. Non-Provisional patent application Ser. No. 14/956,017, filed Dec. 1, 2015, which claims priority to U.S. Provisional Patent Application No. 62/086,051, filed Dec. 1, 2014, and to U.S. Provisional Patent Application No. 62/132,319 filed Mar. 12, 2015, the disclosures of which are hereby incorporated by reference in their entireties.

TECHNICAL FIELD
(1) The present disclosure relates to health and personal hygiene equipment and more particularly, to oral irrigators.
BACKGROUND

(2) Oral irrigators typically are used to clean a user's teeth and gums by discharging a pressurized fluid stream into a user's oral cavity. The fluid impacts the teeth and gums to remove debris. Many oral irrigators include electrical components, such as batteries, a motor, or the like. For example, typically oral irrigators include a motor driven pump that pumps fluid from a reservoir to the tip. Often oral irrigators are used in a wet environment, such as a bathroom and some users may even take the irrigators into the shower or bath, but conventional oral irrigators are not waterproof, merely water resistant. Hence, conventional oral irrigators may be protected from splashes and incidental fluid contact, but as they are not waterproof may not protect electronic components when submersed in water or exposed to large amounts of water. When water and other fluids reach the electronic components, the fluids can cause the oral irrigator to malfunction and may even prevent the oral irrigator from operating completely. As such, there is a need for an oral irrigator that is waterproof.

SUMMARY

(3) One example of the present disclosure may take the form of an oral irrigator pump. The oral irrigator pump may include a motor, a pump body, a connecting rod, and a diaphragm seal. The connecting rod may be at least partially received within the pump body and movably connected to the motor and the motor moves the connecting rod between a first position and a second position within the pump body. As the connecting rod moves from the first position to the second position, the diaphragm seal deforms from a first orientation to a second orientation.

(4) Another example of the present disclosure may take the form of an oral irrigator. The oral irrigator may include a reservoir, a tip fluidly connected to the reservoir, a motor having a drive shaft, and a pump fluidly connected to the reservoir and the tip. The pump may include a pump body including a pump inlet fluidly connected to the reservoir and a pump outlet fluidly connected to the tip, a pinion gear placed on the drive shaft and including a plurality of pinion gear teeth that curve along their length, and a driven gear including a plurality of driven gear teeth that mesh with the pinion gear teeth. In this embodiment, the pinion gear teeth and the driven gear teeth are spiral gears with beveled edges. The pump may also include a connecting rod eccentrically connected to the driven gear and a piston connected to a first end of the connecting rod and received within the pump body. In operation, movement of the drive shaft of the motor causes the pinion gear to rotate, which causes the driven gear to rotate, translating the connecting rod and moving the piston laterally within the pump body to pull fluid from the reservoir and push the fluid to the tip.

(5) Yet another example of the present disclosure may take the form of an oral irrigator including a handle fluidly connected to a reservoir and a tip latch assembly connected to the handle. The tip latch assembly may include a latch with an integrally formed biasing structure and at least one prong selectively movable from an engaged position to a disengaged position. The tip latch assembly may also include a tip release button engaging at least one surface of the latch. To operate the latch, a user exerts a force on the tip release button, which causes the tip release button to exert a force against the at least one surface of the latch, overcoming a biasing force exerted by the biasing structure and causing the at least one prong to move from the engaged position to the disengaged position. When the user removes the force from the tip release button, the biasing structure exerts the biasing force on the tip release button as the at least one prong moves from the disengaged position back to the engaged position.

(6) Another example of the present disclosure may take the form of a waterproof oral irrigator. The waterproof oral irrigator may include a body including a front shell and a rear shell connected together to define a cavity, an interior housing received within the cavity, and a control assembly connected to an outer surface of the interior housing and positioned between an interior surface of the front shell and the interior housing. The waterproof oral irrigator may also include a first sealing member connected to the front shell and the interior housing, where the first sealing member surrounds the control assembly.

(7) Yet another example of the present disclosure may take the form of an oral irrigation assembly including an oral irrigator and a charging unit. The oral irrigator includes a housing, at least one rechargeable battery received within the housing, and at least one housing magnet connected to the housing. The charging unit is selectively connectable to the housing of the oral irrigator and is configured to provide a charge to the at least one rechargeable battery. The charging unit includes at

least one charger magnet connected to the charging unit, such that the at least one housing magnet and the at least one charger magnet cooperate to removably connect the charging unit to the housing of the oral irrigator.

(8) Yet another example of the present disclosure may take the form of an oral irrigator including a drive assembly, a pump assembly, and a flexible membrane seal. The drive assembly is received within a housing. The pump assembly is positioned at least partially within a pump chamber. The pump assembly includes a piston and a connecting rod coupled to the drive assembly, the connecting rod movable between first and second positions through operation of the drive assembly. The flexible membrane seal extends from an interior surface of the pump chamber to the connecting rod to fluidly seal an open end of the pump chamber. The flexible membrane seal deforms from a first orientation to a second orientation as the connecting rod moves from the first position to the second position.

(9) Yet another example of the present disclosure may take the form of an oral irrigator including a housing, a pump assembly, and a flexible membrane seal. The housing defines a dry compartment for receiving a drive assembly. The pump assembly is positioned at least partially within a wet environment defined by a pump chamber. The pump assembly includes a connecting rod extending from the wet environment to the dry compartment. The flexible membrane seal extends from an interior surface of the pump chamber to the connecting rod and across an open end of the pump chamber to fluidly seal the dry compartment from the wet environment.

(10) Yet another example of the present disclosure may take the form of an oral irrigator including a housing, a pump assembly, and a flexible membrane seal. The housing defines a compartment. The pump assembly includes one or more wet components and an actuation member extending into the compartment. The flexible membrane seal extends from an interior surface of the housing to the actuation member and deforming to fluidly seal the compartment from the one or more wet components.

(11) While multiple examples are disclosed, still other examples of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative examples of the invention. As will be realized, the invention is capable of modifications in various aspects, all without departing from the spirit and scope of the present invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1**A is a front isometric view of an oral irrigator.

(2) FIG. **1**B is a side elevation view of the oral irrigator.

(3) FIG. **10** is a rear elevation view of the oral irrigator.

(4) FIG. **2**A is a front elevation view of the oral irrigator with a charging unit connected thereto.

(5) FIG. **2**B is a side elevation view of the oral irrigator with the charging unit connected thereto.

(6) FIG. **3** is an exploded view of the oral irrigator.

(7) FIG. **4** is a rear isometric view of a front shell for the oral irrigator.

(8) FIG. **5**A is a cross-section view of the oral irrigator taken along line **5**A-**5**A in FIG. **1**B.

(9) FIG. **5**B is an enlarged view of the cross-section view of FIG. **5**A.

(10) FIG. **6** is a front elevation view of the oral irrigator with select elements removed.

(11) FIG. **7** is a side elevation view of the oral irrigator of FIG. **6**.

(12) FIG. **8**A is a cross-section view of the oral irrigator taken along line **8**A-**8**A in FIG. **1**A.

(13) FIG. **8**B is an enlarged view of the cross-section view of FIG. **8**A.

(14) FIG. **9** is a cross-section view of the oral irrigator taken along line **9**-**9** in FIG. **10**.

(15) FIG. **10**A is an isometric view of the drive assembly and the pump assembly with certain elements removed from clarity.

(16) FIG. **10**B is a cross-section view of the drive and pump assemblies taken along line **10**B-**10**B in FIG. **10**A.

(17) FIG. **11**A is a top isometric view of a diaphragm seal of the oral irrigator.
(18) FIG. **11**B is a cross-section view of the diaphragm seal taken along line **11**B-**11**B in FIG. **11**A.
(19) FIG. **11**C is a cross-section view of a diaphragm seal included a beaded engagement wall taken along a line similar to **11**B-**11**B in FIG. **11**A.
(20) FIG. **12** is an enlarged cross-section view of the oral irrigator similar to FIG. **5**A.
(21) FIG. **13**A is an isometric view of a tip latch assembly for the oral irrigator.
(22) FIG. **13**B is a cross-section view of the tip latch assembly taken along line **13**B-**13**B in FIG. **13**A.
(23) FIG. **14** is an enlarged top isometric view of the oral irrigator with the tip collar removed for clarity.
(24) FIG. **15** is a top plan view of the oral irrigator of FIG. **14**.
(25) FIG. **16**A is an isometric view of a latch chassis for the tip latch assembly for the oral irrigator.
(26) FIG. **16**B is an isometric view of a latch for the tip latch assembly for the oral irrigator.
(27) FIG. **16**C is a top-front isometric view of the latch of FIG. **16**B.
(28) FIG. **17** is a top isometric view of a tip release button for the tip latch assembly for the oral irrigator.
(29) FIG. **18**A is a top isometric view of a tip collar for the tip latch assembly for the oral irrigator.
(30) FIG. **18**B is a bottom isometric view of the tip collar of FIG. **18**A.
(31) FIG. **18**C is a cross-section view of the tip collar taken along line **18**C-**18**C in FIG. **18**A.
(32) FIG. **19** is a rear isometric view of a charging unit for the oral irrigator.
(33) FIG. **20** is a cross-section view of the charging unit taken along line **20**-**20** in FIG. **19**.
(34) FIG. **21** is an exploded view of a coil assembly for the charging unit of FIG. **20**.
(35) FIG. **22** is an isometric view of the charging unit connected to the oral irrigator with select components removed for clarity.
(36) FIG. **23**A is a partial cross-section enlarged view of the oral irrigator similar to FIG. **12** during an upstroke of the pumping assembly.
(37) FIG. **23**B is a partial cross-section enlarged view similar to FIG. **23**A during a transition between the upstroke position and down-stroke position.
(38) FIG. **23**C is a partial cross-section enlarged view similar to FIG. **23**A during a down-stroke of the pumping assembly.
(39) FIG. **24** is a simplified view of the tip latch assembly with select elements removed for clarity.
(40) FIG. **25** is a cross-section view of another example of the oral irrigator of FIG. **1** taken along line similar to line **5**A-**5**A in FIG. **1**B.
(41) FIG. **26** is bottom plan view of the oral irrigator of FIG. **1** including a slide latch.
(42) FIG. **27** is an enlarged cross-section view of the oral irrigator of FIG. **26** taken along line **27**-**27** in FIG. **26**.
(43) FIG. **28** is an isometric view of a latch for the slide latch of FIG. **26**.
(44) FIG. **29** is a bottom plan view of the reservoir for the oral irrigator of FIG. **26**.
(45) FIG. **30**A is a top isometric view of a venting assembly for the battery compartment.
(46) FIG. **30**B is a cross-sectional view of the venting assembly of FIG. **30**A taken along line **30**B-**30**B in FIG. **30**A.

DETAILED DESCRIPTION

(47) Some examples of the present disclosure include a cordless oral irrigator. The cordless oral irrigator may include an integrated handle and reservoir to allow the irrigator to be held in a user's hand without requiring cords or hoses extending to a base station to provide fluid communication to a reservoir and/or electrical communication to a power source. The oral irrigator of the present disclosure may include a body, a tip, a reservoir, a control panel, a power source, and a drive assembly. The power source in many embodiments will be a battery or other rechargeable component that can provide portable electricity to the drive assembly. However, it should be noted that multiple aspects of the present disclosure can be incorporated into a countertop oral irrigator.
(48) The oral irrigator may include a number of waterproofing elements that help to ensure that water (and other fluids) do not enter into certain compartments or reach certain components, e.g., the motor and battery. In one example, the oral irrigator may include three separate waterproof compartments,

one for the control assembly, one for a charging assembly, and one for the motor and batteries. The waterproofing elements may allow the oral irrigator to be waterproof and be able to function even if dropped into a meter or more of water. The waterproofing elements seal the outer surface of the oral irrigator to prevent water from entering into the internal compartments, as well seal internal compartments within the irrigator, so that if there are internal leaks within the oral irrigator, fluid from the reservoir, pump, and/or tip does not damage any electrical components. The waterproofing elements are discussed in more detail below, but some examples include seals between the control panel and the body or housing, overmolded buttons on the control panel, and ultrasonically welding a portion of the control panel to the body of the oral irrigator. Alternatively or additionally, the oral irrigator may include components that are coated with a super-hydrophobic coating to help protect electronic components from damage. The waterproofing elements allow the oral irrigator to receive an IPX7 waterproof rating under the International Protection Marking standard, which means that the device is suitable in immersion in fluid up to 1 meter.

(49) In some embodiments the drive assembly may include a motor, a pump, and a linkage connecting the pump to the motor. The linkage may include a pinion gear and a driven gear, with the pinion gear being received around a drive shaft of the motor and the driven gear meshing with the pinion gear. In one example the driven gear and the pinion gear are bevel gears mounted on shafts arranged approximately 90 degrees relative to one another. The gears of the linkage may be configured to transmit an eccentric motion to the pump, which will be discussed in more detail below. In one embodiment, both the pinion gear and the driven gear may include helical or spiral-shaped gear teeth. That is, the gear teeth on both gears may be curved along their length. The spiral shape of the pinion gear and the driven gear of the present disclosure, although they may be more difficult to machine and manufacture, have a reduced noise level as compared to straight teeth gears.

(50) Conventional oral irrigating devices typically include gears, such as crown gears, with substantially straight gear teeth having a 90 degree pitch cone. Crown gears are relatively easy to manufacture, allow larger tolerances, and have a high efficiency, but with crown gears only one set of teeth carries the load at a time. In particular, with straight cut gears (such as crown gears), the load cannot be distributed. On the contrary, with the spiral shape of the gears of the present disclosure, multiple teeth can carry the load at a time, which increases the load that can be handled by the linkage, as well as makes the gears less susceptible to failure.

(51) The spiral shape of the gear teeth further have effectively larger sized teeth as compared to a similarly sized crown gear since the teeth extend diagonally rather than straight across. Also, the angle of the teeth of the gears engages more gradually, since the pitch is less than 90 degrees. The gradual engagement of the teeth of the spiral gears reduces the noise, as well as allows the gears to mesh more smoothly. Spiral gears have an increased durability as compared to crown gears and therefore have improved reliability and create less noise. However, spiral gears require tight tolerances to manufacture as the axial, radial, and vertical positions, as well as the shaft angle, should be correct to allow the gear to run smoothly and avoid excessive wear. Further, spiral gears have a greater sliding friction as compared to crown gears and therefore may be less efficient than crown gears.

(52) In some embodiments, the oral irrigator may include a diaphragm seal that seals the pump from the electrical components of the oral irrigator (e.g., the motor and the power source). The diaphragm seal connects to a piston rod or connecting rod of the pump that moves a piston to pump fluid from the reservoir to the tip. The diaphragm seal includes a rod aperture through which the piston rod is received. The diaphragm seal is secured to the position rod and is secured to a pump body or other location along an exterior of the pump. The diaphragm is connected so that as the connecting rod moves to drive the piston, the diaphragm moves correspondingly, but does not rub against any surfaces as it moves. This increases the durability of the diaphragm as it reduces wear due to friction and, because the diaphragm does not experience friction during use, the diaphragm does not reduce the efficiency of the pump.

(53) The oral irrigator may also include a removably attachable charging device. The charging device may selectively attach to the body and charge the power source, such as the battery, when connected. As an example, the charging device may include one or more magnets that magnetically couple to one

or more body magnets positioned with the body of the oral irrigator. When the charging device is connected to the body, a first induction coil of the charging device is positioned to align with a second induction coil in the body of the oral irrigator so as to induce a current flow in the second induction coil. In some embodiments, the charging device may generally conform to the shape of the oral irrigator body. This allows the charging device to more securely connect to the body, as well as provide an aesthetically pleasing uniform appearance between the body of the oral irrigator and the charger. Further, the charger may also include a plurality of cooling grooves defined on a side of the charger housing. The cooling grooves allow airflow between the oral irrigator and the charger when the oral irrigator is charging, which dissipates heat and helps to prevent damage to components, such as the housing of the irrigator and/or charger, due to the heat generated by the coils during charging.

(54) Overview of the Oral Irrigator

(55) Turning to the figures, FIGS. **1**A-**1**C illustrate various views of an oral irrigator **100** in accordance with the present disclosure, FIGS. **2**A and **2**B illustrate the oral irrigator **100** with a removable charger attached thereto, FIG. **3** is an exploded view of the oral irrigator **100** of FIG. **1**A. With reference now to FIGS. **1**A-**1**C, the oral irrigator **100** may include a body **102**, a reservoir **104**, a tip **106**, and a control panel **108**. The removable tip **106** connects to the body **102** and is releasable through a tip release button **120**. A tip collar **110** may surround the tip **106** at the connection to the body **102**. The various components of the oral irrigator will be discussed in more detail below.

(56) The body **102** may be contoured to comfortably fit in the hand of a user. For example, as shown in FIGS. **1**A-**1**C the body **102** may include a broad bottom that tapers upward to form a waist having a smaller diameter than the bottom, the body **102** then expands outwards again to form a top portion. The location of the waist may be selected so as to be about three-quarters of the height from the bottom of the body **102**, or in other locations that may be desired or determined comfortable for a user's hand to grip the irrigator **100**. The shape of the body **102** may also be selected to be a shape that is aesthetically appealing, while still allowing a user to comfortably grip the body **102**.

(57) The body **102** may also include one or more gripping elements. As one example, the body **102** may include a grip surface **118** (see FIG. **10**) on a back surface of the body **102**. The grip surface **118** includes a plurality of raised ridges, bumps, or other features, that increase the friction coefficient of the body **102** to help a user hold the body **102** without slipping. Other gripping features may be defined on other elements of the irrigator **100**, such as the reservoir **104**, tip collar **110**, and so on, as discussed in more detail below.

(58) With reference to FIG. **3**, the body **102** may include a front shell **138** and a back shell **140** that connect together to form the outer housing for the irrigator **100**. The two shells **138**, **140** may be connected together to define a cavity that receives various internal components of the oral irrigator **100**, e.g., the drive assembly and power assembly. The shells **138**, **140** may be configured with various internal features that are configured to receive and support various components of the irrigator **100**, as well as features that allow the two shells to connect together in a sealing manner. In one embodiment, the front shell **138** may be somewhat longer than the rear shell **140** as the rear shell **140** is shaped to accommodate the reservoir **104**. However, in other embodiments, the two shells may be substantially the same length and/or shape.

(59) The front shell **138** will now be discussed in more detail. FIG. **4** is a rear isometric view of the front shell **138** of the body **102**. With reference to FIGS. **1**A, **3**, and **4**, the front shell **138** may include one or more sealing features **142**, **144** extending from an interior surface **150** of the front shell **138**. The sealing features **142**, **144** may be generally oval shaped and define a compartment for receiving one or more components of the oral irrigator **100**, e.g., the control and power assemblies. The sealing features **142**, **144** also are configured to accommodate one or more sealing gaskets, such as O-rings or other sealing members, to protect the components positioned within the sealing features **142**, **144** from fluid.

(60) The front shell **138** may further include a plurality of connecting posts **152***a*-**152***k*. The connecting posts **152***a*-**152***k* may assist in aligning the front shell **138** with the back shell **140** as well as connecting the two shells **138**, **140** together. For example, the connecting posts **152***a*-**152***k* may be configured to align with corresponding posts on the rear shell **140** and receive fasteners, e.g., press fit pins, screws,

or other mechanisms, to secure the posts **152***a*-**152***k* of the front shell **138** with those on the rear shell **140**. Some of the connecting posts **152***a*-**152***k* may instead be used to connect various internal components as well.

(61) With continued reference to FIGS. **1**A, **3**, and **4**, the front shell **138** of the body **102** may also include a window panel **146**. The window panel **146** seats within an aperture formed in the front shell **138** and connects along an edge to the front shell **138**. Additionally, the front shell **138** includes a plurality of light windows **148***a*, **148***b*, **148***c*, **148***d*. The light windows **148***a*, **148***b*, **148***c*, **148***d* may include a transparent material positioned in front or otherwise allow light to be transmitted therethrough. The window panel **146** may be welded ultrasonically to the body **102** once the control assembly and power assembly have been electrically connected together, as discussed in more detail below. Thus, the window panel **146** allows select components of the oral irrigator to be connected together and accessible during assembly, but after assembly, the panel **146** can be ultrasonically welded to the front shell **138** to prevent fluids from leaking into the body **102**.

(62) With reference to FIG. **4**, the front shell **138** may also include a plurality of cavities to receive one or more magnets which, as described in more detail below, are used to selectively connect the charger to the oral irrigator **100** and/or to activate the charger. For example, a first magnet recess **446** may be defined on an interior of the shell **138** within a portion surrounded by the second sealing feature **144**. Two magnet pockets **448***a*, **448***b* may be defined on opposing longitudinal sides of the sealing feature **144**. It should be noted that the magnet pockets **448***a*, **448***b* may be defined in any location as desired, but typically will be located adjacent the location of the power assembly and circuit board **196** (see FIG. **6**), so as to align the charger unit **134** with the induction coils and other related components.

(63) The control panel **108** may be connected to the front shell **138** of the body **102**. With reference to FIGS. **1**A, **2**A, and **3**, the control panel **108** includes a power button **112** and a mode button **114** that provide an input mechanism to allow a user to operate the oral irrigator **100**. The two buttons **112**, **114** are connected to and extend away from the front shell **138**. The two buttons **112**, **114** may be compressed to selectively change a state of the oral irrigator **100**, such as turning the irrigator **100** on or off or changing the mode of the irrigator **100**, as will be discussed in more detail below. In one embodiment, the buttons **112**, **114** are overmolded with the front shell **138**, which helps to further waterproof the oral irrigator **100**. For example the buttons **112**, **114** may be formed of a thermoplastic elastomer material and the front shell **138** may be a thermoplastic material so that when the buttons **112**, **114** are molded to the front shell **138** a chemical bond is formed so that the seal between the buttons **112**, **114** and the front shell **138** is waterproof. The buttons **112**, **114** may also include raised areas that form contacts for switches on the control assembly as will be discussed in more detail below.

(64) The reservoir **104** of the oral irrigator **100** will now be discussed in more detail. FIG. **5**A is a cross-section view of the oral irrigator **100** taken along line **5**A-**5**A in FIG. **1**B. FIG. **5**B is an enlarged view of FIG. **5**A. With reference to FIGS. **1**B, **10**, **3**, **5**A, and **5**B, the reservoir **104** may be removable from the body **102** or may be formed integrally therewith. In embodiments where the reservoir **104** is removable, the user may refill the reservoir **104** while it is connected to the body **102** through a fill port **122** or may remove the reservoir **104** to refill it through the port or an aperture defined on a top end of the reservoir **104**. The reservoir **104** may have a generally L-shape body that defines a fluid cavity **154**. The horizontal extension of the reservoir **104** may include a stepped platform **158** extending from the top surface which helps to increase the capacity of the reservoir. In one embodiment, see, e.g., FIG. **25**, the reservoir **104** may further include a latch **477** that assists a user in removing the reservoir **104** from the oral irrigator **100**.

(65) The refill port **122** is defined as an aperture through an outer sidewall of the reservoir **104**. A port recess **132** may surround the refill port **122** and define a generally oval shape recessed compartment in the outer surface of the reservoir **104**. A lid **124** is movably connected to the reservoir **104** by a hinge **126**. The lid **124** extends over the refill port **122** and includes a flange **164** that is received into the port recess **132**. An O-ring **156** (see FIG. **5**A) sits around the flange **164** to seal against the walls of the refill port **122**.

(66) With reference to FIGS. **3** and **5**A, the reservoir **104** may include an outer sidewall **166** with two alignment grooves **168***a*, **168***b* (see FIG. **3**) defined longitudinally along its height. The top surface of

the reservoir **104** defines a main port **160** that is fluidly connected to the reservoir cavity **154**. A reservoir lip **170** extends upwards from the top surface of the reservoir **104** and surrounds the main port **160**. The main port **160** defines a larger diameter aperture to allow the reservoir **104**, when removed, to be filed more quickly than through the refill port **122**. Additionally, the main port **160** fluidly connects the rear shell **140** to the reservoir **104**.

(67) The oral irrigator **100** may further include a reservoir hose **206** that extends into the reservoir **104** from a tube protrusion feature **165** extending from a surface of the rear shell and a tube **202** that fluidly connects a pump body **200** to a reservoir hose **206** (see FIG. **6**). With brief reference to FIG. **25**, in some embodiments, a filter **479** may be connected to a bottom end of the reservoir hose **206**. The filter **479** may filter the fluid from the reservoir **104** prior to the fluid being provided to the tip **106**.

(68) With reference to FIG. **1**B, the reservoir **104** may also include one or more finger grips **116** defined on the outer surface. The finger grips **116** may be recessed from the outer surface and optionally may include one or more raised elements, such as ridges, that assist a user in griping the reservoir **104**. The finger grips **116** assist a user in removing the reservoir **104** from the body **102** and in griping the reservoir **104** when refilling it. It should be noted that in other embodiments, the finger grips **116** may be omitted from the oral irrigator **100** or may be positioned at other locations on the outer surface of the irrigator.

(69) The internal components of the oral irrigator **100** will now be discussed in more detail. FIG. **6** is a front elevation view of the oral irrigator of FIG. **1**A with the front shell **138** and the back shell **140** removed for clarity. FIG. **7** is a side elevation view of the oral irrigator of FIG. **6**. With reference to FIGS. **6** and **7**, the oral irrigator **100** may include an upper housing **184** and a lower housing **182**. The two housings **182**, **184** define interior compartments for receiving various elements of the oral irrigator **100**, as well as provide a chassis structure for anchoring components to the outer walls thereof. Each of the housings **182**, **184** may include a raised flange **208**, **210** extending from a sidewall configured to receive a sealing member, such as gaskets **212**, **214** or O-rings. The two housings **182**, **184** are configured to be connected together and received within the body **102** and act as a chassis for the irrigator, supporting the various components within the body.

(70) With reference to FIGS. **5**A, **5**B, and **12**, the lower housing **182** may define a dry compartment **276** that receives components of the pump assembly **176** and the drive assembly **178**. The lower housing **182** may be fluidly sealed from the wet components of the pump assembly **176**, discussed in more detail below. The wet and dry compartments may be aligned so as to be generally parallel with one another, which reduces the form factor and diameter of the oral irrigator. The lower housing **182** includes a sealing end **278** defined on a terminal end of the lower housing **182**. The sealing end **278** includes an annular groove **280** defined in a top surface thereof. The annular groove **280** defines an outer wall **282** and an inner wall **284** on the sealing end **278** of the lower housing **182**. The sealing end **278** further defines a rod aperture **286** extending through the top surface thereof and in communication with the dry compartment **276** of the lower housing **182**.

(71) With continued reference to FIG. **5**B, the oral irrigator **100** may also include a drive mount **304**. The drive mount **304** is configured to support the motor **172** and other components of the drive assembly **178** as discussed in more detail below. The drive mount **304** may be a somewhat rigid member received within the lower housing **182** and secured thereto. In other embodiments, the drive mount **304** may be omitted and the lower housing **182** may include integral features that may be used to secure the motor **172** to the lower housing **182**.

(72) With reference again to FIG. **6**, the oral irrigator **100** may include a first circuit board **204** having a power switch **186**, a mode switch **188**, a plurality of indicator lights **190***a*, **190***b*, **190***c*, **190***d* and may include a processing element, such as a microprocessor. The power switch **186** and the mode switch **188** are selected by the user to selectively activate the irrigator **100** and to change the mode of the irrigator **100**, respectively. The indicator lights **190***a*, **190***b*, **190***c*, **190***d*, illuminate and/or vary an emitted light color to indicate a change in status of the irrigator **100**. The indicator lights **190***a*, **190***b*, **190***c*, **190***d* may be light emitting diodes, organic light emitting diodes, or substantially any other type of light emitting component.

(73) The oral irrigator **100** may include a second circuit board **196** in electrical communication with

the first circuit board **204** via a plurality of connection wires **192**. The second circuit board **196** may include a secondary coil assembly **194** and other components, such as one or more electrical components (e.g., capacitors, resistors, microprocessor, or the like), for charging the oral irrigator **100**, discussed in more detail below.

(74) Drive and Pump Assemblies

(75) The drive assembly **178** will now be discussed in more detail. FIG. **8**A is a cross-section view of the oral irrigator taken along line **8**A-**8**A in FIG. **1**B. FIG. **8**B is an enlarged view of the oral irrigator of FIG. **8**A. FIG. **9** is a cross-section of the oral irrigator taken along line **9**-**9** in FIG. **10**. FIG. **10**A is an isometric view of the drive assembly with select elements removed for clarity. FIG. **10**B is a cross-section view of the drive assembly taken along line **10**B-**10**B in FIG. **10**A. With reference to FIGS. **8**A-**10**B, the drive assembly **178** is configured to pump fluid from the reservoir **104** to the tip **106**. The drive assembly **178** may include a pump assembly **176**, a motor **172**, and a linkage **174** interconnected between the pump assembly **176** and the motor **172**.

(76) The motor **172** includes a drive shaft **216** connected thereto which is rotatably driven by the motor **172**. The motor **172** may be any type of suitable motor depending on the desired output of the oral irrigator. The linkage **174** or transmission includes a drive or pinion gear **218**, a driven gear **220**, and a gear pin **224**. As will be discussed in more detail below, the linkage **174** transforms the rotational movement of the drive shaft **216** to longitudinal movement of a piston of the pump assembly **176**.

(77) The pinion gear **218** includes a plurality of gear teeth **230** on an outer surface or engagement surface thereof. The gear teeth **230** are spiral shape and extend along a curve from a top edge **234** of the outer surface to a bottom edge **236** of the outer surface. In other words, rather than extending in a substantially straight line, the gear teeth **230** wrap around a portion of the outer perimeter of the pinion gear **218**. Additionally, the pinon gear **218** may include a frustum or conical shape having a larger bottom end diameter than a top end diameter, i.e., the pinon gear may have a tapered shape that narrows towards the top end of the component. The shape of the pinion gear may allow the gear teeth to mesh as desired with the driven gear.

(78) The driven gear **220** may be oriented at substantially a 90 degree angle with respect to the pinion gear **218**. The driven gear **220** includes a plurality of gear teeth **232** extending outwards from an engagement surface of the driven gear **220**. In some embodiments, the gear teeth **232** may also extend outwards relative to the center of the driven gear **220** such that the outer perimeter of the gear **220** expands from the beginning of the teeth to an end point of the teeth. The gear teeth **232** are configured to mesh with the gear teeth **230** of the pinion gear **218**. Similar to the pinion gear **218**, the gear teeth **232** of the driven gear **220** may be helically shape and may extend at a curve from the interior of the driven gear **220** towards an outer edge of the driven gear **220**. In this manner, the gear teeth **232** start and end at an angle with respect to each other.

(79) In other examples, the gears **218**, **220** may be hypoid gears having curved teeth, but with shaft axes that are offset from one another. Also, it should be noted that in some embodiments, different types of gears may be used together. For example, the pinion gear **218** may be a helical gear whereas the driven gear **220** may be a face gear.

(80) The driven gear **220** may also include an eccentric shaft **226** including a cam surface **222** and a gear pin aperture **228** defined through a center of the driven gear **220**. The eccentric shaft **226** is offset from a center (and gear pin aperture) of the driven gear **220**, the offset depends on the desired fluid pressure delivery, the pump characteristics, and/or the rotational speed of the motor **172**. For example, as shown in FIG. **10**B, the eccentric shaft **226** may be positioned closer to one edge of the driven gear **220** to define the eccentricity. The eccentric shaft **226** may include a crescent shaped opening **238** therethrough. The crescent shaped opening **238** assists in controlling the rotational inertia of the driven gear **220** as it rotates by reducing the total inertia of the gear, as well as simplifies the manufacture of the gear **220** and reduces material costs. The pin aperture **228** receives the gear pin **224** and is used to secure the driven gear **220** in position and forms an axle about which the gear rotates. The eccentric shaft **226** may be formed integrally with the driven gear **220** or may be a separate component connected thereto. Typically, the eccentric shaft **226** will have a larger width than the width of the driven gear **220**.

(81) With reference to FIGS. **8**B, **10**A, and **10**B, the pump assembly **176** will now be discussed. The pump assembly **176** may include a pump body **200**, a connecting rod **240**, a piston **248**, an inlet valve body **250** having an inlet reed valve **252**, and an outlet valve body **424** having an outlet reed valve **254**. The pump assembly **176** is driven by the drive assembly **178** to pump fluid from the reservoir **104** to the tip **106**.
(82) The connecting rod **240** or piston rod is driven by the driven gear **220** and connects to the piston **248**. The connecting rod **240** may include a ball **242** on a first end and a gear aperture **262** on a second end. The gear aperture **262** is defined by a cylindrical wall extending from the second end of the connecting rod **240** and is configured to be placed around the eccentric shaft **226** of the gear. The gear aperture **262** includes a radius that substantially matches a radius of the eccentric shaft **226** of the driven gear **220** so as to form a tight connection with the eccentric shaft **226**, such that the connecting rod will move with the eccentric shaft rather than rotate about the connecting shaft. The connecting rod **240** may include a first securing rib **244** and a second securing rib **246** spaced apart from and below the first securing rib **244** along the shaft of the connecting rod **240**. The two ribs **244**, **246** extend around an outer perimeter of the connecting rod **240** shaft and are annular shaped following the outer surface of the connecting rod. The two ribs **244**, **246** may be positioned in the middle or upper portion of the connector rod **240**. In other embodiments, the connecting rod **240** may include other types of securing features, other than ribs, such as, but not limited to, protrusions, nubs, apertures, fasteners, adhesive, or the like.
(83) The pump body **200** defines a volume as pump chamber **260** for receiving fluid from the reservoir and is configured to receive the piston **248** and a portion of the connecting rod **240**. The pump body **200** includes a pump inlet **256** and a pump outlet **258** arranged substantially perpendicularly to the pump inlet **256**. The pump body **200** includes a piston section **239** having a substantially cylindrical shape that terminates in a receiving section **241** having a frustum shape terminating in a connecting flange **243**. The connecting flange **243** forms the bottom end of the pump body **200** and includes a plurality of fastening brackets **245** configured to receive fasteners that secure the pump body **200** to the lower housing. The connecting flange **243** also acts to better seal the pump chamber and fluid passageways within the pump.
(84) The top end of the pump body **200** includes a pump head **247** defining the pump inlet **256** and pump outlet **258**, optionally, the pump head **247** includes a connecting portion that receives one or more fasteners to secure the top end of the pump body **200** to the outlet valve body **424**. A valve receiving section **251** is defined on a top end of the pump head **247** and defines a valve chamber for receiving an outlet valve. The valve receiving section **251** may include a cylindrical wall extending upwards from a bottom wall that defines the outlet **258**. Below and oriented perpendicular to the pump outlet, an inlet valve receiving section **249** is formed on the side of the pump head **247**. The inlet valve receiving section **249** is configured to receive and connect to the inlet valve **250**. For example, the inlet valve receiving section **249** may include a wall structure that mates with or receives the inlet valve **250** to fluidly connect the valve to the inlet of the pump. The pump body **200** is configured to have a pump chamber and other components that are substantially aligned with one another to allow the oral irrigator to have a smaller diameter and thus easier to be held by users having smaller hands (e.g., children).
(85) A pump fluid passage **264** is defined within the pump body **200** and fluidly connects the pump inlet **256** to a pump chamber **260** and fluidly connects the pump chamber **260** to the pump outlet **258**. In one embodiment, the fluid passageway **264** extends longitudinally along a length of the pump body **200** and the pump chamber **260** is located at a first end of the fluid passageway **264** and the pump outlet **258** is located at a second end of the fluid passageway **264** with the pump inlet **256** being positioned between the pump chamber **260** and the pump outlet **258**. In this embodiment, the pump inlet **256** may define an intersection in the fluid passageway **264** creating a T-shape lumen through the pump body **200**. In this example, the pump inlet **256** is substantially perpendicularly oriented relative to the pump outlet and pump chamber **260**. Additionally, in some embodiments, the pump inlet **256** may be positioned lower on the pump body **200** as compared to the pump outlet which is formed at the top end of the pump body **200**, such that as fluid is pumped out of the pump body **200**, the fluid passes

the fluid inlet into the pump body **200**.
(86) The inlet reed valve **252** is positioned in or on the inlet valve body **250** at the pump inlet **256**. The inlet reed valve **252** is selectively opened and closed to regulate the flow of fluid to and from the pump body **200**. The inlet reed valve **252** includes a flap that opens inwards toward the fluid passageway **264** of the pump body **200**. The outlet reed valve **254** is positioned on top of the pump outlet **258** and selectively controls flow into and out of the pump body **200**. The outlet reed valve **254** may be substantially similar to the inlet reed valve **252** and may include a flap that opens outwards away from a top end of the pump body **200**. Operation of the reed valves will be discussed in more detail below during a discussion of the operation of the oral irrigator **100**. Other types of inlet and outlet one-way valves may be used as well.
(87) With reference to FIGS. **8**B and **10**B, the piston **248** has a generally cylindrically shaped body with a rod cavity **266** defined on a bottom end **268** and configured to receive a portion of the connecting rod **240**. The piston **248** also includes a sealed top end **270** forming a pedestal with an annular groove **272** defined on the top surface. The groove **272** defines a flexible top wall **271** for the piston that expands outwards to form a seal against the internal walls of the pump, while still allowing the piston to move smoothly within the pump, as discussed in more detail below. The piston **248** is configured to selectively pull and push fluid within the pump body **200** as it is moved by the connecting rod **240**. In some embodiments, the piston may have a diameter that varies in shape along its length, the shape is selected based on the shape of the pump body and allows the piston to seal against the walls of the pump, while still move within the pump.
(88) With reference to FIGS. **7** and **8**B, the inlet valve body **250** may be substantially cylindrically shaped having an integrated tube or a tube connector extending downward perpendicularly from the top surface. The inlet valve body **250** defines a fluid passageway that is in selective communication with the pump fluid passageway **264**. The inlet valve body **250** may also include fastening apertures to receive fasteners to secure the inlet valve body **250** to the pump body **200**.
(89) The outlet valve body **424** may be a somewhat tube shaped member having a plurality of grooves and flanges defined an outer surface thereof, as shown in FIG. **8**B. The outlet valve body **424** may define a main outlet pathway **426** that is fluidly connected to an inlet chamber **432** fluidly connected to the pump outlet **258**. The inlet chamber **432** may have a larger diameter than the outlet pathway **426**. The outlet pathway **426** varies in diameter along its length and at top end expands outward to form the tip cavity **428** that is configured to receive a portion of the tip **106**. The annular grooves on the outer surface of the outlet valve body **424** may be configured to receive one or more sealing members **436**, **440**, **442**, such as O-rings, seal-cups, or the like. Additionally, a bottom end of the outlet valve body **424** may include a flange **430** that is used to secure to the outlet valve body **424** to the pump body **200** as will be discussed below.
(90) The oral irrigator **100** may also include one or more sealing members that seal the pump from the electrical components of the power assembly. FIG. **11**A is a top isometric view of a diaphragm seal for the oral irrigator. FIG. **11**B is a cross-section view of the diaphragm seal taken along line **11**B-**11**B in FIG. **11**A. FIG. **12** is an enlarged view of a portion of FIG. **9**. With reference to FIGS. **11**A-**12**, the oral irrigator **100** may include a diaphragm seal **274** that seals the pump assembly **176** from the lower housing **182**. The diaphragm seal **274** may be formed of a flexible and waterproof material. For example, in some embodiments the diaphragm seal **274** may be elastomeric, rubber (one example being nitrile butadiene rubber), or a thermoplastic elastomer (TPE). In embodiments where the diaphragm seal **274** is a TPE material, the seal may be overmolded to one or more components of the pump assembly **176**, such as to the connecting rod and/or lower housing, as discussed in more detail below.
(91) The diaphragm seal **274** includes a seal top surface **302** with a rod aperture **292** defined through a center thereof. The seal top surface **302** extends radially outwards from the rod aperture **292** and then downwards at an angle to define a flexible skirt **296**. The skirt **296** may be conical or frustum shaped and may define a hollow space in the seal **274**. The skirt **296** is flexible and is configured to deform and resiliently return to its original shape. At a bottom end of the skirt **296**, a crease **298** or bend is defined as the diaphragm seal **278** extends back upwards and outwards. As will be discussed in more

detail below, the depth of the crease **298** varies as the seal is deformed during operation of the pump. A beaded flange **288** extends radially outwards from a top end of the crease **298**. The beaded flange **288** has a substantially flat top surface **294** while the bottom surface **300** is convexly curved forming an annular bead on the bottom surface. The top surface **294** may be substantially flat and configured to be received between the pump body and the lower housing **182**.

(92) With continued reference to FIGS. **11**A-**12**, the diaphragm seal **274** further includes an engagement wall **290** surrounding and defining the rod aperture **292**. The engagement wall **290** forms a sidewall conforming to the shape of the rod aperture **292** and extends partially above the seal top surface **302** and extends partially into the hollow space defined by the flexible skirt **296**. In this manner, the engagement wall **290** defines a cylindrically shaped flange that is seated within the rod aperture **292**.

(93) In the embodiment shown in FIGS. **11**A-**12**, the engagement wall **290** of the diaphragm seal **274** is a cylindrically shaped flange. However, in other embodiments, the engagement wall **290** may take other forms, in order to create a better seal and/or match the configuration of the connecting rod. FIG. **11**C illustrates a cross-section view of another example of the diaphragm seal **274**. With reference to FIG. **11**C, the diaphragm seal **275** may be substantially the same as the diaphragm seal **274** of FIGS. **11**A and **11**B. However, in this example, the engagement wall **291** is a bead extending around and defining the rod aperture **292**. In particular, the engagement wall **291** bead includes a rounded outer surface, similar to an O-ring, rather than the relatively straight edges of the engagement wall **290**.

(94) Tip Latch Assembly

(95) The tip latch assembly will now be discussed in more detail. FIG. **13**A is a side elevation view of the tip latch assembly for the oral irrigator **100**. FIG. **13**B is a cross-section of the tip latch assembly taken along line **13**B-**13**B in FIG. **13**A. FIG. **14** is a top isometric view of the oral irrigator with the tip collar removed to illustrate certain features. With reference to FIGS. **13**A-**14**, the tip latch assembly **306** releasably secures the tip **106** to the oral irrigator **100**. The tip latch assembly **306** allows a user to remove a tip, insert a new tip **106**, as well as rotate the tip **106**. The tip latch assembly **306** may include a latch **318**, a tip release **120**, a latch chassis **308**, a return spring **316**, a detent spring **310**, and the tip collar **110**.

(96) The latch chassis **308** supports various components of the tip latch assembly **306** to the oral irrigator **100**. FIG. **16**A is a top isometric view of the tip latch chassis. With reference to FIGS. **13**A, **13**B, and **16**A, the latch chassis **308** includes a support plate **338** with a tip support column **322** extending above and below the support plate **338**. The tip support column **322** defines a passage in which the tip **106** may be received. A top end of the tip support column **322** includes two slots **328** defined as U-shaped cutouts positioned across from one another on the column **322**. Additionally, two latch windows **336** are defined through the sidewalls of the column **322**. The latch windows **336** are aligned with one another and may be rectangular shaped cutouts configured to receive tangs of the latch **318**, discussed in more detail below. Two alignment ribs **326** extend longitudinally along a portion of a length of the tip column **322** and are positioned approximately above a center of the latch windows **336** on the outer surface of the tip column **322**. An outer wall **324** extends downwards from the support plate **338** and surrounds the tip support column **322**. The outer wall **324** is separated from the tip support column **322** to define an annular compartment between the outer wall **324** and the column **322**.

(97) With reference to FIG. **16**A, the latch chassis **308** may also include a brace **340** extending upwards from an edge of the support plate **338**. The brace **340** is a curved wall that follows the curvature of the support plate **338**. The brace **340** includes two leg notches **342** defined as cutouts through a sidewall to the brace **340** and extending inwards towards a center portion of the brace **340**. Two posts **314***a*, **314***b* extend upwards from a top end of the brace **340** and a fastening aperture **334** is defined between the two posts **314***a*, **314***b*. A spring recess **344** is defined as a generally circular recess in the outer surface of the brace **340**.

(98) With reference to FIGS. **14** and **16**A, the latch chassis **308** includes two latch posts **320***a*, **320***b* extending upwards from the support plate **338** on an opposite edge of the plate **338** from the brace **340**. The latch chassis **308** may further include a plurality of fastener brackets **332** extending outwards from

a support bracket **331** of the support plate **338**. The fastener brackets **332** may include fastening apertures and may be configured to connect to fastening mechanisms to secure the chassis to the oral irrigator **100**. As such, the configuration, size, and location of the fasteners brackets **332** may be varied based on the type of fastening mechanisms used.

(99) With reference again to FIG. **14**, the detent spring **310** may be a U-shaped resilient member that includes two spring arms **346**. The spring arms **346** extend substantially parallel to each other and include a detent **348** formed on a terminal end thereof.

(100) The latch **318** of the tip latch assembly **306** will now be discussed in more detail. FIG. **15** is a cross-section view of the oral irrigator taken along line **15-15** in FIG. **1**B. FIGS. **16**B and **16**C are various views of the latch **318**. With reference to FIGS. **14-16**C, the latch **318** includes a biasing structure **352** formed at a first end and a pair of engagement arms **350***a*, **350***b* extending generally parallel to each other from either end of the biasing structure **352**. The biasing structure **352** forms a flexible and resilient element of the latch **318** and is formed integrally with the latch **318**. For example, in one embodiment, the biasing structure **352** is a plastic component formed in a undulating or wave pattern that provides flexibility to the structure. As shown in FIGS. **16**B and **16**C, the biasing structure **352** may be formed in a W shape with rounded corners. However, other structures providing flexibility to the structure are envisioned and the above-mentioned examples are merely illustrative only.

(101) The engagement arms **350***a*, **350***b* of the latch **318** include a first portion **366** and a second portion **368**, with the first portion **366** being connected to the biasing structure **352** and the second portion extending from the first portion **366**. The engagement arms **350***a*, **350***b* may be mirror images of each other and so the discussion of any component for one of the arms **350***a*, **350***b* may be understood to apply to the other arm. Each arm **350***a*, **350***b* may include a fastening aperture **354***a*, **354***b* defined on a top surface and extending through a height or a portion of the height of the engagement arm **350***a*, **350***b*.

(102) The ends of the engagement arms **350***a*, **350***b* are configured to both engage with the tip release **120** as well as the tip **106**, as discussed in more detail below. The engagement arms **350***a*, **350***b* include a tang **356***a*, **356***b* extending towards the opposite arm **350***a*, **350***b* from an interior surface **358** of its respective arm **350***a*, **350***b*. The tang **356***a*, **356***b* includes a locking surface **370** that is somewhat parallel to the extension of the engagement arms **350***a*, **350***b*. Additionally, a top surface **364** of each tang **356***a*, **356***b* slopes downwards as it extends outwards from the top surface of the engagement arm **350***a*, **350***b* to transition into the locking surface **370**. The ends of the engagement arms **350***a*, **350***b* include an actuation surface **360** that begins at the terminal end of each engagement arm **350***a*, **350***b* and extends at an angle in towards the opposite engagement arm and towards the biasing structure **352**. For example, the actuation surface **360** may extend at an angle of about 45 degrees from the end of the engagement arm **350***a* **350***b*. A lip **362** is formed at the end of the engagement arms **350***a*, **350***b*; the lip **362** defines a relatively flat surface that is perpendicular to the top surface of the engagement arms **350***a*, **350***b*.

(103) With reference to FIG. **17**, the tip release **120** of the tip latch assembly **306** will now be discussed in more detail. The tip release **120** includes an input surface **378** or button that is configured to extend outside of the oral irrigator **100** body. In some embodiments, the input surface **378** may be curved to substantially match the curvature of the tip ring **388** or other exterior surface of the oral irrigator **100**. The tip release **120** also includes two actuation prongs **372***a*, **372***b* that extend outward from a rear side of the tip release **120**. The actuation prongs **372***a*, **372***b* are substantially parallel to one another and may be mirror images of each other. In some embodiments, each of the actuation prongs **372***a*, **372***b* include a stop **374** projecting outwards from an interior surface of the actuation prong **372***a*, **372***b* towards the opposite prong **372***a*, **372***b*. The stops **374** may be located along a length of each respective actuation prong **372***a*, **372***b* and the location of each stop **374** may be selected based on a desired extension of the input surface **378** from the tip ring **388**. In other words, the stops **374** may determine the amount that the input surface **378** extends outwards from the exterior of the oral irrigator. The stops **374** help to prevent the tip release **120** from disconnecting from the tip release assembly **306**.

(104) With continued reference to FIG. **17**, a terminal end **376** of each actuation prong **372***a*, **372***b* may have a flat surface and an angled surface **379**. The angled surface **379** may correspond to the angle of

the actuation surface **360** of the latch **318**. For example the angled surface **379** may be a beveled edge where the angle of the bevel from the terminal end **376** substantially matches as an opposing angle to the angle of the actuation surface **360** of the latch **318**.

(105) The tip release **120** may also include a spring seat **380** including a stud **382** portion. The spring seat **380** is formed as a cylindrical extension that extends from a back wall **390** of the tip release **120**. The spring seat **380** seats within a recess **384** formed in the back wall **390**. The stud portion **382** has a smaller diameter than the spring seat **380** and extends outward from the spring seat **380**. The diameter differential between the stud **382** and the seat **380** defines a seat configured to receive a spring **316** as discussed in more detail below.

(106) The tip collar **110** allows a user to change the orientation of the tip **106**. FIGS. **18**A-**18**C are various views of the tip collar **110**. With reference to FIGS. **18**A-**180**, the tip collar **110** is generally frustum shaped and includes a relatively flat top end **396** transitioning into a skirt **392** extending outward and downward at an angle therefrom. A bottom end **410** of the skirt **392** defines a bottom of the collar **110**. A plurality of finger grips **394** extend outward from and longitudinally along an outer surface of the skirt **392**. The finger grips **394** are spatially separated from one another and extend at spaced intervals around the skirt **392**.

(107) With continued reference to FIGS. **18**A-**180**, an inner collar **406** extends downward from the top end **396** of the collar **110**. The inner collar **406** defines a tip passageway **398** therethrough, the tip passageway **398** being configured to substantially match the diameter of the support column **322** of the support plate. The tip passageway **398** may vary in diameter along its length. For example, a first shelf **404** and a second shelf **402** may be formed at two separate locations along the length of the tip passageway **398**. The first shelf **404** may be positioned closer to the top end **396** of the collar **110** than the second shelf **402**. With reference to FIGS. **18**A and **18**C, a keyed sidewall **400** having a plurality of facets or angled walls are defined on the interior sidewall of the inner collar **406**. The facets of the keyed sidewall **400** extend in length between the first shelf **404** and the second shelf **402**.

(108) With reference to FIG. **18**B, the tip collar **110** further includes a plurality of fluted feedback teeth **408** along an outer surface of the inner collar **406**. The feedback teeth **408** are cylindrical bumps extending longitudinally along a length of the inner collar **406**. In one embodiment, the feedback teeth **408** extend only along a portion of the inner collar **406**. However, the length and other dimensions of the feedback teeth **408** may be varied as desired.

(109) Assembly of the Oral Irrigator

(110) Assembly of the oral irrigator **100** will now be disused in more detail. It should be noted that the below discussion is meant as illustrative only and that although certain components are discussed as being assembled in a particular order, the components of the oral irrigator **100** may be assembled in any manner as desired. With reference to FIGS. **5**B and **5**A, in one embodiment, the drive assembly **178** may be coupled together first. In this example, the motor **172** may be secured to the drive mount **304** with two fasteners **205***a*, **205***b*. The motor **172** may be positioned so that the drive shaft **216** extends through a bottom wall of the drive mount **304**. The pinion gear **218** may then be received around the drive shaft **216** and secured thereto.

(111) With reference to FIGS. **5**B and **10**A, the connecting rod **240** is placed around the cam **226** of the driven gear **220**. The driven gear **220** is arranged so as to be substantially perpendicular to the pinion gear **218** where the teeth of both gears **218**, **220** mesh together. The driven gear **220** is also mounted between the two sidewalls of the drive mount **304**. The gear pin **224** is then connected to a first sidewall of the drive mount **304**, through the gear aperture **262** in the driven gear **220** and out through a second sidewall of the drive mount **304** to secure the driven gear **220** and connecting rod **240** in position.

(112) The drive assembly **178** may be received in the lower housing **182**. With reference to FIGS. **5**B and **12**, the drive assembly **178** is connected to the lower housing **182** such that the lower portion of the connecting rod **240**, the driven gear **220**, and the pinion gear **218** are positioned within the dry cavity **276**. Once the drive assembly **178** is positioned within the lower housing, with reference to FIGS. **11**B and **12**, the diaphragm seal **274** may then be connected to the connecting rod **240**. In particular, the connecting rod **240** may be slid through the rod aperture **292** and the engagement wall **290** of the seal

274 may be positioned between the upper rib **244** and the lower rib **246** on the outer surface of the connecting rod **240**. As shown in FIG. **12**, the engagement wall **290** of the seal **274** may be dimensioned so as to be exactly the same thickness as the space between the ribs **244**, **246**, so as to prevent the seal **274** from sliding along the outer surface of the connecting rod **240** when the connecting rod **240** moves. In instances where the diaphragm seal **275** of FIG. **11**C is used, rather than the diaphragm seal **274** of FIGS. **11**A and **11**B, the rounded or bead engagement wall **291** may be positioned between the upper rib **244** and the lower rib **246**, with the rounded outer surface of the bead engaging the outer surface of the connecting rod **240**. Additionally, similar to the engagement wall **290**, the engagement wall **291** may be dimensioned so as to fit within the space between the ribs **244**, **246**.

(113) With reference to FIG. **10**B, the ball **242** of the connecting rod **240** may then be connected to the piston **248**. Specifically, the ball **242** may be received into the rod cavity **266** defined on the bottom end **268** of the piston **248**, the rod cavity **266** may snap fit or otherwise frictionally fit around the ball **242**. The connecting rod **240** extends through the rod aperture **286** defined in the top end of the lower housing **182** and the diaphragm seal **274** seats on the sealing end **278** of the lower housing **182**. In particular, with reference to FIG. **12**, the beaded flange **288** of the seal **274** is positioned in the annular groove **280** between the inner wall **284** and the outer wall **282** of the lower housing **182**. In this embodiment, the seal **274** extends from the annular groove **280** upward and over the inner wall **284** and then downward so that the crease **298** extends along a portion of the interior surface of the inner wall **284**.

(114) Once the drive assembly **178** is connected to the lower housing **182**, the batteries **412***a*, **412***b* may be connected to the lower housing **182**. In particular, with reference to FIGS. **3** and **8**A, the batteries **412***a*, **412***b* may be received into respective battery cavities in the lower housing **182**. A battery cable **416** may extend between terminals for the two batteries **412***a*, **412***b* to electrically couple them together. A seal **414** may be positioned around the battery cap **198**, which may then be inserted into a bottom end of the lower housing **182** and connected thereto with a plurality of fasteners **418**. In another embodiment, as shown, for example in FIG. **25**, the battery cap **198** may be ultrasonically welded to the lower housing **182**. In this embodiment, the seal **414** and the fasteners **418** may be omitted as the cap may be connected to the lower housing **182** in a substantially leak proof and secured manner.

(115) With reference to FIG. **6**, after the battery cap **198** is connected, the power circuit board **196** may be connected to the lower housing **182**. In particular, the circuit board **196** may be positioned within a recess defined by the flange **208** on the outer surface of the lower housing **182**. The circuit board **196** may be secured to the lower housing **182** by one or more fasteners. Additionally, the circuit board **196** may be electrically connected to the motor **172** and batteries **412***a*, **412***b* by one or more wires connected to the various components within the lower housing **182** and extending through an aperture in the sidewall of the lower housing **182** to connect to the circuit board **196**.

(116) The circuit board **196** may be assembled prior to connecting it to the lower hosing **182** and the secondary coil **194** assembly may be positioned on the circuit board **196** and mounted to the lower housing **182** with the circuit board **196**.

(117) With reference to FIG. **8**B, the drive assembly **178** may then be connected to the pump body **200**. In particular, the piston **248** may be received into the pump chamber **260** and the bottom end **422** of the pump body **200** may seal against the flange top surface **294** of the diaphragm seal **274**. One or more fasteners may then be used to secure the bottom end **422** of the pump body **200** to the seal end **278** of the lower housing **182**.

(118) With continued reference to FIG. **8**B, the reed valves **252**, **254** may be positioned over the pump inlet **256** and pump outlet **258**, respectively. The inlet valve body **250** may then be connected to the valve receiving section **249** of the pump body **200** and may optionally include a seal **438**, such as an O-ring, around an outer surface to seal against the outer surface of the inlet valve body **250** and interior surface of the valve receiving section **249** of the pump body **200**. Additionally, the outlet valve body **424** may be connected to a top end of the pump body **200** by being received in the valve receiving section **251**. For example, the outlet valve body **424** may be inserted into the valve receiving section **251** with the inlet chamber **432** being aligned with the outlet reed valve **254**. As with the inlet valve

250, a seal **436** (such as an O-ring or cup seal) may be positioned on an outer surface of the portion of the outlet valve **424** that is received into valve receiving section **251** of the pump body **200** to seal the connection between the two components. Fasteners **434** may then be used to secure the outlet valve body **424** to the top end of the pump body **200**.

(119) Once the outlet valve body **424** is connected to the pump body **200**, the upper housing **184** may be connected to the assembly. With reference to FIGS. **5**B-**8**B, the pump body **200** and outlet valve body **424** may be received into bottom end of the upper housing **184**. A seal **440** may seal against the outer surface of the outlet valve body **424** and the upper housing **184**. In some embodiments, the outer flange **210** of the upper housing **184** may extend downwards and outwards over a portion of the lower housing **182** and be aligned with the flange **208** of the lower housing **182** (see, FIG. **7**).

(120) With reference to FIG. **6**, the control assembly **180** may be connected to the upper housing **184**. In particular, the control assembly **180** may be positioned within the recessed area defined by the flange **210** of the upper housing **184** and connected to the upper housing **184** with a plurality of fasteners.

(121) With reference to FIGS. **7** and **8**B, when the upper housing **184** is connected to the pump assembly **176**, the hose **202** is connected to the bottom tube portion of the inlet valve body **250**. The hose **202** may be secured in place with friction fit, one or more hose clamps, adhesive, and/or other types of fasteners.

(122) With reference to FIGS. **3** and **4**, the alignment and securing magnets **450***a*, **450***b* and the activation magnet **420** for the charger may be connected to the front shell **138**. For example, with reference to FIGS. **3** and **4**, the activation magnet **420** may be received within the magnet recess **446** and the two lateral magnets **450** may be positioned in the magnet pockets **448***a*, **448***b* defined on either side of the sealing feature **144**. It should be noted that in embodiments where a non-magnetic charger or a power cord are used the magnets and magnet pockets can be omitted.

(123) After magnets **420**, **450** are connected to the front shell **138**, with reference to FIGS. **4** and **6**, the front and rear shells **138**, **140** may be connected together around the pump and drive assemblies **176**, **178**. The front shell **138** may be connected to and around a portion of the upper and lower housings **182**, **184**. In particular, the first sealing wall **142** may be placed around the gasket **214** positioned around the flange **210** on the upper housing **184**. The sealing feature **142** compresses the gasket **214** and defines a seal around the interior section of the flange **210** to form a first waterproof compartment. The power button **112** of the front shell **138** aligns with the power switch **186** on the control assembly **180** and the mode button **114** aligns with the mode switch **188**. The window **146** section of the front shell **138** is aligned with the bottom portion of the control assembly **180** so that the LED windows **148***a*, **148***b*, **148***c*, **148***d* align with the LEDs **190***a*, **190***b*, **190***c*, **190***d*.

(124) The second sealing feature **144** of the front shell **138** may be positioned around the outer edge of the second flange **208**, compressing the gasket **212** between the feature **144** and the flange **208** to form a second waterproof compartment. A plurality of fasteners, such as press fit pins or screws, may be connected to the lower and upper housings **182**, **184** and into the connecting posts **152***a*-**152***k* to secure the front shell **138** to the upper housing **184** and the lower housing **182**. It should be noted that depending on the type of fasteners used, the connecting posts may be omitted.

(125) In some embodiments, the connection wires **192** may then be connected to the control assembly **180** and the power circuit board **196** after the front shell **138** has been connected to the upper and lower housings. In these embodiments, the window panel **146** may not be connected to the front shell **138** until the connection wires **192** are connected. Once the connection wires **192** are connected, the window panel **146** is ultrasonically welded to the front shell **138**. The welding connection helps to prevent fluid from entering into the front shell **138** through the window **146** by creating a leak-proof seal, but because the panel **146** may be added after the connection wires **192** have been connected, the wires may be accessible during manufacturing and assembly of oral irrigator **100**.

(126) To connect the rear shell **140** to the oral irrigator **100**, the hose **202** is connected to the tube projection feature **165** on the rear shell **140** and the reservoir **206** hose is connected to the opposite side of the feature **165**, fluidly connecting the reservoir hose **206** to the hose **202** (see FIG. **5**B). As shown in FIG. **5**B, the rear shell **140** may include a dividing wall **452** that extends outwards from an interior

surface of the rear shell **140** and then extends downwards parallel to the lower housing **182**. In this manner, the dividing wall **452** acts to fluidly separate the reservoir **154** from the housings **182**, **184**. The rear shell **140** may then be secured to the front shell **138** and the lower and upper housings **182**, **184**.

(127) Once the two shells **138**, **140** are connected, the reservoir hose **206** is connected to the hose **202** and the reservoir **104** may be secured to the oral irrigator **100**. With reference to FIGS. **5**A, **5**B, and **9**, the reservoir **104** may be connected to the bottom end of the rear shell **140**. The upper rim **170** of the reservoir **104** is connected to a ledge in the rear shell **140** and the battery platform **158** of the reservoir **104** is positioned beneath the battery cap **198** (see FIG. **5**A). The battery platform **158** is raised to provide an increased capacity for the reservoir. The battery cap **198** and the diaphragm seal **274**, along with the interior surface of the lower housing **182** act to define a third waterproof compartment for the oral irrigator.

(128) The tip latch assembly **306** may then be connected to the top end of the outlet valve body **424**. In one embodiment, the top end of the outlet valve body **424** may be positioned between the outer wall **324** and the tip support column **322** of the latch chassis **308**. A seal **442** may be positioned around the outlet valve body **424** to seal against the interior surface of the outer wall **324** of the latch chassis **308**.

(129) Once the latch chassis **308** is connected, the remaining components of the tip latch assembly **306** may be connected and secured to the oral irrigator **100**. With reference to FIGS. **14** and **16**, a first end of the return spring **316** is positioned within the spring recess **344** and a second end of the return spring **316** is placed onto a portion of the stud **382** on the tip release **120**. The tip release **120** is then connected to the latch chassis **308** as the actuation prongs **372***a*, **372***b* are inserted into the leg notches **342** on the latch chassis **308**. The actuation prongs **372***a*, **372***b* are positioned so that the stops **374** on each prong **372***a*, **372***b* are positioned on an interior side of the brace **340** (see FIG. **14**), as will be discussed in more detail below, this positioning of the stops **374** helps to prevent inadvertent removal of the tip release **120**.

(130) After the tip release **120** is connected to the latch chassis **308**, the latch **318** may be connected to the chassis **308**. With reference to FIGS. **14**, **16**A-**16**C, the fastening apertures **354***a*, **354***b* of the latch **318** are received around the posts **320***a*, **320***b* of the latch chassis **308**. The engagement arms **350***a*, **350***b* of the latch **318** are oriented so as to extend across the latch chassis **308** and interface with the actuation prongs **372***a*, **372***b* of the tip release **120** for purposes of selectively releasing the tip **106** as will be discussed in more detail below. Further, the engagement arms **350***a*, **350***b* of the latch **318** seat beneath the ribs **326** positioned on either side of the tip support column **322** on the latch chassis **308**. The tangs **356***a*, **356***b* of each engagement arm **350***a*, **350***b* are partially received into the latch windows **336** also defined on opposing sides of the tip support column **322** (see FIG. **13**B).

(131) The tip ring **388** may be connected to the tip latch assembly **306**. For example, with reference to FIG. **14**, the tip release **120** may be positioned through an aperture defined through a sidewall of the tip ring **388** and a plurality of fasteners may be inserted through fastening apertures defined on both the tip ring **388** and on the fastener brackets **332** of the latch chassis **308**. The fasteners secure the tip ring **388** to the latch chassis **308** and to the two shells **138**, **140**.

(132) With continued reference to FIG. **14**, the detent spring **310** may be connected to the latch chassis **308**. In one embodiment, the detent spring **310** may be a flexible, integral component that includes two post apertures that are received around the posts **314***a*, **314***b* of the latch chassis **308**. A fastener **312** may then be received through a fastening aperture defined in the top surface of the detent spring **310** and the fastening aperture **334** defined on the top surface of the brace **340** of the latch chassis **308**. The detent spring **310** may be oriented so that the arms **346** extend inwards towards and extend on either side of the tip support column **322** of the latch chassis **308**. In one embodiment, the terminal end of the arms **346** may be configured to align in part with the ribs **326** on the tip support column **322**.

(133) Once the tip latch assembly **306** is connected to the oral irrigator **100**, the tip collar **110** is connected to the tip latch assembly **306**. With reference to FIG. **13**B, the inner collar **406** of the tip collar **110** is received around the outer surface of the tip support column **322** of the latch chassis **308**. Additionally, the arms **346** of the detent spring **310** are positioned around the outer surface of the inner collar **406** of the tip collar **110** and each detent **348** prong on the arms **346** engages a channel between a

respective pair of teeth **408** on the outer surface of the inner collar **406**. The rim **330** of the tip support column **322** seats on top of the second shelf **402** on the interior of the tip passageway **398** of the tip collar **110**. The slots **328** defined in the tip support column **322** provide flexibility to the tip support column **322** to allow it to flex radially inward as the inner collar **406** is placed around the tip support column **322** to allow the two components to be more easily connected.

(134) Once the tip collar **110** is connected, the tip **106** may be inserted into the oral irrigator **100**. With continued reference to FIG. **13**B, the tip **106** is slid into the tip passageway **398** in the tip collar **110** and extends into the tip support column **322**. The bottom of the tip **106** causes the latch **318** to open to allow the tip **106** to pass by the latch windows **336** and the engagement tangs **356***a*, **356***b* extend into the tip column **322** to grip the tip **106**, securing it in position. The identifier ring **128** around the outer surface of the tip **106** is configured to seat on the first shelf **404** of the tip collar **110** once the tip **106** is in the proper position. With reference to FIG. **5**B, the bottom end of the tip **106** is received in part into the outlet valve body **424** and is fluidly connected to the pump body **200**.

(135) Operation of the Oral Irrigator

(136) Operation of the oral irrigator **100** will now be discussed in more detail. With reference to FIGS. **1**A and **6**, when the power button **112** is selected by a user, the button **112** compresses, compressing the power switch **186** on the control assembly **180**. The power switch **186** causes the control assembly **180** to transmit a signal to activate the motor **172**. The speed of the motor **172** may be varied by a user selecting the mode button **114**, which activates the mode switch **188**. The mode switch **188** varies the average value of the voltage transmitted to the motor to vary the speed of the motor **172**. In one embodiment, the motor may be powered by a pulse width modulation signal that is used to vary the motor speed and the mode switch **188** may be used to change the output of the motor by selectively changing the signal applied thereto.

(137) With reference to FIGS. **5**B and **10**B, as the motor **172** is powered the motor drive shaft **216** rotates, causing the pinion gear **218** to rotate. The gear teeth **230** of the pinion gear **218** mesh with the gear teeth **232** on the driven gear **220**. The helical shape of the gears **230**, **232** causes the teeth to engage along their entire length, increasing the torque transmitted between the pinion gear **218** and the driven gear **220**. The rotation of the pinion gear **218** causes the driven gear **220** to rotate about the gear pin **224**. The connecting rod **240**, connected to the cam **226** of the driven gear **220** also begins to move. The cam **226** acts to convert the rotational movement of the motor drive shaft **216** and driven gear **220** into a longitudinal reciprocal displacement of the piston **240** within the pump body **200**.

(138) FIG. **23**A is a partial cross-section enlarged view of the oral irrigator during an upstroke of the pump assembly. FIG. **23**B is a partial cross-section enlarged view of the oral irrigator transitioning between the upstroke and a down-stroke. FIG. **23**C is a partial cross-section enlarged view of the oral irrigator during the down-stroke. With reference to FIGS. **23**A-**23**C, the piston **248** moves longitudinally within the pump cavity **260** to varyingly increase and decrease the volume of the pump cavity **260**. As the piston **248** moves due to the movement of the connecting rod **240**, the diaphragm seal **274** moves therewith to maintain the seal between the pump cavity **260** and the drive assembly. As can be seen by comparing FIGS. **23**A-**23**C, the depth of the crease **298** increases as the piston **248** moves from the upstroke position to the down-stroke position. The bellows allows the seal **274** to deform with movement of the connecting rod **240** without introducing friction into the system.

(139) Due to the bellows of the seal **274** forming the crease **298**, the seal **274** allows the piston to reciprocate linearly without introducing friction into the system. In particular, the diaphragm seal **274** deforms as the connecting rod **240** moves longitudinally and as the perimeter edge forming the beaded flange **288** of the diaphragm seal **274** is clamped and prevented from moving, the seal **274** does not rub against any surfaces as it deforms, reducing the risk of wear and tear on the seal **274**. Additionally, as there is substantially no friction between the seal **274** and the connecting rod **240**, parasitic energy losses are reduced as compared to conventional oral irrigators with piston seals, as the motor **172** does not have to overcome friction in addition to the energy required to deform the seal **274**. The configuration of the diaphragm seal allows it to stay in position relative to the connecting rod and pump body, even at high frequencies such as those typically used with oral irrigators. Additionally, the diaphragm seal allows the omission of a radial shaft seal or lip seal that are typically placed on rotary

elements, such as the motor or driven gear. These seals are prone to leak and wear over time and create friction on the rotary element, which requires more energy to operate and reduces the efficiency of the irrigator.

(140) With reference to FIG. **8**B, on a down-stroke of the piston **248**, a vacuum is created in the pump body **200**, which causes fluid to flow from the reservoir cavity **154** into the reservoir hose **206**, into the hose **202**, and into the inlet valve body **250**. The fluid flows through the passageway defined in the inlet valve body **250** and causes the flap of the reed valve **252** to open, allowing the fluid to flow into the pump chamber **260**. With continued reference to FIG. **8**B, on an upstroke of the piston **248**, the connecting rod **240** forces the piston **248** upwards, thus pushing the fluid in the pump chamber **260** upwards into the pump fluid passageway **264** towards the pump outlet **258**. The fluid forces the reed valve **254** open and closes the inlet reed valve **252** so that the fluid flows into the inlet chamber **432** of the valve outlet body **424**. The fluid then enters the outlet passageway **426** and flows into the tip **106** connected to the outlet valve body **424** and is expelled into a user's oral cavity.

(141) With reference to FIG. **13**B, if a user wishes to vary the orientation and position of the tip **106**, he or she may grip and rotate the tip collar **110**. As the tip collar **110** rotates, the teeth **408** on the inner collar **406** are rotated past the arms **346** and the detent spring **310** deforms slighting and the detents **348** on the arms **346** of the return spring **310** provide haptic feedback to the user. As the tip collar **110** rotates, the tip **106** which is engaged with the keyed sidewall **400** of the tip collar **110** rotates therewith. Thus, the tip collar **110** allows a user to more easily rotate the tip **106** to a desired location as the tip collar **110** provides a larger gripping surface than rotating the tip **106** itself and also provides feedback via the teeth **408** regarding the rotational movement of the tip **106**.

(142) Tip Release Operation

(143) The operation of the tip latch assembly **306** will now be discussed in more detail. FIG. **24** is a cross-section view of the oral irrigator **100** with select elements removed for clarity. With reference to FIGS. **15**, **16**B, **17**, and **24**, to release the tip **106**, the user exerts a force F on the input surface **378** of the tip release **120**. The force F overcomes the biasing force exerted by the retention spring **316** and the actuation prongs **372***a*, **372***b* translate laterally towards the latch **318**. As the tip release **120** moves laterally, the spring **316** is compressed. The chamfered or angled surfaces **378** on the ends of the actuation prongs **372***a*, **372***b* interface with the actuation surface **360** of the latch **318** and the terminal ends **372** of each prong **372***a*, **372***b* exert a portion of the force F against the actuation lip **362** of each engagement arms **350***a*, **350***b* of the latch **318**. For example, each side may exert half of the force F, and the force F is translated into a perpendicular force component due to the interface of the angled faces of the tip release **120**, and then into torque around pins **320** (which is resisted by biasing element **352**).

(144) The force exerted by the tip release **120** causes the engagement arms **350***a*, **350***b* of the latch **318** to pivot in the rotation direction R. In particular, the engagement arms **350***a*, **350***b* pivot around the posts **320***a*, **320***b*. This pivoting motion causes the tangs **356***a*, **356***b* of each arm **350***a*, **350***b* to pivot away from the center of the oral irrigator **100** and move out of the latch windows **336** in the latch chassis **308**. With reference to FIG. **13**B, the movement of the tangs **356***a*, **356***b* causes the tangs **356***a*, **356***b* to disengage from the groove **317** formed in the tip **106**. Once the tangs **356***a*, **356***b* are disengaged from the groove **317**, the tip **106** can be easily removed by the user.

(145) With reference again to FIGS. **15** and **24**, once the user force F is removed from the tip release **120**, the retention spring **316** exerts a biasing force in the opposite direction of the user force F and the tip release **120** moves laterally away from the latch **318**. As the tip release button **120** moves, the actuation prongs **372***a*, **372***b* disengage from the engagement arms **350***a*, **350***b* and the biasing structure **352** of the latch **318** exerts a biasing force to cause the engagement arms **350***a*, **350***b* to move into the latch windows **336** of the latch chassis **308**. That is, biasing structure **352** of the latch **318** will return to its natural shape after being deformed by the user force F and will move back inward when the force F is removed. If a new tip **106** has been inserted into the tip support column **322**, the tangs **356***a*, **356***b* will be inserted into the groove of the tip **106** and if a tip is not inserted, the tangs **356***a*, **356***b* will protrude into the interior passage of the tip support column **322**.

(146) It should be noted that in some embodiments, the retention spring **316** may be omitted and the

biasing force of the biasing structure **352** of the latch **318** may be configured to exert a sufficient force to not only pivot the engagement arms **350***a*, **350***b* back to a locked position, but also force the actuation prongs **372***a*, **372***b* of the release button **120** laterally away from the latch **318** to the locked orientation.

(147) The movement of the tip release button **120** by the retention spring **316** is limited by the stops **374** on the interior surfaces of the actuation prongs **372***a*, **372***b*. In particular, with reference to FIGS. **15** and **24**, the stops **374** abut against the brace **340** to prevent further movement away from the latch **318** to help prevent the button **120** from being inadvertently removed from the tip latch assembly **306**.

(148) With the latch assembly **306**, both engagement arms **350***a*, **350***b* of the latch **318** may engage with the tip **106** in the locked position. This structure is more reliable than conventional tip latch assemblies where a single arm engaged with the tip **106**. Further, the dual-arms allow greater assembly tolerances and help to prevent inadvertent disengagement of the tip **106** from the oral irrigator **100**. Further, the integrated biasing structure **352** of the latch **318** reduces the complexity and number of components for the tip latch assembly **306**, which makes manufacturing easier as the chances for error during assembly are reduced. The biasing structure **352** allows the latch **318** to be created as a single part and thus a single mold is needed to form the latch **318** of the present disclosure as compared to other latch assemblies including separate biasing elements.

(149) The Charger and Charging the Oral Irrigator

(150) The charger **134** for the oral irrigator **100** will now be discussed in more detail. FIG. **19** is a rear isometric view of the charger **134**. FIG. **20** is a cross-section view of the charger taken along line **20-20** in FIG. **19**. FIG. **21** is an exploded view of a primary charging coil assembly **478** for the charger **134**. With reference to FIGS. **19-21**, the charger **134** may include a charger housing **454**, a power cord **136**, a primary coil assembly **478**, and interior electronic components. Each will be discussed in turn below.

(151) The charger housing **454** may define a somewhat oval shaped body having a curved interior surface **460** configured to match the exterior curve of the front shell **138** of the oral irrigator **100**, as well as be aesthetically appealing. The interior source **460** may include two cooling grooves **462***a*, **462***b* that extend parallel to each other from a top end to a bottom end of the charger **134**. The cooling grooves **462***a*, **462***b* allow airflow between the charger **134** and the oral irrigator **100** when the charger is connected. The shape and dimensions of the cooling grooves **462***a*, **462***b* may be configured not only to enhance airflow but also to provide an aesthetically appealing appearance for the charger **134**. The exterior surface **480** may be convexly curved and bow outwards at a middle section (see FIG. **20**). In some embodiments, the exterior surface **480** may be removable from the charger housing **434** and may connect to the sidewalls of the charger **434**.

(152) With reference to FIGS. **19** and **20**, the charger **134** may also include a power cord **136** electronically coupled via a wire **474** to a circuit board **472** positioned within the charger housing **454**. The power cord **136** extends from a sidewall of the charger housing **454** and may include a strain relief **458** section at the connection location to help prevent the cord from being damaged due to bending and flexing at the connection to the housing **454**. In some embodiments, an O-ring **473** may be received between the strain relief **458** and the charger housing **453** to help prevent fluids from entering into the charger housing.

(153) Adjacent the outer edges of each of the cooling grooves **462***a*, **462***b* the charger **134** may include one or more magnet pockets **464***a*, **464***b* configured to receive one or more magnets **476***a*, **476***b* (see FIG. **20**).

(154) The charger **134** may also include one or more activation switches that activate the charger **134** when it is connected to the oral irrigator **100**. In one embodiment, the activation switch **487** may be a Hall effect sensor that interacts with magnet **420** on the oral irrigator to activate the charger **134**. This type of activation prevents the charger from being activated when it is not in a position to charge the oral irrigator **100**, which reduces power consumption and increases the energy efficiency of the irrigator **100** and charger. Other types of sensors or switches may also be used, for example, mechanical or optical switches, that switch the charger into a charging mode once it is secured to the body of the oral irrigator **100**. However, in embodiments where waterproofing is desired, a magnetic sensor, such as a Hall effect sensor, may be preferred as the sensor is not affected by fluids, such as

water or mouthwash and the magnets can be concealed within the housings of the oral irrigator and charger to allow for a cleaner aesthetic appearance.
(155) With reference to FIGS. **20** and **21**, the charger **134** also includes the primary coil assembly **478**. The primary coil assembly **478** may include a primary coil **466**, a bobbin **468**, and a core **470**. The primary coil assembly **478** may be substantially similar to the secondary coil assembly **486**. For example, with reference to FIG. **22**, the secondary coil assembly **194** in the lower housing **112** of the oral irrigator **100** may include a secondary coil **486**, a bobbin **488**, and a core **490**, each being substantially similar to its counterpart in the primary coil assembly **478**. As will be discussed in more detail below, the coil assembly **478** is configured to couple with circuit board **196** in the oral irrigator **100** to charge the batteries **412***a*, **412***b*.
(156) In one embodiment, the primary coil **466** and the secondary coil **486** may include a plurality of twisted copper wires, such as Litz wires, and each of the multiple wires may be insulated from each other. In these embodiments, the coils **466**, **486** may allow for fast inductive charging of the oral irrigator **100**, while having a low amount of heat generation. In conventional charging devices for oral care products, such as electric toothbrushes, an inductive coil may be made from a solid enameled copper wire. However, these types of coils have a low charging rate to prevent heat generation. On the contrary by using the twisted wires for the coils **466**, **486**, the multiple wires reduce the heat generated by the coils during charging due to reduced skin effect and proximity effect losses. This allows the charger **134** to be made of plastic or other low-heat resistant products since the heat generated by the coils **466**, **486** is much lower. Further, the coil **466**, **486** configurations with multiple wires charges faster than conventional single-wire structures as current has multiple pathways to flow.
(157) It should be noted that in some embodiments, the primary coil **466** and the secondary coil **486** may be made with multiple parallel wires, rather than twisted wires. As another example, in some embodiments, the coils **466**, **486** may be braided, woven, or otherwise formed. The wires forming the coils **466**, **486** may be substantially any type of multiple wire arrangement and may be round or rectangular in cross section and may include a core, such as a fiber core that the wires are wound around, and/or may include insulating sleeves or the like around the group of wires, individual wires, or the like.
(158) The core **470** may be a ferrite core or other type of magnetic core. In one embodiment, the core **470** may be “E” shaped and include a central prong and two peripheral prongs on either side of the central prong.
(159) With reference to FIGS. **20** and **21**, to assemble the charger **134**, the coil assembly **478** is connected together. In particular, the primary coil **466** is wound around the outer surface of the bobbin **468** and the central prong of the core **470** may be inserted through a center of the bobbin **468** with the outer prongs be positioned on a top and a bottom of the bobbin **468** and primary coil **466**. The coil assembly **478** is then mounted to the circuit board **472**, which may be a printed circuit board, and electronically connected to the connection wire **474**.
(160) With reference to FIGS. **19** and **20**, the magnets **476***a*, **476***b* may be inserted into the respective magnet pockets **464***a*, **464***b* in the charger housing **434**. The coil assembly **478** and circuit board **472** can then be received into the charger housing **434** and the connection wire **474** may be electrically connected to the power cord **136**. The exterior surface **480** may then be connected to the charger housing **434** and secured thereto.
(161) Operation of the charger **134** to charge the batteries of the oral irrigator **100** will now be discussed in more detail. With reference to FIGS. **2**A and **2**B, the user aligns the charger **134** with the outer surface of the front shell **138** of the oral irrigator **100**. In particular, the interior surface **460** is aligned and abuts the outer surface of the front shell **138**. The magnets **476***a*, **476***b* of the charger **134** are attracted to and align with the magnets **450***a*, **450***b* connected to the front shell **138** to align the charger **134** with the power assembly circuit board **196** and secure the charger **134** to the oral irrigator **100**. Additionally, the activation switch **487** interacts with the magnets within the front shell **138** to turn on the charger **134**. For example, when the activation switch is a Hall effect sensor, as the charger **134** is secured in position, the magnet activates the Hall effect sensor, allowing the charger to begin to charge the batteries of the oral irrigator.

(162) Once the charger **134** is connected to the oral irrigator **100**, the user may connect the power cord **136** to an electrical source, such as a wall outlet, battery, or the like. Once connected to a power source, the charger **134** causes a current to be induced in the coil assembly **194** of the oral irrigator. FIG. **22** is a simplified diagram illustrating the operation of the charger **134**. With reference to FIG. **22**, during charging, current is transmitted from the power cord **136** of the charger **134** to the primary coil assembly **478** via the circuit board **472** and wire **474**. Current moves through the primary coil **466**, which creates a magnetic field due to the core **470**. As the two coil assemblies **194**, **478** for the oral irrigator **100** and charger **134** are separated by a small gap **456** (defined by the thickness of the front shell **138** and the charger housing **454**); the magnetic field generated by the primary coil assembly **478** induces a current in the secondary coil **486** of the secondary coil assembly **194**. The current induced in the secondary coil **486** is then transmitted to the batteries **412***a*, **412***b* to charge the battery pack.
(163) As discussed above, due to the twisted copper wire configuration of the coils **466**, **486** the charge currents generated are larger as compared to conventional inductive charging devices. This allows the oral irrigator **100** to charge more quickly than conventional inductive devices. Additionally, the multiple wires reduce heat generated by the coils during charging, which reduces the risk of damage to other components of the oral irrigator **100**, such as the shell **138**, housings, etc., and helps to prevent the outer surfaces of the oral irrigator **100** from becoming heated, which could present a risk to a user.
(164) Further, the cooling grooves **462***a*, **462***b* allow airflow to flow between the charger **134** and the outer surface of the oral irrigator **100**, even when the charger **134** is connected to the irrigator **100**. The cooling grooves **462***a*, **462***b* may be spaced around the primary coil assembly **478** to allow heat dissipation from the coil assembly **478** during charging. The heat dissipation provided by the cooling grooves **462***a*, **462***b* helps to cool the coil **478** and helps to prevent the heat generated during charging from damaging other components, such as the charger housing **454** and/or oral irrigator housing. This allows the charger housing **454** to be made out of plastics or other similar materials as the risk of melting or other damage is minimized by the cooling grooves **462***a*, **462***b*.
(165) With continued reference to FIG. **22**, during charging, the microprocessor **484** or microcontroller (or other processing element), which may be on the main circuit board **204** and/or the circuit board **196**, may monitor the status of the batteries **412***a*, **412***b*. When the voltage (or other characteristic, e.g., a “battery full signal”) sensed by the microprocessor **484** drops below a predetermined threshold, the microprocessor **484** may determine that the batteries **412***a*, **412***b* are charged to a desired percentage. The microprocessor **484** may then deactivate the charger to preserve energy. For example, the microprocessor **484** may send a signal to the charger **134** to indicate that the connection to the power supply should be deactivated. By deactivating the charging process when the batteries have been fully charged, the lifespan of the batteries **412***a*, **412***b* may be increased. For example, in some instances the batteries **412***a*, **412***b* may be nickel metal hydride (NiMH) batteries **412***a*, **412***b* and overcharging the batteries once they have reached capacity may reduce the life span. Because the charging system of the oral irrigator **100** may monitor the charging capacity of the batteries during charging, and deactivate the charging when capacity is reached, the batteries **412***a*, **412***b* may have an increased life span as compared to conventional batteries. Further, because the charging system terminates charging when capacity is reached, the charging system is more energy efficient.
(166) Slide Latch for the Removable Reservoir
(167) As discussed above, in some embodiments, the reservoir **104** may be removable from the body **102**. In these embodiments, the oral irrigator **100** may include a latching system to selectively secure and release the reservoir **104** from the body **102**. FIGS. **26-28** illustrate a slide latch for the oral irrigator. With reference to FIGS. **26-28** in this embodiment, a latch assembly **500** may include a latch **516** and a button **518** connected thereto. The latch assembly **500** is connected to reservoir **104** and assists in securing the reservoir **104** to the body **102**.
(168) With reference to FIG. **28**, the latch **516** may be formed as a latch body **538** that defines a void area **521** surrounded by a perimeter **523**. A first finger **526** and a second finger **528** may each extend from the perimeter **523** into the void area **521** parallel to each other. The two fingers **526**, **528** are connected on one end to the latch body **538** and are free on the opposite end so that the fingers **526**, **528** are flexible relative to the latch body **538**. The two fingers **526**, **528** may be secured on opposite

ends relative to each other so that the secured end of the first finger **526** is adjacent to the free end of the second finger **528** and vice versa. Each of the fingers **526**, **528** may include a securing element on their respective free ends. For example, the first finger **526** may include a nub **524** formed on its free end and the second finger **528** may include a tang **520** formed on its free end. The two securing elements may be oriented so as to extend upwards from a top surface **525** of the latch **516**.

(169) With reference to FIGS. **27** and **28**, the latch **516** may also include two pegs **522***a*, **522***b* extending from a bottom surface **527** of the latch body **538**. The pegs **522***a*, **522***b* may be parallel to each and extend from the latch body **538** so as to border the ends of the fingers **526**, **528** on the bottom surface **527**. The button **518** of the latch assembly **500** may be connected to the latch **516** via the pegs **522***a*, **522***b*. For example, the pegs **522***a*, **522***b* may include apertures **529** defined therein may extend through the latch body **538** to the top surface **525** and that may be configured to receive corresponding pegs on the button **518**. This may allow the button **518** to be removable from the latch **516**. However, in other embodiments, the latch **516** and the button **518** may be formed as an integral, single component or be permanently connected to one another.

(170) With reference to FIG. **29**, in embodiments including the latch assembly **500**, the reservoir **104** may include a latch cavity **504** or recess defined on a bottom surface **502**. The latch cavity **504** may include a track **506** for the latch **516**, the track **506** including a first end and a second end forming a first stop **508** and a second stop **510**, respectively. The latch cavity **504** may also include a first detent **534** and a second detent **536** aligned adjacent to and set off from the track **506**. The bottom surface **502** of the reservoir **104** may also include an unlock icon **530** and a lock icon **532** painted, molded, etched, or otherwise formed in the bottom surface **502**. Alternatively, the icons may be attached via adhesive or the like (e.g., as a decal or sticker). The unlock icon **530** corresponds to a position of the latch **516** where the reservoir **104** is removable from the body **102** and the lock icon **532** corresponds to a position of the latch **516** where the reservoir **104** is secured to the body **102**.

(171) With reference to FIGS. **26-29**, the latch assembly **500** may be connected to the reservoir **104** and body **102** so that the latch **516** is arranged in the latch cavity **504** with the first finger **526** being aligned with the first and second detents **534**, **536** and the second finger **528** being aligned with the track **506**. The tang **520** is positioned between the first stop **508** and the second stop **510** within the track **506** and the nub **524** is positioned within one of the detents **534**, **536**. The button **518** is connected so as to face away from the bottom surface **502** of the reservoir **104**.

(172) Operation of the latch assembly **500** will now be discussed in more detail. With continued reference to FIGS. **26-29**, in the locked position, the latch **516** may be positioned so that a first end of the button **518** abuts against the body **102** and the latch body **538** extends between a first shelf **512** and a bottom surface **514** of the front shell **138** of the body **102**. The first shelf **512** and the bottom surface **514** act to sandwich the latch **516** therebetween and prevent vertical movement of the latch **516**. This restraint assists in securing the reservoir **104** to the body **102**. The reservoir **104** may be restrained from lateral movement by the flange **171** that seals against the interior surface of the front shell **138**. Thus, when in the locked position, the latch assembly **500** helps to prevent the reservoir **104** from being removed from the body **102**.

(173) To unlock the reservoir **104**, a user slides the button **518** in the DU direction towards the unlock icon **530**. As the button **518** slides, the latch **516** moves correspondingly, and the first finger **526** flexes downward and the nub **524** disengages from the first detent **534** and slides towards the second detent **536**, flexing upwards to seat the nub **524** in the second detent **536**. At the same time, the second finger **528** moves within the track **506** and the tang **520** moves from abutting against the second stop **510** to abutting against the first stop **508**. Once the tang **520** abuts against the first stop **508** and the nub **524** is seated in the second detent **536**, the latch **516** is positioned in the unlock position and adjacent the unlock icon **530**. This lateral movement of the latch **516** within the latch cavity **504** locates the latch **516** so that the latch **516** is no longer positioned between the first shelf **512** and the bottom surface **514** of the front shell **138**. With the latch **516** disengaged from the front shell **138**, a user may move the reservoir **104** vertically downwards away from the body **102** and front shell **138**, disconnecting the flange **171** of the reservoir **104** from its sealed position, allowing the reservoir **104** to be removed.

(174) To secure the reservoir **104** back to the body **102**, the reservoir **104** flange **171** is repositioned

within the body **102** and the bottom surface **502** of the reservoir **104** is aligned with the bottom surface **514** of the front shell **138**. Once aligned, the user slides the button **518** in the lock direction DL towards the lock icon **532**. As the button **518** moves laterally, the latch **516** moves correspondingly and seats between the first shelf **512** and the bottom surface **514** and the fingers **526**, **528** move to the locked positions, with the nub **524** seated in the first detent **534** and the tang **520** positioned adjacent the second stop **510**. In these embodiments, the tang **520** and nub **524** provide haptic and audible feedback to a user to indicate that the latch **516** has moved to the unlocked or locked positions.

(175) It should be noted that in embodiments where the reservoir **104** is removable from the body **102**, other latching or securing mechanisms may be used as well. For example, a spring latch including a molded integral spring body may be used. The type of latch or securing assembly may be varied based on the shape and configuration of the reservoir and body.

(176) Battery Venting

(177) In some embodiments, the oral irrigator includes a venting assembly for the battery compartment. FIGS. **30**A and **30**B illustrate various views of the venting assembly. With reference to FIGS. **30**A and **30**B, the venting assembly **600** is formed as a part of the battery cap **198** and includes a vent **608** that attaches to the battery cap **198**. As will be discussed below, the vent **608** provides mitigation for battery outgassing and will equalize the pressure within the battery compartment. Depending on the configuration of the oral irrigator and batteries, the vent assembly **600** may be positioned on a number of different walls of the battery compartment. However, in the embodiment shown in FIGS. **30**A and **30**B, the venting assembly **600** is formed as part of the battery cap **198**.

(178) With reference to FIGS. **30**A and **30**B, the battery cap **198** in this example includes one or more battery stabilizing walls **604** extending upwards from a top surface **610** of the cap base **602**. The stabilizing walls **604** may be shaped so as to match the diameter and shape of the batteries and may be modified depending on the configuration and desired stabilization of the batteries. The top surface **610** of the cap base **602** may be raised or elevated relative to the edge of the base **602**, which allows the reservoir to have an increased capacity as discussed above. The top surface **610** may also include a plurality of positioning brackets **606***a*, **606***b*, **606***c*, **606***d* that are used to position the vent **608** on the battery cap **198**. The positioning brackets **606***a*, **606***b*, **606***c*, **606***d* may be substantially any type of configuration, but in one embodiment are L or U shaped brackets having rounded corners. The positioning brackets **606***a*, **606***b*, **606***c*, **606***d* may be spaced apart from one another and are typically configured so that the vent **608** can be positioned within a space defined between each of the brackets **606***a*, **606***b*, **606***c*, **606***d*.

(179) With reference to FIG. **30**B, the battery cap **198** also includes a venting aperture **614** defined through the top surface **610** of the cap base **602**. The venting aperture **614** is positioned in generally a central region between each of the positioning brackets **606***a*, **606***b*, **606***c*, **606***d*. The venting aperture **614** has a diameter selected to allow proper venting for the battery cavity and may be determined based on the size, number, and type of batteries used for the oral irrigator **100**.

(180) With continued reference to FIG. **30**B, in some embodiments, the venting assembly **600** may also include an attachment protrusion **612** extending upwards from the top surface **610**. The attachment protrusion **612** may surround the venting aperture **614** but be spaced apart therefrom by a groove **616** concentric with the venting aperture **614**. The attachment protrusion **612** is used to form a seal with the vent **608** as will be discussed in more detail below.

(181) The vent **608** is positioned over the venting aperture **614** and is a material impermeable to fluids, but allows gases and air to pass therethrough. For example, the vent **608** may be a laminated product of porous polytetrafluoroethylene (PTFE) or porous ultra-high-molecular-weight polyethylene (UHMW-PE), such as DeWAL 235ep by DeWal Industries. The vent **608** is sized and shaped so as to cover the vent aperture **614** and may be varied as desired.

(182) With reference to FIGS. **30**A and **30**B, the connection of the venting assembly **600** will now be discussed in more detail. The vent **608** is positioned between the positioning brackets **606***a*, **606***b*, **606***c*, **606***d* and over the vent aperture **614** and the attachment protrusion **612**. The vent **608** typically may be centered over the vent aperture **614**, but as long as the vent **608** is positioned so as to completely cover the vent aperture **614** and the attachment protrusion **612**, it does not need to be

centered (e.g., as shown in FIG. **30**A). Once the vent **608** is aligned with the venting aperture **614** and the attachment protrusion **612**, the vent **608** is attached to the battery cap **198**. For example, a heat staking process may be used that heats the vent **608** and the battery cap **198** so that the material forming the attachment protrusion **612** melts to the vent **608** material and fuses therewith. As the material from the attachment protrusion **612** melts to the battery cap **198**, a seal is formed around the venting aperture **614**, which acts to prevent liquids from entering in or exiting the battery compartment via the venting aperture **614**, as well as secures the vent **608** to the battery cap **198**. After the vent **608** is attached to the battery cap **198**, the battery cap **198** is connected to the oral irrigator as discussed above.

(183) In operation, the venting assembly **600**, in particular the vent **608** and venting aperture **614** allow gasses, such as gases due to outgassing from the batteries, to pass through the battery cap **198** and exit the battery compartment. This allows the pressure within the battery compartment and other locations within the dry compartments to be equalized with ambient pressure. This equalization feature helps to prevent the sealing features, such as the diaphragm seal **274**, from being damaged due to variations in air pressure (e.g., shipping the product from a low altitude to a high altitude).

(184) Conclusion

(185) As discussed above, the oral irrigator of the present disclosure may be waterproof and be able to be immersed within 1 meter of water without damage to the internal components. Further, internal leakage, such as leakage from the pump, may be sealed from reaching any electronic components. In some embodiments, the oral irrigator may also include a waterproofing spray, such as a super-hydrophobic coating, on certain electronic components, such as the batteries, circuit boards, and so on. In these embodiments, the coating may repel water and some fluids and thus further help to prevent damage to the electronic components due to fluid.

(186) It should be noted that any of the features in the various examples and embodiments provided herein may be interchangeable and/or replaceable with any other example or embodiment. As such, the discussion of any component or element with respect to a particular example or embodiment is meant as illustrative only. It should be noted that although the various examples discussed herein have been discussed with respect to oral irrigators, the devices and techniques may be applied in a variety of applications, such as, but not limited to, toothbrushes, bath appliances, or the like.

(187) All directional references (e.g., upper, lower, upward, downward, left, right, leftward, rightward, top, bottom, above, below, vertical, horizontal, clockwise, and counterclockwise) are only used for identification purposes to aid the reader's understanding of the examples of the invention, and do not create limitations, particularly as to the position, orientation, or use of the invention unless specifically set forth in the claims. Joinder references (e.g., attached, coupled, connected, joined and the like) are to be construed broadly and may include intermediate members between the connection of elements and relative movement between elements. As such, joinder references do not necessarily infer that two elements are directly connected and in fixed relation to each other.

(188) In some instances, components are described by reference to “ends” having a particular characteristic and/or being connected with another part. However, those skilled in the art will recognize that the present invention is not limited to components which terminate immediately beyond their point of connection with other parts. Thus the term “end” should be broadly interpreted, in a manner that includes areas adjacent rearward, forward of or otherwise near the terminus of a particular element, link, component, part, member or the like. In methodologies directly or indirectly set forth herein, various steps and operations are described in one possible order of operation but those skilled in the art will recognize the steps and operation may be rearranged, replaced or eliminated without necessarily departing from the spirit and scope of the present invention. It is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative only and not limiting. Changes in detail or structure may be made without departing from the spirit of the invention as defined in the appended claims.

Claims

1. An oral irrigator comprising: a drive assembly received within a housing; a pump assembly positioned at least partially within a pump chamber, the pump assembly comprising a piston, expanding and contracting a piston cavity, and a connecting rod, the connecting rod coupled to the piston and coupled to the drive assembly opposite the piston, the connecting rod movable between first position and a second position through operation of the drive assembly, the first position being substantially at a top of an upstroke where the piston pushes liquid from the pump cavity, the second position being substantially at a bottom of a down-stroke where the piston pulls liquid into the pump cavity; and a flexible membrane seal extending from an interior surface of the pump chamber to the connecting rod, between the piston and the drive assembly, to fluidly seal an open end of the pump chamber, wherein the flexible membrane seal comprises a conical skirt and a crease, formed in the conical skirt, at a bottom of the conical skirt, wherein the crease comprises a depth, and wherein the depth is greatest at the second position and least at the first position.
2. The oral irrigator of claim 1, wherein the pump assembly is positioned at least partially within a wet environment defined by a pump body, and wherein the flexible membrane seal is sealingly connected to the pump body to fluidly seal the drive assembly from the wet environment.
3. The oral irrigator of claim 1, wherein the flexible membrane seal comprises an engagement wall positioned between first and second ribs of the connecting rod.
4. The oral irrigator of claim 1, wherein the drive assembly comprises a gear, and wherein the connecting rod is coupled to the gear such that a rotational movement of the gear causes a longitudinal reciprocal displacement of the connecting rod.
5. The oral irrigator of claim 1, wherein the housing defines an annular groove, and wherein the flexible membrane seal comprises a beaded flange positioned in the annular groove.
6. The oral irrigator of claim 1, wherein the flexible membrane seal does not introduce friction into operation of the piston.
7. The oral irrigator of claim 6, wherein the crease slopes upward to a seal top surface that extends radially outward for a rod aperture that holds the flexible membrane seal to the piston, and slopes upward to a flat top surface of a beaded flange that seals the flexible membrane seal to a bottom end of the pump body.
8. An oral irrigator comprising: a housing defining a dry compartment for receiving a drive assembly; a pump assembly positioned at least partially within a wet environment defined by a pump chamber, the pump assembly comprising a connecting rod extending from the wet environment to the dry compartment with a piston coupled to the connecting rod; and a flexible membrane seal extending from an interior surface of the pump chamber to the connecting rod and across an open end of the pump chamber to fluidly seal the dry compartment from the wet environment, wherein the flexible membrane seal comprises a conical skirt and a crease, formed in the conical skirt, at a bottom of the conical skirt, wherein the crease comprises a depth, and wherein the depth is greatest at a first position of the connecting rod, which is near a bottom of a down-stroke of the piston, and the depth is least at a second position, which is near a top of an upstroke of the piston.
9. The oral irrigator of claim 8, wherein the connecting rod is movable between the first position and the second position through operation of the drive assembly, and wherein the flexible membrane seal deforms from a first orientation to a second orientation as the connecting rod moves from the first position to the second position.
10. The oral irrigator of claim 9, wherein the flexible membrane seal comprises a bellows extending from the interior surface to the connecting rod, the bellows deforming between the first and second orientations as the connecting rod reciprocates between the first and second positions.
11. The oral irrigator of claim 8, wherein the connecting rod comprises first and second ribs, and wherein the flexible membrane seal comprises an engagement wall sealed against an outer surface of the connecting rod between the first and second ribs.
12. The oral irrigator of claim 8, wherein the flexible membrane seal comprises a beaded flange positioned in an annular groove.
13. The oral irrigator of claim 12, wherein the engagement wall moves relative to the beaded flange to

deform the flexible membrane seal as the connecting rod reciprocates between first and second positions.

14. An oral irrigator comprising: a housing defining a compartment; a pump assembly comprising one or more wet components and a connecting rod extending into the compartment; and a flexible membrane seal extending from an interior surface of the housing to an inner portion of an actuation member and deforming to fluidly seal the compartment from the one or more wet components, wherein the flexible membrane seal is a diaphragm seal comprising a conical skirt and a crease, formed in the conical skirt, at a bottom of the conical skirt, the conical skirt and crease deforming to maintain a fluid seal across an open end of a pump housing, wherein the crease comprises a depth, and wherein the depth is greatest at a first position of the connecting rod, which is near a bottom of a down-stroke of the piston, and the depth is least at a second position, which is near a top of an upstroke of the piston.

15. The oral irrigator of claim 14, wherein the flexible membrane seal is made of an elastomeric rubber or a thermoplastic elastomer (TPE).

16. The oral irrigator of claim 14, wherein the housing defines an annular groove, and wherein the flexible membrane seal comprises a beaded flange positioned in the annular groove.

17. The oral irrigator of claim 16, wherein at least some portion of the elastomeric rubber is nitrile butadiene rubber.

18. The oral irrigator of claim 14, wherein the flexible membrane seal comprises an aperture defined by an engagement wall, and wherein the connecting rod extends through the aperture.

19. The oral irrigator of claim 14, wherein the flexible membrane seal is located on the connecting rod between first and second ribs of the connecting rod.

20. The oral irrigator of claim 14, wherein the flexible membrane seal is overmolded to at least one of the actuation member or the housing.