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(54) **THROTTLING METHOD FOR DENTAL IRRIGATOR, THROTTLING SYSTEM, AND METHOD FOR USING SAME**

(71) Applicants: **Bixdo (SH) Healthcare Technology Co.,Ltd.**, Shanghai (CN); **GuangDong Bixdo Health Technology Co.,Ltd.**, Foshan (CN)

(72) Inventor: **Jiaquan FU**, Shanghai (CN)

(73) Assignees: **Bixdo (SH) Healthcare Technology Co.,Ltd.**, Shanghai (CN); **GuangDong Bixdo Health Technology Co.,Ltd.**, Foshan (CN)

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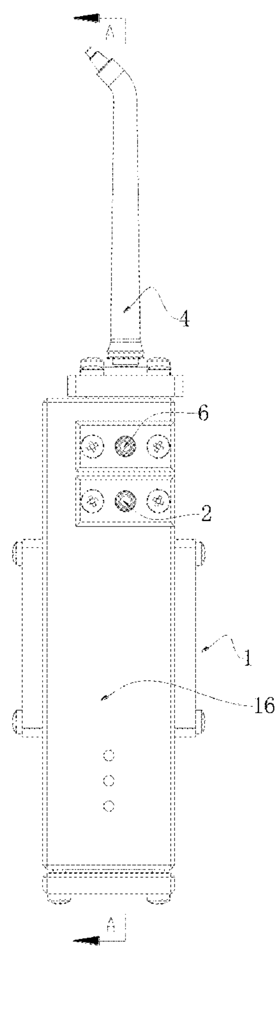
(57) **ABSTRACT**

A throttling method for a dental irrigator, a throttling system, and a method for using the throttling system are provided. The throttling method comprises obtaining flow pulses showing a flow of the dental irrigator varying over time in a pulsatile manner during operation; defining a flow threshold, and dividing a region defined by a flow curve and a time axis within a single pulse cycle into high-flow spraying region and low-flow reflux regions; determining whether a present flow value of the dental irrigator is greater than the flow threshold; if yes, spraying out liquid in a liquid pump device of the dental irrigator through a nozzle; and if not, configuring the dental irrigator such that the liquid in the liquid pump device before and/or after a flow peak flows back to a liquid storage tank of the dental irrigator, making the cleaning liquid's impact on the oral cavity more rhythmic.



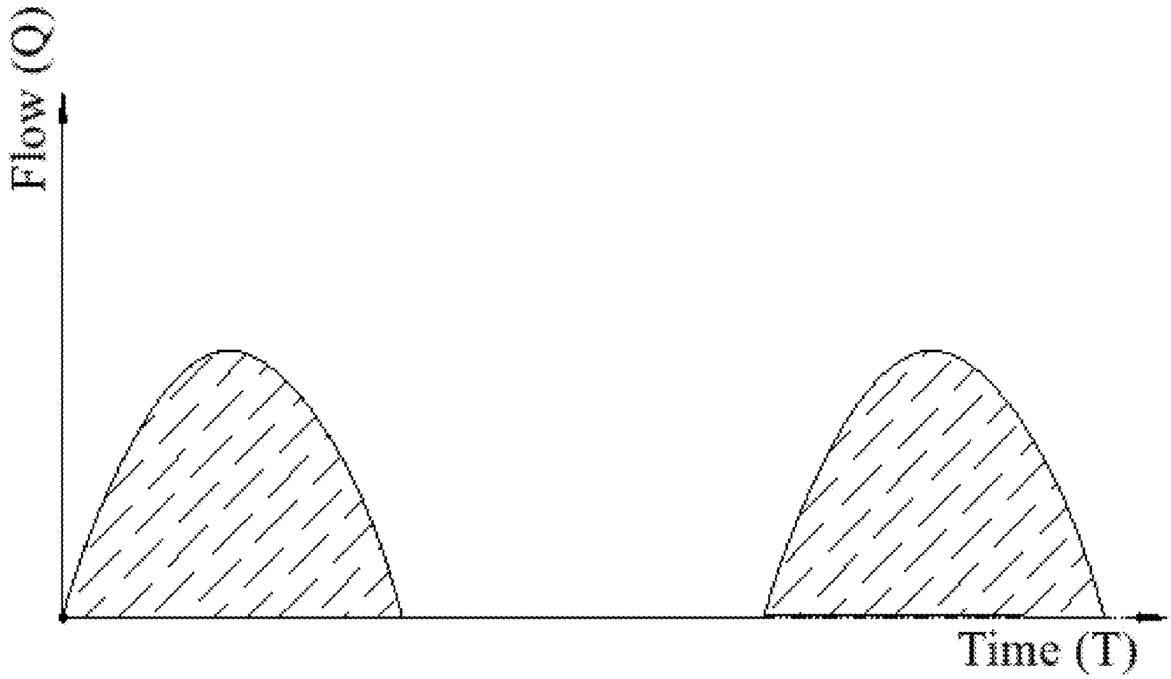


FIG. 1 (prior art)

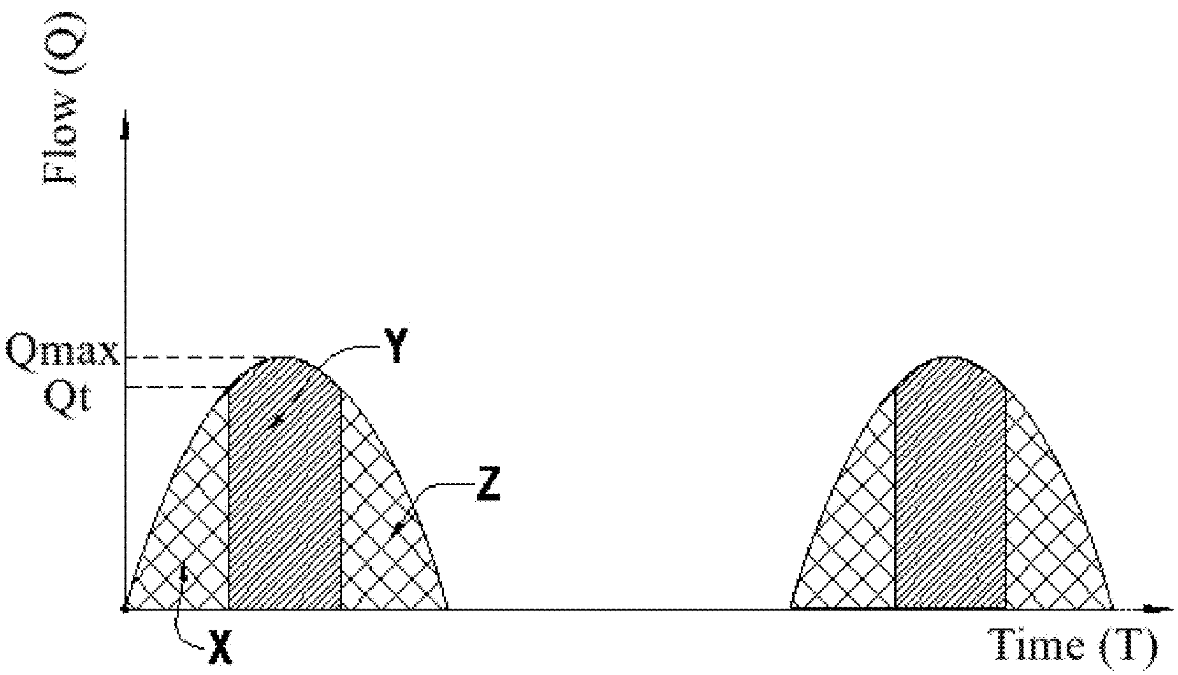


FIG. 2

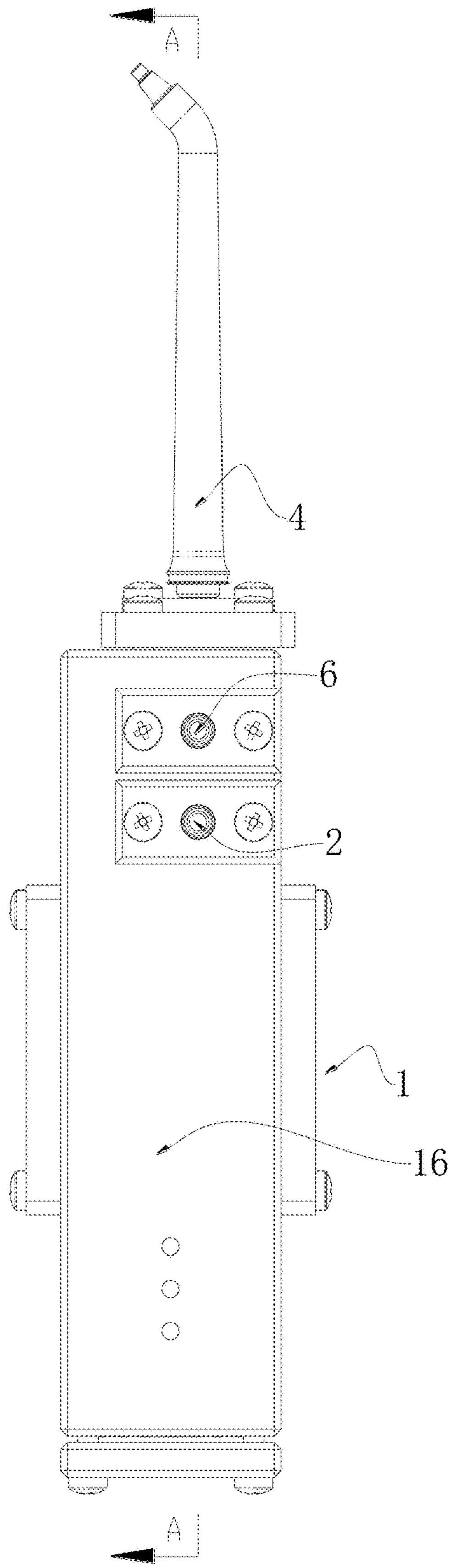


FIG. 3

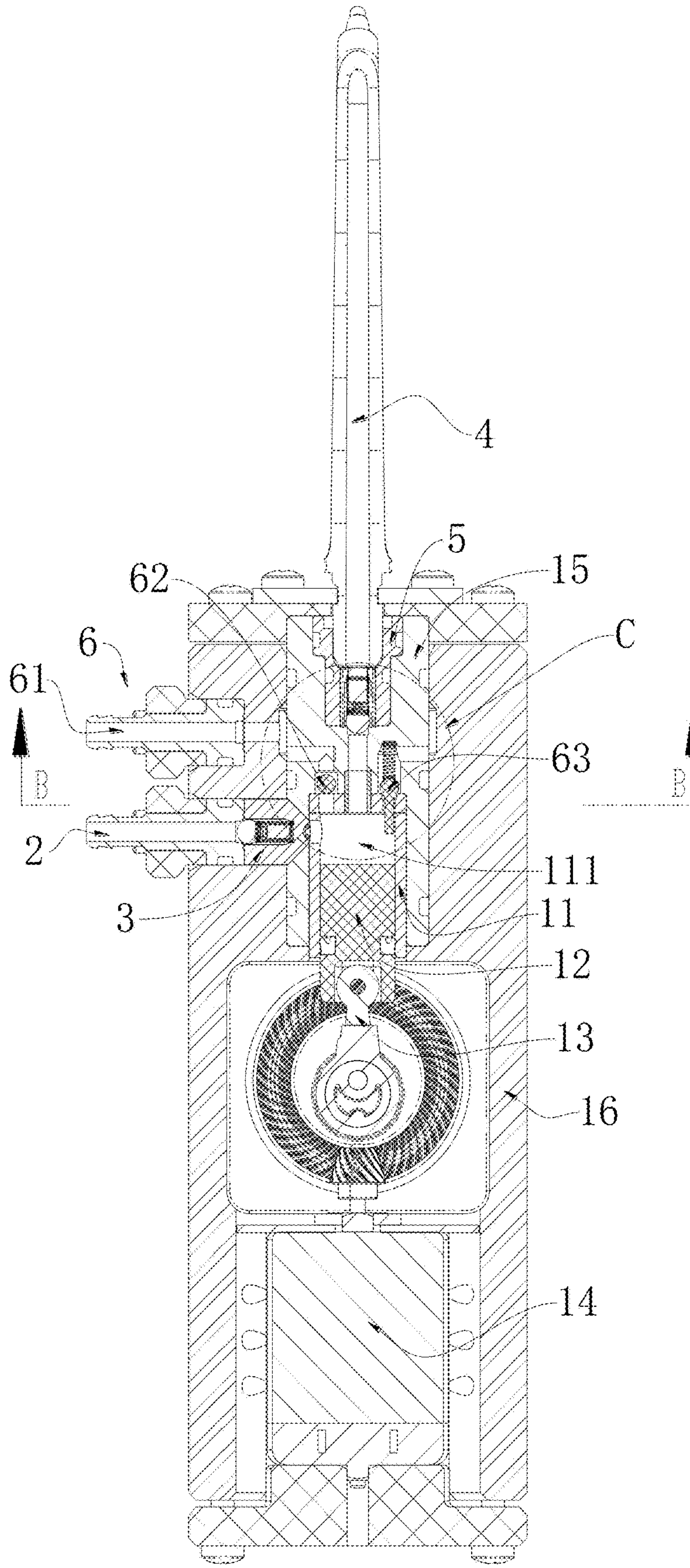


FIG. 4

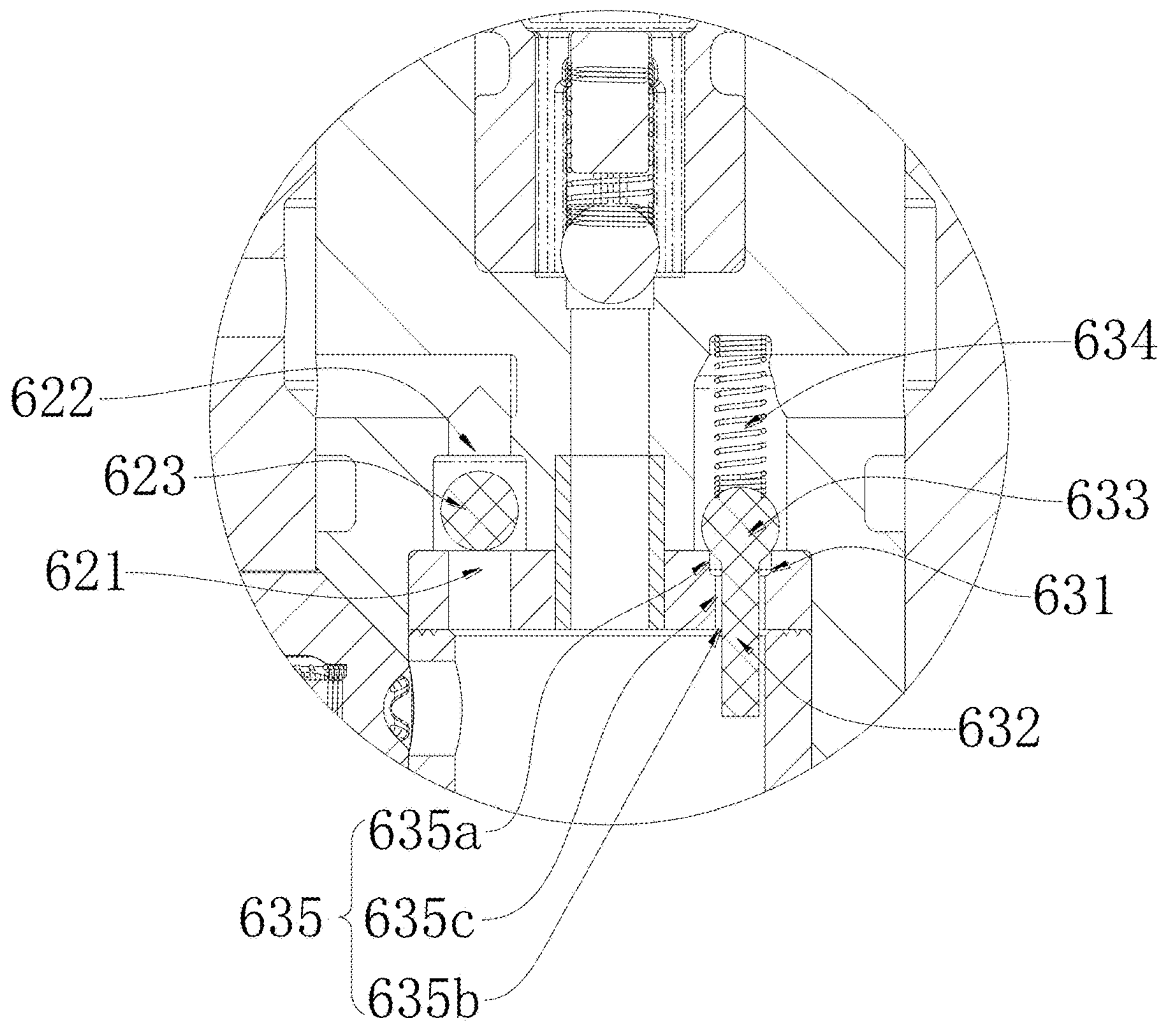


FIG. 5

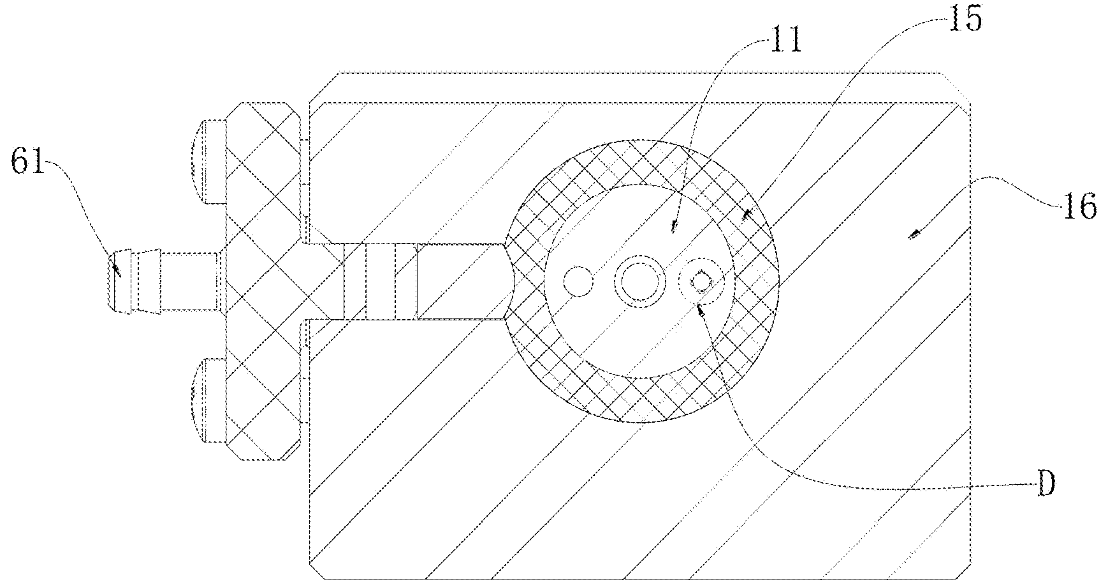


FIG. 6

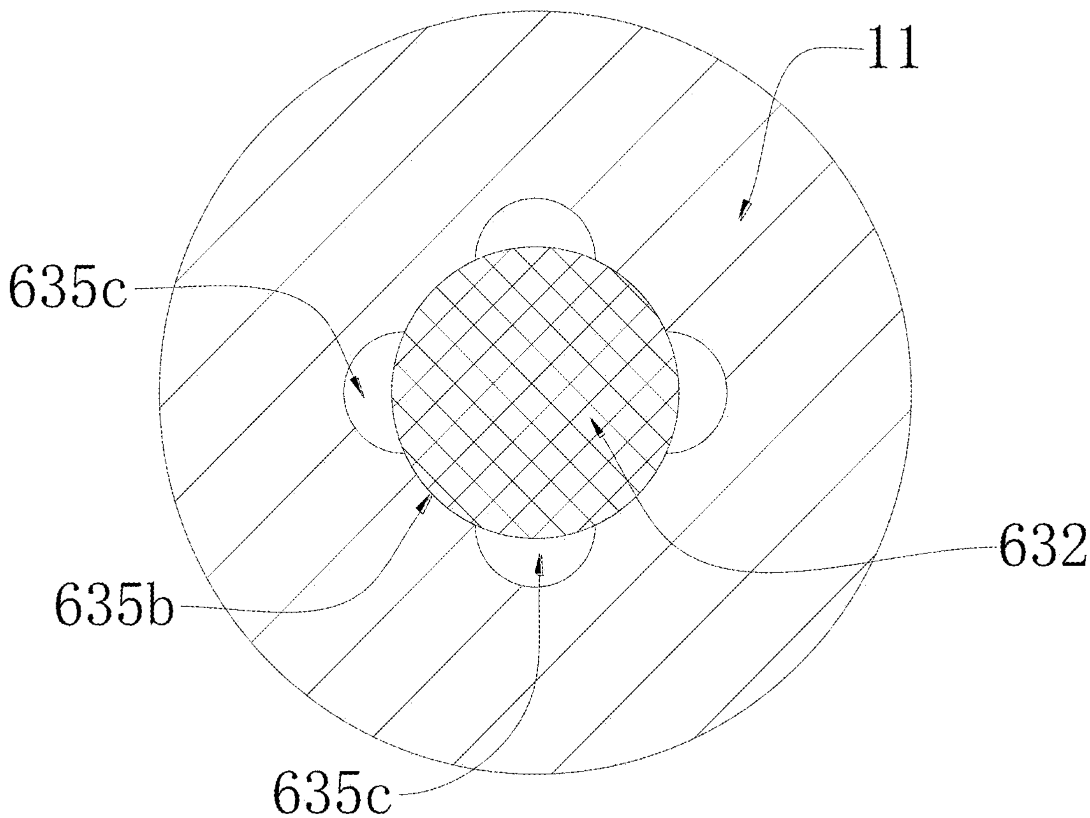


FIG. 7

THROTTLING METHOD FOR DENTAL IRRIGATOR, THROTTLING SYSTEM, AND METHOD FOR USING SAME

FIELD OF THE INVENTION

[0001] The present disclosure relates to the technical field of oral cleaning, and in particular, to a throttling method for a dental irrigator, a throttling system, and a method for using the throttling system.

BACKGROUND OF THE INVENTION

[0002] As living standards improve, people are becoming increasingly conscious of oral hygiene. Among various oral cleaning tools available on the market, dental irrigators have emerged as essential household appliances, serving as substitutes for traditional dental floss. The basic working principle involves using a pump to draw water from a water tank. The extracted water is then sprayed through a nozzle at high pressure several hundred to over a thousand times per minute. This powerful pulsating water stream effectively cleans food debris and dental plaque, and massages the gums, thereby enhancing oral health.

[0003] Traditional pulse-type dental irrigators rely on both pulse and water pressure as key mechanisms for effective cleaning. To achieve optimal cleaning results, it is crucial to maintain a longer duration of pulsating water flow in the dental irrigator.

[0004] FIG. **1** illustrates flow pulses showing a flow of a plunger pump in the dental irrigator varying over time in a pulsatile manner. The flow curve resembles a series of separated "mound structures." The shaded area corresponding to each "mound structure" represents the total flow ejected during one pulse cycle. However, within each pulse cycle, the instantaneous flow (hereinafter referred to as flow) before and/or after the flow peak is not high, and therefore has a low velocity, leading to less impact on the user's oral cavity and weaker cleaning effectiveness. Consequently, water utilization efficiency is suboptimal.

SUMMARY OF THE INVENTION

[0005] In view of the above-mentioned shortcomings, the present disclosure provides a throttling method for a dental irrigator, a throttling system, and a method for using the throttling system, which allow for recycling and reusing portions of oral cleaning liquid before and after flow peaks, enhancing cleaning endurance, reducing the duration of each spray, lengthening each interval between two sprays (i.e., the time when no liquid is sprayed out), and making the oral cleaning liquid's impact on the oral cavity more rhythmic.

[0006] A first aspect of the present disclosure provides a throttling method for a dental irrigator, which comprises steps S1-S3.

[0007] S1 includes obtaining flow pulses showing a flow of the dental irrigator varying over time in a pulsatile manner during operation.

[0008] S2 includes defining a flow threshold, and dividing a single pulse cycle of the flow pulses into a high-flow phase and a low-flow phase, where a maximum flow value of the dental irrigator within the single pulse cycle occurs in the high-flow phase.

[0009] S3 includes determining whether a present flow value of the dental irrigator is greater than the flow threshold; if yes, determining the dental irrigator to be in an oral irrigating mode, and spraying out liquid in a liquid pump device of the dental irrigator through a nozzle; and if not, determining the dental irrigator to be in a reflux throttling mode, where the liquid in the liquid pump device before and/or after a flow peak flows back to a liquid storage tank of the dental irrigator.

[0010] Preferably, S3 is performed by: denoting, a pump chamber pressure of the liquid pump device when the present flow value equals the flow threshold, as a reflux pressure value; determining whether a present pump pressure value of the liquid pump device is greater than the reflux pressure value, if yes, closing a flow channel valve structure between the liquid pump device and the liquid storage tank, and if not, opening the flow channel valve structure.

[0011] Preferably, S3 is performed by: denoting positions of an eccentric wheel of the liquid pump device as P1 and P2 when the present flow value equals the flow threshold, where the eccentric wheel rotates from P1 to P2 in the high-flow phase, and rotates from P2 to P1 in the low-flow phase; determining whether the eccentric wheel is in the high-flow phase, if yes, closing a flow channel valve structure between the liquid pump device and the liquid storage tank, and if not, opening the flow channel valve structure.

[0012] A second aspect of the present disclosure provides a throttling system for implementing the throttling method of the first aspect of the present disclosure, which comprises a liquid pump device, a liquid-inlet flow channel, a nozzle, and a reflux system.

[0013] The liquid pump device comprises a liquid pump cavity and a piston, and the piston reciprocates within a pump chamber of the liquid pump cavity.

[0014] A liquid-inlet end of the liquid-inlet flow channel is communicated with the liquid storage tank, and a liquid-outlet end of the liquid-inlet flow channel is communicated with the pump chamber through a liquid-inlet one-way valve.

[0015] The nozzle is communicated with the pump chamber through a liquid-outlet one-way valve.

[0016] The reflux system comprises a reflux flow channel and a reflux valve assembly. A liquid-inlet end of the reflux flow channel is communicated with the pump chamber through the reflux valve assembly, and a liquid-outlet end of the reflux flow channel is communicated with the liquid storage tank.

[0017] Preferably, the reflux valve assembly comprises a pre-peak reflux valve and/or a post-peak reflux valve, both of which recycle liquid when the piston performs an exhaust stroke. The pre-peak reflux valve recycles liquid that occurs before the high-flow phase and the post-peak reflux valve recycles liquid that occurs after the high-flow phase.

[0018] Preferably, the pre-peak reflux valve comprises a first pre-peak valve seat, a second pre-peak valve seat, and a pre-peak valve core. The first pre-peak valve seat is formed in the liquid pump cavity, the second pre-peak valve seat is formed in the reflux flow channel, and the pre-peak valve core adjusts with hydraulic variations in the pump chamber, floating to establish a liquid-tight connection with the first pre-peak valve seat and/or the second pre-peak valve seat.

[0019] Preferably, the post-peak reflux valve comprises a post-peak valve seat, a slider, a post-peak valve core, and an elastic reset member. The post-peak valve seat is formed in the liquid pump cavity, the slider slidably extends through the post-peak valve seat, the post-peak valve core is disposed in the reflux flow channel and on the slider, and the elastic reset member is disposed between an inner wall of the reflux flow channel and the post-peak valve core. The post-peak valve seat and the post-peak valve core are pressed against each other to form a liquid-tight connection.

[0020] Preferably, the slider extends into the pump chamber along a reciprocating motion direction of the piston, and the slider is configured to be ejected out of the pump chamber by the piston to open the post-peak reflux valve only when the piston performs the exhaust stroke and the present flow value of the dental irrigator is not greater than the flow threshold.

[0021] Preferably, the throttling system further comprises an inlet/outlet adapter disposed outside the liquid pump cavity, and the liquid-inlet one-way valve, the liquid-outlet one-way valve, and the reflux valve assembly are disposed on the inlet/outlet adapter.

[0022] Preferably, the throttling system further comprises a liquid pump housing for mounting the inlet/outlet adapter, and part of the reflux flow channel is formed between the liquid pump housing and the inlet/outlet adapter.

[0023] A third aspect of the present disclosure provides a method for using the throttling system of the second aspect of the present disclosure, comprising: when the present flow value of the dental irrigator is not greater than the flow threshold and before the flow peak occurs, opening the pre-peak reflux valve and closing the post-peak reflux valve, after which the liquid flows back to the liquid storage tank through first the pre-peak reflux valve and then the reflux flow channel; when the present flow value of the dental irrigator is greater than the flow threshold, closing the pre-peak reflux valve and the post-peak reflux valve; when the present flow value of the dental irrigator is not greater than the flow threshold and after the flow peak occurs, closing the pre-peak reflux valve and opening the post-peak reflux valve, after which the liquid flows back to the liquid storage tank through first the post-peak reflux valve and then the reflux flow channel.

[0024] As described above, the throttling method for the dental irrigator, the throttling system, and the method for using the throttling system of the present disclosure have the following beneficial effects.

[0025] Firstly, the flow data of the dental irrigator during operation can be collected by experimental testing methods, obtaining flow pulses showing the flow of the dental irrigator varying over time in a pulsatile manner during operation. In FIG. **2**, the horizontal axis represents time T, and the vertical axis represents flow Q. Secondly, the flow threshold is defined based on the required flushing force of the jet stream during oral cavity irrigation. In FIG. **2**, each region defined by the flow curve and the time axis within a single pulse cycle is divided, by the flow threshold, into one high-flow spraying region (Region Y) and two low-flow reflux regions (Region X and Region Z), with peak data points located within the high-flow spraying region. Here, Q_{max} represents the flow peak, and $Q_{threshold}$ represents the flow threshold. Region X corresponds to the low-flow reflux region before the flow peak, while Region Z corresponds to the low-flow reflux region after the flow peak. Regions X and Z have a lower flow velocity, and their respective total flow can be refluxed. In contrast, Region Y has a higher flow velocity, and its corresponding total flow is used for oral cleaning. Lastly, when users use a dental irrigator, the dental irrigator performs the following throttling method: determining whether the present flow value of the dental irrigator is greater than the flow threshold; if yes, determining the dental irrigator to be in the oral irrigating mode, and spraying out the liquid in the liquid pump device of the dental irrigator through the nozzle; and if not, determining the dental irrigator to be in the reflux throttling mode, where the liquid in the liquid pump device before and/or after the flow peak flows back to the liquid storage tank of the dental irrigator. In other words, in some cases either the oral cleaning liquid before or after flow peaks is refluxed, and in some other cases both are refluxed, avoiding any waste of the oral cleaning liquid. Therefore, compared to the traditional cleaning methods of dental irrigators, the throttling method of the present disclosure allows for recycling and reusing portions of the oral cleaning liquid before and after flow peaks, enhancing cleaning endurance, reducing the duration of each spray, lengthening each interval between two sprays, and making the oral cleaning liquid's impact on the oral cavity more rhythmic.

BRIEF DESCRIPTION OF DRAWINGS

[0026] FIG. **1** shows a graph of flow pulses of a plunger pump of a dental irrigator in the prior art.

[0027] FIG. **2** shows a graph of flow pulses related to a throttling method of the present disclosure.

[0028] FIG. **3** shows a front view of a throttling system of the present disclosure.

[0029] FIG. **4** shows a cross-sectional view along A-A in FIG. **3**.

[0030] FIG. **5** shows an enlarged view of portion C in FIG. **4**.

[0031] FIG. **6** shows a cross-sectional view along B-B in FIG. **4**.

[0032] FIG. **7** shows an enlarged view of portion D in FIG. **6**.

REFERENCE NUMERALS

[0033] **1** Liquid pump device
[0034] **11** Liquid pump cavity
[0035] **111** Pump chamber
[0036] **12** Piston
[0037] **13** Transmission mechanism
[0038] **14** Driving mechanism
[0039] **15** Inlet/outlet adapter
[0040] **16** Liquid pump housing
[0041] **2** Liquid-inlet flow channel
[0042] **3** Liquid-inlet one-way valve
[0043] **4** Nozzle
[0044] **5** Liquid-outlet one-way valve
[0045] **6** Reflux system
[0046] **61** Reflux flow channel
[0047] **62** Pre-peak reflux valve
[0048] **621** First pre-peak valve seat
[0049] **622** Second pre-peak valve seat
[0050] **623** Pre-peak valve core
[0051] **63** Post-peak reflux valve
[0052] **631** Post-peak valve seat
[0053] **632** Slider
[0054] **633** Post-peak valve core
[0055] **634** Elastic reset member
[0056] **635** Post-peak flow-through hole
[0057] **635***a* Large-diameter hole portion
[0058] **635***b* Small-diameter hole portion

[0059] **635**_c_ Post-peak communication slot

DETAILED DESCRIPTION OF THE INVENTION

[0060] The embodiments of the present disclosure will be described below. Those skilled can easily understand disclosure advantages and effects of the present disclosure according to contents disclosed by the specification.

[0061] It should be noted that the structure, ratio, size, etc. shown in the accompanying drawings in this specification are only used to illustrate the content disclosed in the specification for the understanding and reading of those familiar with this technology, and are not intended to limit the implementation of the present invention. Any structural modification, proportional relationship change or size adjustment should still fall within the scope of the present disclosure, given that no effect and objective achievable by the present disclosure are hindered. In the meantime, the terms “upper”, “lower”, “left”, “right”, “intermediate” and “one” as used in this specification are also for convenience of description, and are not intended to limit the scope of the present disclosure, and the change or adjustment of the relative relationship is considered to be within the scope of the present disclosure without substantial changes in technology.

[0062] As shown in FIGS. **2** and **3**, the present disclosure provides a throttling method for a dental irrigator. The throttling method comprises steps S1-S3.

[0063] S1 includes obtaining flow pulses showing a flow of the dental irrigator varying over time in a pulsatile manner during operation.

[0064] S2 includes defining a flow threshold, and dividing a single pulse cycle of the flow pulses into a high-flow phase and a low-flow phase, where a maximum flow value of the dental irrigator within the single pulse cycle occurs in the high-flow phase.

[0065] S3 includes determining whether a present flow value of the dental irrigator is greater than the flow threshold; if yes, determining the dental irrigator to be in an oral irrigating mode, and spraying out liquid in a liquid pump device **1** of the dental irrigator through a nozzle **4**; and if not, determining the dental irrigator to be in a reflux throttling mode, where the liquid in the liquid pump device **1** before and/or after a flow peak flows back to a liquid storage tank (not shown) of the dental irrigator.

[0066] Regarding the present disclosure, firstly, the flow data of the dental irrigator during operation can be collected by experimental testing methods, obtaining the flow pulses showing the flow of the dental irrigator varying over time in a pulsatile manner during operation. Generally, the flow pulses can be represented on a graph, with the horizontal axis representing time T and the vertical axis representing flow Q. Secondly, the flow threshold is defined based on the required flushing force of the jet stream during oral cavity irrigation. In the graph, the region defined by a flow curve and a time axis within a single pulse cycle is divided, by the flow threshold, into one high-flow spraying region (Region Y) and two low-flow reflux regions (Region X and Region Z), with peak data points located within the high-flow spraying region. Referring to FIG. **2**, Q_{max} represents the flow peak, $Q_{threshold}$ (or, Q_t) represents the flow threshold. Besides, X and Z regions are shaded with meshes, while Region Y is shaded with diagonal lines. Additionally, Region X corresponds to the low-flow reflux region (i.e., low-flow phase) before the flow peak, Region Y corresponds to the high-flow spraying region (i.e., high-flow phase), and Region Z corresponds to the low-flow reflux region (i.e., low-flow phase) after the flow peak. Regions X and Z have a lower flow velocity, and their respective total flow can be refluxed. In contrast, Region Y has a higher flow velocity, and its corresponding total flow is used for oral cleaning. Lastly, when users use a dental irrigator, the dental irrigator performs the following throttling method: determining whether the present flow value of the dental irrigator is greater than the flow threshold in real time; if yes, determining the dental irrigator to be in the oral irrigating mode, and spraying out the liquid in the liquid pump device **1** of the dental irrigator through the nozzle **4**; and if not, determining the dental irrigator to be in the reflux throttling mode, where the liquid in the liquid pump device **1** before and/or after the flow peak flows back to the liquid storage tank of the dental irrigator. In other words, in some cases either the oral cleaning liquid before or after flow peak times is refluxed, and in some other cases both are refluxed, avoiding any waste of the oral cleaning liquid.

[0067] Therefore, compared to the traditional cleaning methods of dental irrigators, the throttling method of the present disclosure allows for recycling and reusing portions of the oral cleaning liquid before and after flow peaks, enhancing cleaning endurance, reducing the duration of each spray, lengthening each interval between two sprays, and making the oral cleaning liquid’s impact on the oral cavity more rhythmic.

[0068] In a preferred embodiment, S3 is performed by: denoting, a pump chamber pressure of the liquid pump device **1** when the present flow value equals the flow threshold, as a reflux pressure value; determining whether a present pump pressure value of the liquid pump device **1** is greater than the reflux pressure value, if yes, closing a flow channel valve structure between the liquid pump device **1** and the liquid storage tank, and if not, opening the flow channel valve structure. Specifically, the flow channel valve structure may switch between its open and closed states under the control of a control system of the dental irrigator. Additionally, the flow channel valve structure may also switch its state based on its own pressure performance.

[0069] In another preferred embodiment, S3 is performed by: denoting positions of an eccentric wheel of the liquid pump device **1** as P1 and P2 when the present flow value equals the flow threshold, where the eccentric wheel rotates from P1 to P2 in the high-flow phase, and rotates from P2 to P1 in the low-flow phase; determining whether the eccentric wheel is in the high-flow phase, if yes, closing the flow channel valve structure between the liquid pump device **1** and the liquid storage tank, and if not, opening the flow channel valve structure. During the high-flow phase, a rotation angle of the eccentric wheel is less than 180 degrees, while during the low-flow phase, the rotation angle exceeds 180 degrees. A total rotation angle across both phases sums up to 360 degrees. Instead of relying on the present pump pressure value to determine whether the present flow value of the dental irrigator is greater than the flow threshold, assessing it based on the positions of the eccentric wheel provides a more precise method.

[0070] As shown in FIGS. **3**, **4** and **5**, the present disclosure further provides a throttling system for implementing the above throttling method. The throttling system comprises a liquid pump device **1**, a liquid-inlet flow channel **2**, a nozzle **4**, and a reflux system **6**.

[0071] The liquid pump device **1** comprises a liquid pump cavity **11** and a piston **12**, and the piston **12** reciprocates within a pump chamber **111** of the liquid pump cavity **11**.

[0072] A liquid-inlet end of the liquid-inlet flow channel **2** is communicated with the liquid storage tank, and a liquid-outlet end of the liquid-inlet flow channel **2** is communicated with the pump chamber **111** through a liquid-inlet one-way valve **3**.

[0073] The nozzle **4** is communicated with the pump chamber **111** through a liquid-outlet one-way valve **5**.

[0074] The reflux system **6** comprises a reflux flow channel **61** and a reflux valve assembly. A liquid-inlet end of the reflux flow channel **61** is communicated with the pump chamber **111** through the reflux valve assembly, and a liquid-outlet end of the reflux flow channel **61** is communicated with the liquid storage tank.

[0075] In the present throttling system, when the piston **12** is pulled back to perform a suction stroke, the liquid-outlet one-way valve **5** closes, the liquid-inlet one-way valve **3** opens, and the oral cleaning liquid flows to the pump chamber **111** through first the liquid-inlet flow channel **2** and then the liquid-inlet one-way valve **3**.

[0076] When the piston **12** is pushed out to perform an exhaust stroke, the liquid-outlet one-way valve **5** opens, the liquid-inlet one-way valve **3** closes, and the oral cleaning liquid sprays out through first the liquid-outlet one-way valve **5** and then the nozzle **4**.

[0077] The reflux system **6** operates in at least three manners.

[0078] In a first manner, when the exhaust stroke begins, the reflux valve assembly opens; as the piston **12** is being pushed out, the reflux valve assembly closes before the high-flow phase occurs, and remains closed until the exhaust stroke is finished.

[0079] In a second manner, when the exhaust stroke begins, the reflux valve assembly closes; as the piston **12** is being pushed out, the reflux valve assembly opens after the high-flow phase concludes, and remains open until the exhaust stroke is finished.

[0080] In a third manner, when the exhaust stroke begins, the reflux valve assembly opens; as the piston **12** is being pushed out, the reflux valve assembly closes before the high-flow phase occurs; then as the piston **12** continues its motion, the reflux valve assembly opens again after the high-flow phase concludes, and remains open until the exhaust stroke is finished.

[0081] The liquid pump device **1** further comprises a transmission mechanism **13** and a driving mechanism **14**, and the piston **12** is in transmission connection with the driving mechanism **14** through the transmission mechanism **13**. The driving mechanism **14** drives the piston **12** to perform a reciprocating motion.

[0082] The liquid pump device **1** may be a plunger pump; the transmission mechanism **13** and the driving mechanism **14** may both be existing mechanisms; the transmission mechanism **13** may be an eccentric wheel assembly, and the driving mechanism **14** may be a motor assembly.

[0083] The liquid-inlet one-way valve **3** and the liquid-outlet one-way valve **5** may be ball valves (with reset springs) and valve plates.

[0084] The reflux valve assembly may comprise one or two valves. As an example, the reflux valve assembly comprises a pre-peak reflux valve **62** and/or a post-peak reflux valve **63**, both of which recycle liquid when the piston **12** performs the exhaust stroke. The pre-peak reflux valve **62** recycles liquid that occurs before the high-flow phase and the post-peak reflux valve **63** recycles liquid that occurs after the high-flow phase. It should be noted that term "liquid that occurs before/after the high-flow phase" refers to liquid in the pump chamber **111** with a flow no higher than $Q_{threshold}$. When the exhaust stroke begins, the pre-peak reflux valve **62** opens; as the piston **12** is being pushed out, the pre-peak reflux valve **62** closes before the high-flow phase occurs; then as the piston **12** continues its motion, the post-peak reflux valve **63** opens after the high-flow phase concludes, and remains open until the exhaust stroke is finished.

[0085] To enable automatic state switching for the pre-peak reflux valve **62**, the pre-peak reflux valve **62** comprises a first pre-peak valve seat **621**, a second pre-peak valve seat **622**, and a pre-peak valve core **623**. The first pre-peak valve seat **621** is formed in the liquid pump cavity **11**, the second pre-peak valve seat **622** is formed in the reflux flow channel **61**, and the pre-peak valve core **623** adjusts with hydraulic variations in the pump chamber **111**, floating to establish a liquid-tight connection with the first pre-peak valve seat **621** and/or the second pre-peak valve seat **622**. Specifically, the first pre-peak valve seat **621** has a first pre-peak flow-through hole, and is formed from part of the liquid pump cavity **11**. The second pre-peak valve seat **622** has a second pre-peak flow-through hole, and is formed from an end portion of the reflux flow channel **61**. The pre-peak valve core **623** is configured to block the first pre-peak flow-through hole and/or the second pre-peak flow-through hole.

[0086] When the liquid pump cavity **11** sucks liquid, the pre-peak valve core **623** rests on the first pre-peak valve seat **621**, enhancing the suction capability of the liquid pump cavity **11**. When the liquid pump cavity **11** exhausts liquid, initially, the pre-peak valve core **623** is neither on the second pre-peak valve seat **622** nor on the first pre-peak valve seat **621** (that is, the pre-peak reflux valve **62** is in an open state); as an internal pressure of the pump chamber **111** increases, the liquid flows back to the reflux flow channel **61** through the pre-peak valve core **623**, driving the pre-peak valve core **623** toward the second pre-peak valve seat **622** until it completely blocks the second pre-peak flow-through hole. By adjusting a spacing between the first pre-peak valve seat **621** and the second pre-peak valve seat **622**, a size or weight of the pre-peak valve core **623**, and a gap between the pre-peak valve core **623** and an inner wall of the pre-peak reflux valve **62**, the pre-peak valve core **623** can be controlled to completely block the second pre-peak flow-through hole before the flow peak occurs, in a precise manner.

[0087] If the gap between the pre-peak valve core **623** and the inner wall of the pre-peak reflux valve **62** is small, a volume resulting from a motion of the pre-peak valve core **623** (which is the product of its cross-sectional area and its motion distance) approximately matches a volume decrease of the liquid before the flow peak occurs.

[0088] Specifically, the first pre-peak flow-through hole is disposed at a top portion of the liquid pump cavity **11**, and a chamber of the pre-peak reflux valve **62** is at a junction of the liquid pump cavity **11** and the reflux flow channel **61**. The pre-peak valve core **623** may be spherical.

[0089] To enable automatic state switching for the post-peak reflux valve **63**, the post-peak reflux valve **63** comprises a post-peak valve seat **631**, a slider **632**, a post-peak valve core **633**, and an elastic reset member (such as compression springs) **634**. The post-peak valve seat **631** is formed in the liquid pump cavity **11**, the slider **632** slidably extends through the post-peak valve seat **631**, the post-peak valve core **633** is disposed in the reflux flow channel **61** and on the slider **632**, and the elastic reset member **634** is disposed between an inner wall of the reflux flow channel **61** and the post-peak valve core **633**. The post-peak valve seat **631** and the post-peak valve core **633** are pressed against each other to form a liquid-tight connection. The post-peak valve seat **631** has a post-peak flow-through hole **635**.

[0090] When the post-peak valve core **633** is pressed against the post-peak valve seat **631** under the elastic force of the elastic reset member **634**, the post-peak reflux valve **63** switches to a closed state. After the flow peak, when the post-peak valve core **633** overcomes the elastic force of the elastic reset member **634**, the post-peak valve core **633** can move away from the post-peak valve seat **631**, and the post-peak reflux valve **63** switches to an open state.

[0091] To simplify the above switching manner for the post-peak reflux valve **63**, the slider **632** extends into the pump chamber **111** along a reciprocating motion direction of the piston **12**, and the slider **632** is configured to be pushed out of the pump chamber **111** by the piston **12** to open the post-peak reflux valve **63** only when the piston **12** performs the exhaust stroke and the present flow value of the dental irrigator is not greater than the flow threshold.

[0092] Specifically, the normal internal pressure of the pump chamber **111** is insufficient to move the post-peak valve core **633** away from the post-peak valve seat **631**. When the nozzle **4** is blocked, the internal pressure of the pump chamber **111** increases until it reaches a preset pressure, at which time the internal pressure of the pump chamber **111** is released through relief valves (may be existing relief valves) of the dental irrigator.

[0093] When the liquid pump cavity **11** exhausts the liquid, after the flow peak, the piston **12** reaches a preset position. Subsequently, the slider **632** is configured to be pushed out of the liquid pump cavity **11** by the piston **12**. Since the post-peak valve core **633** moves synchronously with the slider **632**, the post-peak valve core **633** moves away from the post-peak valve seat **631**, thereby achieving forced pressure release, during which time portions of the liquid flow back to the liquid storage tank through the reflux flow channel **61**, reducing the liquid that occurs after the flow peak. Additionally, the slider **632** serves as a motion guide, ensuring precise movement of the post-peak valve core **633** after the flow peak and enhancing liquid-tightness and stability. In some specific embodiments, the slider **632** is cylindrical. The slider **632** slidably extends through the post-peak flow-through hole **635**. Furthermore, as shown in FIGS. **5**, **6** and **7**, the post-peak flow-through hole **635** has a two-stage stepped structure. The post-peak flow-through hole **635** comprises a large-diameter hole portion **635***a* and a small-diameter hole portion **635***b* communicated with each other. A hole wall of the small-diameter hole portion **635***b* is provided with a post-peak communication slot **635***c*, and the large-diameter hole portion **635***a* is blocked by the post-peak valve core **633**. The small-diameter hole portion **635***b* is slidably arranged on and around the slider **632**, and the large-diameter hole portion **635***a* is communicated with the pump chamber **111** through the post-peak communication slot **635***c*.

[0094] To enhance the structural integration of the throttling system, the throttling system further comprises an inlet/outlet adapter **15** disposed outside the liquid pump cavity **11**. The liquid-inlet one-way valve **3**, the liquid-outlet one-way valve **5**, and the reflux valve assembly are disposed on the inlet/outlet adapter **15**.

[0095] To facilitate the connection between the reflux flow channel **61** and the liquid pump cavity **11**, the throttling system further comprises a liquid pump housing **16** for mounting the inlet/outlet adapter **15**, and part of the reflux flow channel **61** is formed between the liquid pump housing **16** and the inlet/outlet adapter **15**.

[0096] The present disclosure also provides a method for using the above throttling system, comprising:

[0097] when the present flow value of the dental irrigator is not greater than the flow threshold and before the flow peak occurs, opening the pre-peak reflux valve **62** and closing the post-peak reflux valve **63**, after which the liquid flows back to the liquid storage tank through first the pre-peak reflux valve **62** and then the reflux flow channel **61**; exemplarily, the flow of the dental irrigator is an inlet flow of the dental irrigator, and is sensed by flow sensors disposed at an inlet of the dental irrigator; or the flow of the dental irrigator is an internal flow of the dental irrigator, and is sensed by flow sensors disposed in the pump chamber **11** of the dental irrigator.

[0098] when the present flow value of the dental irrigator is greater than the flow threshold, closing the pre-peak reflux valve **62** the post-peak reflux valve **63**;

[0099] when the present flow value of the dental irrigator is not greater than the flow threshold and after the flow peak occurs, closing the pre-peak reflux valve **62** and opening the post-peak reflux valve **63**, after which the liquid flows back to the liquid storage tank through first the post-peak reflux valve **63** and then the reflux flow channel **61**.

[0100] The throttling method of the present disclosure allows for recycling and reusing portions of the oral cleaning liquid before and after flow peaks, enhancing cleaning endurance, reducing the duration of each spray, lengthening each interval between two sprays, and making the oral cleaning liquid's impact on the oral cavity more rhythmic.

[0101] In summary, the throttling method of the present disclosure allows for recycling and reusing portions of the oral cleaning liquid before and after flow peaks, enhancing cleaning endurance, reducing the duration of each spray, lengthening each interval between two sprays, and making the oral cleaning liquid's impact on the oral cavity more rhythmic. Therefore, the present disclosure effectively overcomes various shortcomings in the existing technology and has high industrial utilization value.

[0102] The above-mentioned embodiments are for exemplarily describing the principle and effects of the present disclosure instead of limiting the present disclosure. Those skilled in the art can make modifications or changes to the above-mentioned embodiments without going against the spirit and the range of the present disclosure. Therefore, all equivalent modifications or changes made by those who have common knowledge in the art without departing from the spirit and technical concept disclosed by the present disclosure shall be still covered by the scope of the present disclosure.

1. A throttling method for a dental irrigator, comprising:
S1: obtaining flow pulses showing a flow of the dental irrigator varying over time in a pulsatile manner during operation;
S2: defining a flow threshold, and dividing a single pulse cycle of the flow pulses into a high-flow phase and a low-flow phase; wherein a maximum flow value of the dental irrigator within the single pulse cycle occurs in the high-flow phase;
S3: determining whether a present flow value of the dental irrigator is greater than the flow threshold; if yes, determining the dental irrigator to be in an oral irrigating mode, and spraying out liquid in a liquid pump device (**1**) of the dental irrigator through a nozzle (**4**); and if not, determining the dental irrigator to be in a reflux throttling mode, where the liquid in the liquid pump device (**1**) before and/or after a flow peak flows back to a liquid storage tank of the dental irrigator.

2. The throttling method according to claim **1**, wherein S3 is performed by:
denoting, a pump chamber pressure of the liquid pump device (**1**) when the present flow value equals the flow threshold, as a reflux pressure value;
determining whether a present pump pressure value of the liquid pump device (**1**) is greater than the reflux pressure value, if yes, closing a flow channel valve structure between the liquid pump device (**1**) and the liquid storage tank, and if not, opening the flow channel valve structure.

3. The throttling method according to claim **1**, wherein S3 is performed by:
denoting positions of an eccentric wheel of the liquid pump device (**1**) as P1 and P2 when the present flow value equals the flow threshold, wherein the eccentric wheel rotates from P1 to P2 in the high-flow phase, and rotates from P2 to P1 in the low-flow phase;
determining whether the eccentric wheel is in the high-flow phase, if yes, closing a flow channel valve structure between the liquid pump device (**1**) and the liquid storage tank, and if not, opening the flow channel valve structure.

4. A throttling system for implementing a throttling method according to claim **1**, comprising:
a liquid pump device (**1**) comprising a liquid pump cavity (**11**) and a piston (**12**), wherein the piston (**12**) reciprocates within a pump chamber (**111**) of the liquid pump cavity (**11**);
a liquid-inlet flow channel (**2**), wherein a liquid-inlet end of the liquid-inlet flow channel (**2**) is communicated with the liquid storage tank, and a liquid-outlet end of the liquid-inlet flow channel (**2**) is communicated with the pump chamber (**111**) through a liquid-inlet one-way valve (**3**);
a nozzle (**4**) communicated with the pump chamber (**111**) through a liquid-outlet one-way valve (**5**); and
a reflux system (**6**) comprising a reflux flow channel (**61**) and a reflux valve assembly, wherein a liquid-inlet end of the reflux flow channel (**61**) is communicated with the pump chamber (**111**) through the reflux valve assembly, and a liquid-outlet end of the reflux flow channel (**61**) is communicated with the liquid storage tank.

5. The throttling system according to claim **4**, wherein the reflux valve assembly comprises a pre-peak reflux valve (**62**) and/or a post-peak reflux valve (**63**), both of which recycle liquid when the piston (**12**) performs an exhaust stroke, wherein the pre-peak reflux valve (**62**) recycles liquid that occurs before the high-flow phase and the post-peak reflux valve (**63**) recycles liquid that occurs after the high-flow phase.

6. The throttling system according to claim **5**, wherein the pre-peak reflux valve (**62**) comprises a first pre-peak valve seat (**621**), a second pre-peak valve seat (**622**), and a pre-peak valve core (**623**), wherein the first pre-peak valve seat (**621**) is formed in the liquid pump cavity (**11**), the second pre-peak valve seat (**622**) is formed in the reflux flow channel (**61**), and the pre-peak valve core (**623**) adjusts with hydraulic variations in the pump chamber (**111**), floating to establish a liquid-tight connection with the first pre-peak valve seat (**621**) and/or the second pre-peak valve seat (**622**).

7. The throttling system according to claim **5**, wherein the post-peak reflux valve (**63**) comprises a post-peak valve seat (**631**), a slider (**632**), a post-peak valve core (**633**), and an elastic reset member (**634**), wherein the post-peak valve seat (**631**) is formed in the liquid pump cavity (**11**), the slider (**632**) slidably extends through the post-peak valve seat (**631**), the post-peak valve core (**633**) is disposed in the reflux flow channel (**61**) and on the slider (**632**), and the elastic reset member (**634**) is disposed between an inner wall of the reflux flow channel (**61**) and the post-peak valve core (**633**), wherein the post-peak valve seat (**631**) and the post-peak valve core (**633**) are pressed against each other to form a liquid-tight connection.

8. The throttling system according to claim **7**, wherein the slider (**632**) extends into the pump chamber (**111**) along a reciprocating motion direction of the piston (**12**), and the slider (**632**) is configured to be ejected out of the pump chamber (**111**) by the piston (**12**) to open the post-peak reflux valve (**63**) only when the piston (**12**) performs the exhaust stroke and the present flow value of the dental irrigator is not greater than the flow threshold.

9. The throttling system according to claim **4**, wherein the throttling system further comprises an inlet/outlet adapter (**15**) disposed outside the liquid pump cavity (**11**), wherein the liquid-inlet one-way valve (**3**), the liquid-outlet one-way valve (**5**), and the reflux valve assembly are disposed on the inlet/outlet adapter (**15**).

10. The throttling system according to claim **9**, wherein the throttling system further comprises a liquid pump housing (**16**) for mounting the inlet/outlet adapter (**15**), and part of the reflux flow channel (**61**) is formed between the liquid pump housing (**16**) and the inlet/outlet adapter (**15**).

11. A method for using a throttling system according to claim **5**, comprising:
when the present flow value of the dental irrigator is not greater than the flow threshold and before the flow peak occurs, opening the pre-peak reflux valve (**62**) and closing the post-peak reflux valve (**63**), after which the liquid flows back to the liquid storage tank through first the pre-peak reflux valve (**62**) and then the reflux flow channel (**61**);
when the present flow value of the dental irrigator is greater than the flow threshold, closing the pre-peak reflux valve (**62**) and the post-peak reflux valve (**63**);
when the present flow value of the dental irrigator is not greater than the flow threshold and after the flow peak

occurs, closing the pre-peak reflux valve (**62**) and opening the post-peak reflux valve (**63**), after which the liquid flows back to the liquid storage tank through first the post-peak reflux valve (**63**) and then the reflux flow channel (**61**).

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