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COMPACT LIQUID-OUTLET SYSTEM AND ORAL CLEANING METHOD

Abstract

A compact liquid-outlet system comprising a liquid pump device, a liquid-inlet flow channel, and a liquid-outlet flow channel and an oral cleaning method. The liquid pump device comprises a liquid pump cavity, a piston slidably disposed in the liquid pump cavity, and a piston rod. The piston rod extends through the liquid pump cavity in a liquid-tight manner and is connected to the piston. The piston divides a pump chamber of the liquid pump cavity into a rod chamber and a rodless chamber. The piston comprises a liquid-outlet one-way valve allowing only liquid to flow from the rod chamber to the rodless chamber. The liquid-inlet flow channel communicates with the rod chamber through a liquid-inlet one-way valve. The liquid-outlet flow channel communicates with the rodless chamber. This system eliminates the need of extra space for installing the liquid-outlet one-way valve, resulting in a more compact structure.

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Background/Summary

FIELD OF THE INVENTION

[0001] The present disclosure relates to the technical field of oral cleaning, and in particular, to a compact liquid-outlet system and an oral cleaning method.

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. Their basic working principle involves using a pump to draw water from a water tank, and 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] The water flow of the traditional dental irrigator is low both before and after the flow peak, resulting in weak water pressure and inefficient water usage. Additionally, due to the bulky design of the pump structure, the traditional dental irrigator is not convenient for carrying or gripping.

SUMMARY OF THE INVENTION

[0005] In view of the above-mentioned shortcomings, the present disclosure provides a compact liquid-outlet system and an oral cleaning method, which eliminates the need of extra space for installing the liquid-outlet one-way valve, resulting in a more compact structure, especially beneficial for small products like portable dental irrigators.

[0006] The compact liquid-outlet system comprises a liquid pump device, a liquid-inlet flow channel, and a liquid-outlet flow channel.

[0007] The liquid pump device comprises a liquid pump cavity, a piston, and a piston rod. The piston is slidably disposed in the liquid pump cavity, and the piston rod extends through the liquid pump cavity in a liquid-tight manner and is connected to the piston. The piston divides a pump chamber of the liquid pump cavity into a rod chamber and a rodless chamber. The piston comprises a liquid-outlet one-way valve allowing only liquid to flow from the rod chamber to the rodless chamber.

[0008] The liquid-inlet flow channel is communicated with the rod chamber through a liquid-inlet one-way valve.

[0009] The liquid-outlet flow channel is communicated with the rodless chamber.

[0010] Preferably, the liquid-outlet one-way valve comprises a liquid-outlet valve chamber, a liquid-outlet valve core, and a liquid-outlet valve seat. The liquid-outlet valve chamber is formed in the piston and has an opening facing the rodless chamber, the liquid-outlet valve core is floatingly disposed in the liquid-outlet valve chamber, and the liquid-outlet valve seat is formed in the piston and is disposed at a side of the liquid-outlet valve chamber away from the rodless chamber. The

liquid-outlet valve seat is provided with an overflow hole for communicating the liquid-outlet valve chamber and the rod chamber. The liquid-outlet valve core abuts the liquid-outlet valve seat when the piston performs an exhaust stroke, and the liquid-outlet valve core is spaced apart from the liquid-outlet valve seat when the piston performs a suction stroke.

[0011] Preferably, the compact liquid-outlet system further comprises a nozzle communicated with the liquid-outlet flow channel. The rodless chamber is in a negative pressure state when the piston performs a suction stroke, during which time a volume increase of the rodless chamber is greater than a volume decrease of the rod chamber.

[0012] Preferably, the compact liquid-outlet system further comprising a release system. The release system comprises a release flow channel and a post-peak release mechanism. The release flow channel is communicated with the rodless chamber, and the post-peak release mechanism is configured to block the release flow channel. The post-peak release mechanism is configured to open the release flow channel only when the piston performs the exhaust stroke and after a flow peak occurs in the liquid pump device.

[0013] Preferably, the post-peak release mechanism comprises a moving rod and an elastic reset member. The moving rod extends through the liquid pump cavity, and the elastic reset member is configured for driving the moving rod to reset. A first end of the moving rod is provided with a release valve core for blocking the release flow channel, and a second end of the moving rod is provided with a top-abutting member. The top-abutting member abuts the liquid-outlet one-way valve or the piston after the flow peak occurs in the liquid pump device.

[0014] Preferably, the release flow channel comprises a vertical flow channel segment and a transverse flow channel segment. The vertical flow channel segment extends along an axial direction of the liquid pump cavity to communicate with the rodless chamber, and the transverse flow channel segment extends along a radial direction of the liquid pump cavity to communicate with the vertical flow channel segment. The moving rod extends through the vertical flow channel segment in a clearance manner, and the top-abutting member extends into the rodless chamber or the liquid-outlet valve chamber to limit the liquid-outlet valve core in the liquid-outlet valve chamber.

[0015] Preferably, the liquid pump cavity comprises a liquid-inlet adapter and a liquid-outlet adapter socketed to each other, and a first groove structure of the liquid-inlet adapter and a second groove structure of the liquid-outlet adapter jointly define the pump chamber of the liquid pump cavity.

[0016] Preferably, the liquid-outlet flow channel comprises a nozzle jack and a guiding channel both formed in the liquid pump cavity, and the guiding channel is communicated with the nozzle jack and the rodless chamber, respectively.

[0017] Preferably, the liquid pump cavity is provided with a first sealing ring and a second sealing ring. The first sealing ring is slidably arranged around the piston in a liquid-tight manner, the second sealing ring is slidably arranged around the piston rod in a liquid-tight manner, and a maximum sealing pressure of the first sealing ring is greater than a maximum sealing pressure of the second sealing ring.

[0018] The oral cleaning method applies the above compact liquid-outlet system, and is performed by: pulling back the piston through the piston rod to perform the suction stroke, closing the liquid-inlet one-way valve, and opening the liquid-outlet one-way valve, such that liquid in the rod chamber flows to the rodless chamber through the liquid-outlet one-way valve, and liquid in the nozzle flows back to the rodless chamber; pushing out the piston through the piston rod to perform the exhaust stroke, opening the liquid-inlet one-way valve, and closing the liquid-outlet one-way valve, such that liquid in the liquid-inlet flow channel flows to the rod chamber through the liquid-inlet one-way valve, and liquid in the rodless chamber flows to the nozzle through the liquid-outlet flow channel; part of the liquid in the rodless chamber flows back to a liquid storage tank through the release flow channel after the flow peak occurs in the liquid pump device.

[0019] As decreased above, the compact liquid-outlet system and the oral cleaning method of the present disclosure have the following beneficial effects. When the piston is pulled back through the piston rod to perform the suction stroke, an internal pressure of the rod chamber increases and an internal pressure of the rodless chamber decreases, during which time the liquid-inlet one-way valve switches to a closed state and the liquid-outlet one-way valve switches to an open state, such that liquid in the rod chamber can overcome a closing pre-tightening force of the liquid-outlet one-way valve and flow into the rodless chamber. When the piston is pushed out through the piston rod to perform the exhaust stroke, the internal pressure of the rod chamber decreases and the internal pressure of the rodless chamber increases, the liquid-inlet one-way valve switches to an open state, and liquid in the liquid-inlet flow channel can overcome a closing pre-tightening force of the liquid-inlet one-way valve and flow into the rod chamber, during which time the liquid-outlet one-way valve switches to a closed state, and liquid in the rodless chamber is squeezed into the liquid-outlet flow channel through the piston. One major innovation of the compact liquid-outlet system lies in the setting of the liquid-outlet one-way valve. The liquid-outlet one-way valve is integrated in the internal structure of the piston within the liquid pump device, resulting in a more compact design, which is particularly beneficial for small products like portable dental irrigators. Therefore, the compact liquid-outlet system of the present disclosure eliminates the need of extra space for installing the liquid-outlet one-way valve, resulting in a more compact structure, especially beneficial for small products like portable dental irrigators. Additionally, the oral cleaning method of the present disclosure conserves liquid before and/or after flow peaks, enhancing convenience during oral hygiene procedures.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0020] FIG. **1** shows a front view of a compact liquid-outlet system of the present disclosure.

[0021] FIG. **2** shows a cross-sectional view of the compact liquid-outlet system along A-A in FIG. **1** during a suction stroke.

[0022] FIG. **3** shows a cross-sectional view of the compact liquid-outlet system along B-B in FIG. **2** during the suction stroke.

[0023] FIG. **4** shows a cross-sectional view of the compact liquid-outlet system along A-A in FIG. **1** during an exhaust stroke.

[0024] FIG. **5** shows an enlarged view of portion C in FIG. **4**.

[0025] FIG. **6** shows a cross-sectional view of the compact liquid-outlet system along B-B in FIG. **2** during the exhaust stroke.

[0026] FIG. **7** shows an enlarged view of portion D in FIG. **6**.

[0027] FIG. **8** shows an assembly diagram of a liquid-outlet adapter and a nozzle.

[0028] FIG. **9** shows a first perspective view of the liquid-outlet adapter.

[0029] FIG. **10** shows a second perspective view of the liquid-outlet adapter.

[0030] FIG. **11** shows an exploded view of a post-peak release mechanism, a liquid-outlet one-way valve, a piston, and a piston rod.

REFERENCE NUMERALS

[0031] **1** Liquid pump device [0032] **11** Liquid pump cavity [0033] **111** Liquid-inlet adapter [0034] **112** Liquid-outlet adapter [0035] **12** Piston [0036] **13** Piston rod [0037] **14** Rod chamber [0038] **15** Rodless chamber [0039] **16** First sealing ring [0040] **17** Second sealing ring [0041] **18** Transmission mechanism [0042] **19** Driving mechanism [0043] **2** Liquid-outlet one-way valve [0044] **21** Liquid-outlet valve chamber [0045] **22** Liquid-outlet valve core [0046] **23** Liquid-outlet valve seat [0047] **231** Overflow hole [0048] **3** Liquid-inlet flow channel [0049] **4** Liquid-inlet one-way valve [0050] **5** Liquid-outlet flow channel [0051] **51** Nozzle jack [0052] **52** Guiding channel

[0053] **6** Nozzle [0054] **7** Release system [0055] **71** Release flow channel [0056] **711** Vertical flow channel segment [0057] **712** Transverse flow channel segment [0058] **72** Post-peak release mechanism [0059] **721** Moving rod [0060] **722** Elastic reset member [0061] **723** Release valve core [0062] **724** Top-abutting member

DETAILED DESCRIPTION OF THE INVENTION

[0063] 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.

[0064] 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 restrict 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 restrict 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.

[0065] As shown in FIGS. **1**-**7**, the present disclosure provides a compact liquid-outlet system. The compact liquid-outlet system comprises a liquid pump device **1**, a liquid-inlet flow channel **3**, and a liquid-outlet flow channel **5**.

[0066] The liquid pump device **1** comprises a liquid pump cavity **11**, a piston **12**, and a piston rod **13**. The piston **12** is slidably disposed in the liquid pump cavity **11**, and the piston rod **13** extends through the liquid pump cavity **11** in a liquid-tight manner and is connected to the piston **12**. The piston **12** divides a pump chamber of the liquid pump cavity **11** into a rod chamber **14** and a rodless chamber **15**. The piston **12** comprises a liquid-outlet one-way valve **2** allowing only liquid to flow from the rod chamber **14** to the rodless chamber **15**.

[0067] The liquid-inlet flow channel **3** is communicated with the rod chamber **14** through a liquid-inlet one-way valve **4**.

[0068] The liquid-outlet flow channel **5** is communicated with the rodless chamber **15**.

[0069] Referring to FIGS. **2** and **3**, when the piston **12** is pulled back through the piston rod **13** to perform a suction stroke, an internal pressure of the rod chamber **14** increases and an internal pressure of the rodless chamber **15** decreases, during which time the liquid-inlet one-way valve **4** switches to a closed state and the liquid-outlet one-way valve **2** switches to an open state, such that liquid in rod chamber **14** can overcome a closing pre-tightening force of the liquid-outlet one-way valve **2** and flow into the rodless chamber **15**.

[0070] Referring to FIGS. **4**, **5**, **6** and **7**, when the piston **12** is pushed out through the piston rod **13** to perform the exhaust stroke, the internal pressure of the rod chamber **14** decreases and the internal pressure of the rodless chamber **15** increases, the liquid-inlet one-way valve **4** switches to an open state, and liquid in liquid-inlet flow channel **3** can overcome a closing pre-tightening force of the liquid-inlet one-way valve **4** and flow into the rod chamber **14**, during which time the liquid-outlet one-way valve **2** switches to a closed state, and liquid in rodless chamber **15** is squeezed into the liquid-outlet flow channel **5** by the piston **12**.

[0071] The major innovation of the compact liquid-outlet system lies in the setting of the liquid-outlet one-way valve **2**. The liquid-outlet one-way valve **2** is integrated in an internal structure of the piston **12** within the liquid pump device **1**, resulting in a more compact design, which is particularly beneficial for small products like portable dental irrigators. Therefore, the compact liquid-outlet system of the present disclosure eliminates the need of extra space for installing the liquid-outlet one-way valve **2**, resulting in a more compact structure, especially beneficial for small products like portable dental irrigators.

[0072] As shown in FIG. **2**, the liquid pump device **1** further comprises a transmission mechanism **18** and a driving mechanism **19**, and the piston rod **13** is in transmission connection with the driving mechanism **19** through the transmission mechanism **18**. The driving mechanism **14** drives the piston rod **13** to perform a reciprocating motion.

[0073] The liquid pump device **1** may be a plunger pump; the transmission mechanism **18** and the driving mechanism **19** may both be existing mechanisms; the transmission mechanism **18** may be an eccentric wheel assembly, and the driving mechanism **19** may be a motor assembly.

[0074] The liquid-inlet one-way valve **4** may be ball valves (with reset springs) or valve plates.

[0075] To simplify the liquid-outlet one-way valve **2**, as shown in FIGS. **5** and **7**, the liquid-outlet one-way valve **2** comprises a liquid-outlet valve chamber **21**, a liquid-outlet valve core **22**, and a liquid-outlet valve seat **23**. The liquid-outlet valve chamber **21** is formed in the piston **12** and has an opening facing the rodless chamber **15**, the liquid-outlet valve core **22** is floatingly disposed in the liquid-outlet valve chamber **21**, and the liquid-outlet valve seat **23** is formed in the piston **12** and is disposed at a side of the liquid-outlet valve chamber **21** away from the rodless chamber **15**. The liquid-outlet valve seat **23** is provided with an overflow hole **231** for communicating the liquid-outlet valve chamber **21** and the rod chamber **14**. The liquid-outlet valve core **22** abuts the liquid-outlet valve seat **23** when the piston **12** performs an exhaust stroke, and the liquid-outlet valve core **22** is spaced apart from the liquid-outlet valve seat **23** when the piston **12** performs a suction stroke.

[0076] When the piston **12** is pulled back through the piston rod **13** to perform the suction stroke, the liquid-inlet one-way valve **4** switches to the closed state, and the liquid-outlet one-way valve **2** switches to the open state. Specifically, when the piston **12** moves downwards, the rod chamber **14** becomes smaller, and the internal pressure of the rod chamber **14** increases, and since the liquid-inlet flow channel **3** is the upstream side of the liquid-inlet one-way valve **4** and the rod chamber **14** is the downstream side of the liquid-inlet one-way valve **4**, in this case the liquid-inlet one-way valve **4** remains in the closed state. Alternatively, when the piston **12** moves downwards, the liquid in the rod chamber **14** is squeezed towards the overflow hole **231**, and the liquid-outlet valve core **22** of the liquid-outlet one-way valve **2** is pushed open by the liquid, during which time the liquid in the rod chamber **14** flows into the rodless chamber **15** through the liquid-outlet valve chamber **21**.

[0077] When the piston **12** is pushed out through the piston rod **13** to perform the exhaust stroke, the liquid-inlet one-way valve **4** switches to the open state, and the liquid-outlet one-way valve **2** switches to the closed state. Specifically, as the piston **12** moves upwards, the rod chamber **14** becomes larger, and the internal pressure of the rod chamber **14** decreases, and since the liquid-inlet flow channel **3** is the upstream side of the liquid-inlet one-way valve **4** and the rod chamber **14** is the downstream side of the liquid-inlet one-way valve **4**, in this case the liquid-inlet one-way valve **4** is pushed open by the liquid in the liquid-inlet flow channel **3**, and then the liquid flows into the rod chamber **14**. Specifically, since the piston **12** is used to push liquid out of the rodless chamber **15**, the internal pressure of the rodless chamber **15** increases, such that the liquid-outlet valve core **22** of the liquid-outlet one-way valve **2** abuts the liquid-outlet valve seat **23** in a liquid-tight manner, blocking the overflow hole **231**. The liquid in the rodless chamber **15** is squeezed by the piston **12**, and is sprayed out of the liquid-outlet flow channel **5**. In other words, when the piston **12** performs the exhaust stroke, the liquid-inlet process in the rod chamber **14** happens simultaneously with the liquid-outlet process in the rodless chamber **15**.

[0078] To achieve flow control during the suction stroke, as shown in FIGS. **2** and **3**, the compact liquid-outlet system also comprises a nozzle **6** communicated with the liquid-outlet flow channel **5**. The rodless chamber **15** is in a negative pressure state when the piston **12** performs the suction stroke, during which time a volume increase of the rodless chamber **15** is greater than a volume decrease of the rod chamber **14**. As the piston **12** moves downward, the negative pressure state of the rodless chamber **15** allows it to create suction on liquid in nozzle **6**. This causes the liquid in the

nozzle **6** to flow back, compensating for the volume variation difference between the rodless chamber **15** and the rod chamber **14**, achieving throttling. When the suction stroke is complete, the nozzle's cavity is almost or partially empty. Afterward, the piston **12** begins the exhaust stroke. Before the flow peak occurs in the liquid pump device **1**, the nozzle's cavity is filled with liquid, and therefore the slower-moving portion of the liquid is not sprayed out from the nozzle **6** until a flow peak occurs or is close to occurring. This approach not only maximizes the utilization of the liquid temporarily retained in the nozzle **6**, saving liquid and extending the operational time for oral cleaning, but also reduces the liquid spray before the flow peak occurs in the liquid pump device **1**, achieving pre-peak throttling, enhancing the pulsatile impacts felt by users and the effective utilization of liquid during oral cleaning for users. Additionally, the combined structure of the piston **12** and the piston rod **13** may be a two-stage stepped shaft structure. Since the piston rod **13** partially occupies the internal space of the rod chamber **14**, this design not only reduces the liquid supply to the liquid-inlet flow channel **3** but also enhances the liquid pump device's ability to draw liquid from the nozzle **6**.

[0079] To reduce the liquid spray after the flow peak occurs in the liquid pump device **1**, as shown in FIGS. **4**, **5**, **6** and **7**, the compact liquid-outlet system further comprising a release system **7**. The release system **7** comprises a release flow channel **71** and a post-peak release mechanism **72**. The release flow channel **71** is communicated with the rodless chamber **15**, and the post-peak release mechanism **72** is configured to block the release flow channel **71**. The post-peak release mechanism **72** is configured to open the release flow channel **71** only when the piston **12** performs the exhaust stroke and after a flow peak occurs in the liquid pump device **1**. When the exhaust stroke proceeds to the second half and a flow of the liquid pump device **1** approaches the flow peak, the release flow channel **71** switches to an open state, allowing part of liquid with lower flow velocity, which occurs after the flow peak, to be recycled through the release flow channel **71**, achieving post-peak throttling.

[0080] To simplify the post-peak release mechanism **72**, as shown in FIGS. **5**, **7** and **11**, the post-peak release mechanism **72** comprises a moving rod **721** and an elastic reset member (such as compression springs) **722**. The moving rod **721** extends through the liquid pump cavity **11**, and the elastic reset member **722** is configured for driving the moving rod **721** to reset. A first end of the moving rod **721** is provided with a release valve core **723** for blocking the release flow channel **71**, and a second end of the moving rod **721** is provided with a top-abutting member **724**. The top-abutting member **724** abuts the liquid-outlet one-way valve **2** or the piston **12** after the flow peak occurs in the liquid pump device **1**. When the exhaust stroke is in the second half and after the flow peak occurs in the liquid pump device **1**, the liquid-outlet one-way valve **2** or the piston **12** is configured to abut the top-abutting member **724**, and subsequently, the top-abutting member **724** moves upward in sync with the piston **12**. Since both the top-abutting member **724** and the release valve core **723** are fixed to the moving rod **721**, the release valve core **723** moves in sync with the moving rod **721** until it no longer blocks the release flow channel **71**, allowing part of the liquid that occurs after the flow peak to flow into the release flow channel **71**. When the piston **12** performs the suction stroke, the liquid-outlet one-way valve **2** or the piston **12** is spaced apart from the top-abutting member **724**, and the moving rod **721** returns to its original position by the elastic reset member **722**, until the release valve core **723** once again blocks the release flow channel **71**. Specifically, part of the release flow channel **71** is formed within the liquid pump cavity **11**.

[0081] To make the fluid flow between the rodless chamber **15** and the release flow channel **71** more smooth, the release flow channel **71** comprises a vertical flow channel segment **711** and a transverse flow channel segment **712**. The vertical flow channel segment **711** extends along an axial direction of the liquid pump cavity **11** to communicate with the rodless chamber **15**, and the transverse flow channel segment **712** extends along a radial direction of the liquid pump cavity **11** to communicate with the vertical flow channel segment **711**. The moving rod **721** extends through the vertical flow channel segment **711** with a clearance fit between the two, and the top-abutting

member **724** extends into the rodless chamber **15** or the liquid-outlet valve chamber **21** to limit the liquid-outlet valve core **22** in the liquid-outlet valve chamber **21**. Specifically, the vertical flow channel segment **711** is coaxially connected to the rodless chamber **15**, making it easier for liquid to flow from the rodless chamber **15** into the vertical flow channel segment **711**. Part of the elastic reset member **722** is disposed within the vertical flow channel segment **711**. The elastic reset member **722** is sleeved around the moving rod **721**. A first end of the elastic reset member **722** abuts an inner wall of the vertical flow channel segment (for example, an inner wall of a stepped hole) **711**, and a second end of the elastic reset member **722** abuts the top-abutting member **724**, enabling the movement and reset of the moving rod **721**. Additionally, another significant innovation of the post-peak release mechanism **72** lies in the location of the top-abutting member **724**. Specifically, the top-abutting member **724** extends through the rodless chamber **15** or the liquid-outlet valve chamber **21**. This ensures that the liquid-outlet valve core **22** is always limited in the liquid-outlet valve chamber **21**, preventing it from floating out and ensuring the proper functioning of the liquid-outlet one-way valve **2**. Additionally, yet another significant innovation lies in that the liquid-outlet valve core **22** is spherical and does not have a valve core reset member (such as springs), as detailed below.

[0082] When the piston **12** performs the exhaust stroke, the absence of the valve core reset member in the liquid-outlet valve chamber **21** or the rodless chamber **15** results in minimal liquid resistance. When the piston **12** performs the suction stroke, compared to the exhaust stroke, the liquid pump device **1** has smaller power consumption. Since the liquid in the rod chamber **14** can be forcibly pushed into the rodless chamber **15**, the dimensions of the liquid-outlet one-way valve **2** can be designed relatively small without affecting the resistance experienced by the piston **12** during the exhaust stroke. Besides, a smaller liquid-outlet one-way valve **2** contributes to a more compact liquid pump device **1**.

[0083] Furthermore, after the flow peak occurs in the liquid pump device **1**, the liquid-outlet valve core **22** abuts the top-abutting member **724**, preventing the release valve core **723** from blocking a junction of the vertical flow channel segment **711** and the transverse flow channel segment **712**. Specifically, the release valve core **723** is configured to block the vertical flow channel segment **711**.

[0084] To facilitate liquid discharge, as shown in FIG. **7**, the liquid-outlet flow channel **5** comprises a nozzle jack **51** and a guiding channel **52** both formed in the liquid pump cavity **11**, and the guiding channel **52** is communicated with the nozzle jack **51** and the rodless chamber **15**, respectively. In some embodiments, there are more than one such guiding channels **52**, and all the guiding channels are disposed at the outer periphery of the vertical flow channel segment **711**, so that more liquid flows into the vertical flow channel segment **711** after the flow peak occurs in the liquid pump device **1**, achieving better throttling.

[0085] As shown in FIGS. **5** and **7**, the liquid pump cavity **11** comprises a liquid-inlet adapter **111** and a liquid-outlet adapter **112** socketed to each other; specifically, the liquid-inlet adapter **111** and the liquid-outlet adapter **112** (outside of the liquid-inlet adapter **111**) are connected in a nesting manner. A first groove structure of the liquid-inlet adapter **111** and a second groove structure of the liquid-outlet adapter **112** jointly define the pump chamber of the liquid pump cavity **11**. Specifically, the liquid-inlet adapter **111** is provided with a first docking structure for mounting the liquid-inlet one-way valve **4**, and the liquid-outlet adapter **112** is provided with a second docking structure for mounting the nozzle **6**. Referring to FIGS. **8**, **9** and **10**, the vertical flow channel segment **711**, the transverse flow channel segment **712**, the nozzle jack **51**, and the guiding channel **52** are formed on the liquid-outlet adapter **112**, so as to simplify components and enhance the compactness of the liquid pump device **1**.

[0086] To further enhance the liquid-tightness between the liquid pump cavity **11** and both the piston **12** and the piston rod **13**, as shown in FIG. **5**, the liquid pump cavity **11** is provided with a first sealing ring **16** and a second sealing ring **17**. The first sealing ring **16** is slidably arranged

around the piston **12** in a liquid-tight manner, the second sealing ring **17** is slidably arranged around the piston rod **13** in a liquid-tight manner, and a maximum sealing pressure of the first sealing ring **16** is greater than a maximum sealing pressure of the second sealing ring **17**. The first sealing ring **16** can withstand high pressure, and while a small amount of leakage is acceptable, it doesn't affect its function. This design reduces the tightness requirements for the high-pressure sealing ring. On the other hand, no leakage is allowed for the second sealing ring **17**. Since the second sealing ring **17** operates at lower pressure, this significantly improves the overall working conditions and greatly extends its service life. Unlike existing dental irrigators that only use high-pressure sealing rings, which must withstand significant pressure while preventing leaks, the compact liquid-outlet system of the present disclosure lowers the performance demands for the sealing rings and effectively prolongs their lifespan.

[0087] The oral cleaning method applies the above compact liquid-outlet system, and is performed by: [0088] pulling back the piston **12** through the piston rod **13** to perform the suction stroke, closing the liquid-inlet one-way valve **4**, and opening the liquid-outlet one-way valve **2**, such that liquid in the rod chamber **14** flows to the rodless chamber **15** through the liquid-outlet one-way valve **2**, and liquid in the nozzle **6** flows back to the rodless chamber **15**; [0089] pushing out the piston **12** through the piston rod **13** to perform the exhaust stroke, opening the liquid-inlet one-way valve **4**, and closing the liquid-outlet one-way valve **2**, such that liquid in the liquid-inlet flow channel **3** flows to the rod chamber **14** through the liquid-inlet one-way valve **4**, and liquid in the rodless chamber **15** flows to the nozzle **6** through the liquid-outlet flow channel **5**; part of the liquid in the rodless chamber **15** flows back to a liquid storage tank through the release flow channel **71** after the flow peak occurs in the liquid pump device **1**.

[0090] In the present oral cleaning method, when the piston **12** performs the suction stroke, the liquid in the nozzle **6** flows back to the rodless chamber **15**, allowing for pre-peak throttling (see above for details); when the piston **12** performs the suction stroke, part of the liquid in the rodless chamber **15** flows back to the liquid storage tank through the release flow channel **71**, achieving post-peak throttling (see above system embodiments for details). Furthermore, the compact liquid-outlet system is highly convenient for users during oral cleaning, due to its compact design. Additionally, the oral cleaning method of the present disclosure conserves liquid before and/or after flow peaks, enhancing convenience during oral hygiene procedures.

[0091] In summary, the compact liquid-outlet system of the present disclosure eliminates the need of extra space for installing the liquid-outlet one-way valve, resulting in a more compact structure, especially beneficial for small products like portable dental irrigators. Additionally, the oral cleaning method of the present disclosure conserves liquid before and/or after flow peaks, enhancing convenience during oral hygiene procedures. Therefore, the present disclosure effectively overcomes various shortcomings in the existing technology and has high industrial utilization value.

[0092] 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.

Claims

1. A compact liquid-outlet system, comprising: a liquid pump device (**1**) comprising a liquid pump cavity (**11**), a piston (**12**) and a piston rod (**13**), wherein the piston (**12**) is slidably disposed in the liquid pump cavity (**11**), and the piston rod (**13**) extends through the liquid pump cavity (**11**) in a

liquid-tight manner and is connected to the piston (**12**); wherein the piston (**12**) divides a pump chamber of the liquid pump cavity (**11**) into a rod chamber (**14**) and a rodless chamber (**15**); wherein the piston (**12**) comprises a liquid-outlet one-way valve (**2**) allowing only liquid to flow from the rod chamber (**14**) to the rodless chamber (**15**); a liquid-inlet flow channel (**3**) communicated with the rod chamber (**14**) through a liquid-inlet one-way valve (**4**); and a liquid-outlet flow channel (**5**) communicated with the rodless chamber (**15**).

2. The compact liquid-outlet system according to claim 1, wherein the liquid-outlet one-way valve (**2**) comprises a liquid-outlet valve chamber (**21**), a liquid-outlet valve core (**22**), and a liquid-outlet valve seat (**23**), wherein the liquid-outlet valve chamber (**21**) is formed in the piston (**12**) and has an opening facing the rodless chamber (**15**), the liquid-outlet valve core (**22**) is floatingly disposed in the liquid-outlet valve chamber (**21**), and the liquid-outlet valve seat (**23**) is formed in the piston (**12**) and is disposed at a side of the liquid-outlet valve chamber (**21**) away from the rodless chamber (**15**); wherein the liquid-outlet valve seat (**23**) is provided with an overflow hole (**231**) for communicating the liquid-outlet valve chamber (**21**) and the rod chamber (**14**); wherein the liquid-outlet valve core (**22**) abuts the liquid-outlet valve seat (**23**) when the piston (**12**) performs an exhaust stroke, and the liquid-outlet valve core (**22**) is spaced apart from the liquid-outlet valve seat (**23**) when the piston (**12**) performs a suction stroke.

3. The compact liquid-outlet system according to claim 1, wherein the compact liquid-outlet system further comprises a nozzle (**6**) communicated with the liquid-outlet flow channel (**5**), wherein the rodless chamber (**15**) is in a negative pressure state when the piston (**12**) performs a suction stroke, during which time a volume increase of the rodless chamber (**15**) is greater than a volume decrease of the rod chamber (**14**).

4. The compact liquid-outlet system according to claim 1, further comprising a release system (**7**) comprising a release flow channel (**71**) and a post-peak release mechanism (**72**), wherein the release flow channel (**71**) is communicated with the rodless chamber (**15**), and the post-peak release mechanism (**72**) is configured to block the release flow channel (**71**), wherein the post-peak release mechanism (**72**) is configured to open the release flow channel (**71**) only when the piston (**12**) performs the exhaust stroke and after a flow peak occurs in the liquid pump device (**1**).

5. The compact liquid-outlet system according to claim 4, wherein the post-peak release mechanism (**72**) comprises a moving rod (**721**) and an elastic reset member (**722**), wherein the moving rod (**721**) extends through the liquid pump cavity (**11**), and the elastic reset member (**722**) is configured for driving the moving rod (**721**) to reset, wherein a first end of the moving rod (**721**) is provided with a release valve core (**723**) for blocking the release flow channel (**71**), and a second end of the moving rod (**721**) is provided with a top-abutting member (**724**), wherein the top-abutting member (**724**) abuts the liquid-outlet one-way valve (**2**) or the piston (**12**) after the flow peak occurs in the liquid pump device (**1**).

6. The compact liquid-outlet system according to claim 5, wherein the release flow channel (**71**) comprises a vertical flow channel segment (**711**) and a transverse flow channel segment (**712**), wherein the vertical flow channel segment (**711**) extends along an axial direction of the liquid pump cavity (**11**) to communicate with the rodless chamber (**15**), and the transverse flow channel segment (**712**) extends along a radial direction of the liquid pump cavity (**11**) to communicate with the vertical flow channel segment (**711**); wherein the moving rod (**721**) extends through the vertical flow channel segment (**711**) in a clearance manner, and the top-abutting member (**724**) extends into the rodless chamber (**15**) or the liquid-outlet valve chamber (**21**) to limit the liquid-outlet valve core (**22**) in the liquid-outlet valve chamber (**21**).

7. The compact liquid-outlet system according to claim 1, wherein the liquid pump cavity (**11**) comprises a liquid-inlet adapter (**111**) and a liquid-outlet adapter (**112**) socketed to each other, and a first groove structure of the liquid-inlet adapter (**111**) and a second groove structure of the liquid-outlet adapter (**112**) jointly define the pump chamber of the liquid pump cavity (**11**).

8. The compact liquid-outlet system according to claim 1, wherein the liquid-outlet flow channel

(**5**) comprises a nozzle jack (**51**) and a guiding channel (**52**) both formed in the liquid pump cavity (**11**), and the guiding channel (**52**) is communicated with the nozzle jack (**51**) and the rodless chamber (**15**), respectively.

9. The compact liquid-outlet system according to claim 1, wherein the liquid pump cavity (**11**) is provided with a first sealing ring (**16**) and a second sealing ring (**17**), wherein the first sealing ring (**16**) is slidably arranged around the piston (**12**) in a liquid-tight manner, the second sealing ring (**17**) is slidably arranged around the piston rod (**13**) in a liquid-tight manner, and a maximum sealing pressure of the first sealing ring (**16**) is greater than a maximum sealing pressure of the second sealing ring (**17**).

10. An oral cleaning method using a compact liquid-outlet system according to claim 4, comprising: pulling back the piston (**12**) through the piston rod (**13**) to perform the suction stroke, closing the liquid-inlet one-way valve (**4**), and opening the liquid-outlet one-way valve (**2**), such that liquid in the rod chamber (**14**) flows to the rodless chamber (**15**) through the liquid-outlet one-way valve (**2**), and liquid in the nozzle (**6**) flows back to the rodless chamber (**15**); pushing out the piston (**12**) through the piston rod (**13**) to perform the exhaust stroke, opening the liquid-inlet one-way valve (**4**), and closing the liquid-outlet one-way valve (**2**), such that liquid in the liquid-inlet flow channel (**3**) flows to the rod chamber (**14**) through the liquid-inlet one-way valve (**4**), and liquid in the rodless chamber (**15**) flows to the nozzle (**6**) through the liquid-outlet flow channel (**5**); wherein part of the liquid in the rodless chamber (**15**) flows back to a liquid storage tank through the release flow channel (**71**) after the flow peak occurs in the liquid pump device (**1**).