relative to the handle as the appliance is moved along the user's teeth. The toothbrush is operable in a selected one of two different modes. In a first mode, the user depresses a button to actuate the delivery of working fluid from the nozzle. In a second mode, a controller actuates the delivery of working fluid to the nozzle automatically depending on a signal received from a sensor. The sensor is located in the handle of the toothbrush. A pivoting arm located within the stem connects the nozzle to a magnet located adjacent to the sensor and which moves relative to the sensor as the nozzle moves relative to the handle, for example as the nozzle moves into, or out from, an interproximal gap in the user's teeth.

SUMMARY ~~OF THE INVENTION~~

In a first ~~aspect~~example the present ~~invention~~disclosure provides a dental treatment appliance comprising:

a handle;

a dental treatment system for delivering a treatment to the oral cavity of a user, the dental treatment system comprising detecting means for transmitting a signal towards the oral cavity and for receiving a signal returned from the oral cavity, and a controller for actuating the treatment of the oral cavity of the user; and

moving means for moving the detecting means relative to the handle.

In one aspect, the present disclosure refers to a dental treatment appliance comprising a dental treatment system for delivering a treatment to the oral cavity of a user, the dental treatment system comprising detecting means for transmitting a pulsed signal towards the oral cavity and for receiving a signal returned from the oral cavity, and a controller for actuating the treatment of the oral cavity of the user depending on a signal received from the detecting means and the detecting means is arranged to transmit a signal towards the oral cavity at the same frequency at which the controller is arranged to sample the signal returned from the oral cavity.

Unlike the appliance described in WO2016/185154, the treatment of the oral cavity of the user is actuated in dependence on a signal which is returned to the detecting means from the oral cavity. For example, where the detecting means is configured to transmit an acoustic signal to the oral cavity, the returned signal is an acoustic signal which is reflected back from the oral cavity. As another example, where the detecting means is configured to transmit an optical signal to the oral cavity, the returned signal may an optical signal which is reflected back from the oral cavity, or an optical signal which is emitted by the oral cavity. For example, depending on the wavelength of the transmitted signal, a signal may be returned to the detecting means due to fluorescence of plaque excited by the transmission signal. The wavelength and/or intensity of the returned signal can also be indicative of the transmission of the signal into an interproximal gap between adjacent teeth of the user. Depending on the returned signal, the controller

actuates the treatment of the oral cavity, for example by the ejection of fluid into the interproximal region to remove matter located therein, or to remove plaque from the teeth of the user.

During a treatment of the oral cavity, the detecting means is moved relative to the handle. The detecting means may be moved along a path of any desired shape relative to the handle. For example, the detecting means may be moved along a curved path, such as an arcuate path or an S-shaped path, or a closed loop path, for example a circular path, relative to the handle. At a given position of the appliance relative to the oral cavity, this can enable the size of the region of the oral cavity upon which the transmitted signals are incident to be increased in comparison to an arrangement in which the detecting means is stationary relative to the handle. In a preferred ~~embodiment~~example, the moving means is arranged to move the detecting means reciprocally relative to the handle, preferably along a curved path, more preferably along an arcuate path. The moving means is preferably arranged to move the detecting means relative to the handle along a path which is arranged substantially perpendicular to a longitudinal axis of the handle. In a preferred ~~embodiment~~example, the detecting means is reciprocally swept about the longitudinal axis of the handle by an angle in the range from 10 to 30 , preferably at a frequency in the range from 200 to 300 Hz.

The appliance may be in the form of an appliance for treating an oral condition of the user. For example, the appliance may be in the form of a dedicated interproximal cleaning appliance for cleaning between the gaps in the user's teeth. The treatment system may comprise a fluid delivery system for delivering working fluid to the oral cavity of the user. Depending on the signal returned from the oral cavity, the controller actuates the delivery of working fluid to the oral cavity to dislodge matter located within a gap between the user's teeth. The movement of the detecting means relative to the handle can enable such a gap to be detected in advance of the fluid delivery system being located in an optimal position for delivering working fluid into the gap. This can enable the fluid delivery system to be "primed" by the controller, for example by drawing fluid from a fluid reservoir into a fluid chamber of a pump, once the gap has

of bristles may be attached to a moveable section of the cleaning tool, which section is moveable relative to the handle.

In a preferred ~~embodiment~~example, the appliance comprises a brush unit comprising a bristle carrier and a plurality of bristles mounted on the bristle carrier, with the bristle carrier being moveable relative to the handle. The bristle carrier is preferably mounted on the stem of the cleaning tool. The appliance comprises a drive mechanism for driving the movement of the bristle carrier relative to the handle. The drive mechanism preferably comprises a transmission unit connected to the bristle carrier, and a drive unit for driving the transmission unit to move the bristle carrier relative to the handle. The drive unit is preferably located in the handle.

The drive mechanism is preferably arranged to drive the movement of the detecting means relative to the handle. The detecting means is preferably arranged to move with the bristle carrier relative to the handle. The detecting means may be arranged to move relative to the handle with the same movement pattern as, or with a different movement pattern from, the bristle carrier. For example, both the detecting means and the bristle carrier may be arranged to move reciprocally in a sweeping movement relative to the handle. The detecting means may be spaced from the bristle carrier, or mounted on the bristle carrier. For example, the drive mechanism may be arranged to move the stem relative to the handle so as to move both the brush unit and the detecting means simultaneously relative to the handle.

The nozzle is preferably arranged to move with the detecting means relative to the handle. For example, both the detecting means and the nozzle may be mounted on the bristle carrier so that the drive mechanism moves the bristle carrier, the nozzle and the detecting means simultaneously relative to the handle.

The detecting means may be arranged to transmit an optical signal or an audio signal towards the oral cavity. For example, the detecting means may comprise at least one acoustic transceiver or at least one optical transceiver. As another example, the

detecting means may comprise one or more light transmitters, such as LEDs, for illuminating the oral cavity, and a camera for receiving light returned from the oral cavity and capturing an image of the oral cavity.

The detecting means is preferably arranged proximate to the nozzle so that region of the oral cavity towards which the signal is transmitted is substantially the same as the region which is subsequently treated by the treatment system. The detecting means and the nozzle may be positioned side by side on the cleaning tool. Alternatively, the detecting means may be arranged so as to extend at least partially about the nozzle axis. As another alternative, the detecting means may be arranged immediately behind the nozzle so that signals transmitted by, and returned to, the detecting means pass through the bore of the nozzle. As a further alternative, the detecting means may extend at least partially about the nozzle axis. For example, the detecting means may comprise a C-shaped, or horseshoe shaped, sensor or transceiver which extends partially about the nozzle axis. As another example, the detecting means may comprise a transceiver which surrounds the nozzle axis.

In a second ~~aspect~~example the present ~~invention~~disclosure provides a dental treatment appliance comprising:

a fluid reservoir for storing a working fluid; and

a fluid delivery system for receiving working fluid from the reservoir, the fluid delivery system comprising a nozzle for delivering working fluid to the oral cavity of a user, detecting means for transmitting a signal towards the oral cavity and for receiving a signal from the oral cavity, and a controller for actuating the delivery of working fluid depending on the received signal;

wherein the detecting means surrounds the nozzle axis.

The moving means is preferably arranged to move the detecting means towards and away from at least one reference position. For example, where the detecting means is moved in a reciprocally sweeping movement along a curved path, a reference position

may be located at the centre of that path. Alternatively, or additionally, reference positions may be located midway between the centre and the extremities of that path

The controller is preferably configured to sample a signal received from the detecting means when the detecting means is in a said reference position, and to actuate the treatment of the oral cavity of the user depending on the sampled signal. As well as reducing signal processing by the controller, this can ensure that treatment of the oral cavity occurs when, for a nozzle moving with the detecting means, the nozzle is positioned optimally for that treatment. For example, where the reference position is located at the centre of the path along which the detecting means moves relative to the handle, the treatment of the oral cavity can take place as the nozzle is moving towards and/or away from its central position.

In a third ~~aspect~~example, the present ~~invention~~disclosure provides a dental treatment appliance comprising:

a handle;

a dental treatment system for delivering a treatment to the oral cavity of a user, the dental treatment system comprising detecting means for transmitting a signal towards the oral cavity and for receiving a signal returned from the oral cavity, and a controller for actuating the treatment of the oral cavity of the user; and

moving means for moving the detecting means relative to the handle towards and away from at least one reference position, and wherein the controller is configured to sample a signal received from the detecting means when the detecting means is in a said reference position, and to actuate the treatment of the oral cavity of the user depending on the sampled signal.

The moving means is preferably arranged to oscillate the detecting means relative to the handle at an oscillation frequency F. Depending on the number and locations of reference positions along the movement path of the detecting means, the controller may be arranged to sample a signal returned from the oral cavity at the same frequency F, at a frequency nF, where n is an integer greater than 1, or at a frequency nF/m, where m is

an integer, preferably equal to or less than 16. For example, m may take a value of 2, 4, 6, 8, 12 or 16.

The detecting means may be arranged to transmit a signal towards the oral cavity at the same frequency at which the controller is arranged to sample the signal returned from the oral cavity. This can be particularly beneficial where the detecting means comprises a camera; by pulsing, or strobing, the light signal which is transmitted towards the oral cavity, we have found that the sharpness of the image captured by the camera can be improved in comparison to a situation where the light signal is transmitted continuously to the oral cavity.

The transmission of a pulsed signal towards the optical cavity can be provided separately from the periodic sampling of the received signal by the controller, and so in a fourth ~~aspect~~example, the present ~~invention~~disclosure provides a dental treatment appliance comprising a dental treatment system for delivering a treatment to the oral cavity of a user, the dental treatment system comprising detecting means for transmitting a pulsed signal towards the oral cavity and for receiving a signal returned from the oral cavity, and a controller for actuating the treatment of the oral cavity of the user depending on a signal received from the detecting means.

The appliance preferably comprises moving means for moving the detecting means relative to a handle of the appliance. The moving means is preferably arranged to oscillate the detecting means relative to the handle at an oscillation frequency F. The detecting means is preferably arranged to transmit a pulsed optical signal at a frequency nF, where n is an integer greater than 1, or at a frequency nF/m, where m is an integer which is preferably equal to or less than 16. For example, m may take a value of 2, 4, 6, 8, 12 or 16.

The controller is preferably located in the handle of the appliance. Whilst signals may be transmitted wirelessly from the detecting means to the controller, it is preferred that signals are transmitted from the detecting means to the controller along a physical

transmission path located within the appliance. Preferably, the transmission path extends along part of the drive mechanism. This can allow the number of components of the appliance to be minimised.

In a fifth ~~aspect~~example, the present ~~invention~~disclosure provides a dental treatment appliance comprising:

a handle;

a cleaning tool comprising a bristle carrier and a plurality of bristles mounted on the bristle carrier;

a drive mechanism for driving movement of the bristle carrier relative to the handle;

a dental treatment system for treating the oral cavity of a user, the dental treatment system comprising detecting means for transmitting a signal towards the oral cavity and for receiving a signal returned from the oral cavity, and a controller for actuating the treatment of the oral cavity depending on the received signal;

wherein a transmission path for signals transmitted from the detecting means to the controller extends along part of the drive mechanism.

As mentioned above, the drive mechanism is preferably located in the handle, and preferably comprises a transmission unit connected to the bristle carrier, and a drive unit for driving the transmission unit to move the bristle carrier relative to the handle. The transmission unit is preferably in the form of a shaft which is moved relative to the handle by the motor. The frequency of the vibration of the shaft is preferably in the range from 200 to 300Hz. The motor preferably extends about the shaft so that the shaft rotates or vibrates relative to the handle upon excitation of the motor. The stem of the cleaning tool is mounted on the shaft.

The transmission path preferably extends along the transmission unit, more preferably along an external surface of the shaft. For example, a conductive track for conveying signals towards the controller may be formed on the external surface of the shaft. The track is preferably connected to a handle contact for engaging a cleaning tool contact when the cleaning tool is attached to the handle. The handle contact is preferably an

annular contact which extends about an end part of the shaft. The cleaning tool preferably comprises a recess for receiving this part of the shaft to connect the cleaning tool to the handle. The cleaning tool contact is preferably located within the recess, and preferably protrudes inwardly from an internal peripheral surface of the recess to engage the handle contact when the cleaning tool is attached to the handle. A wire, track or other conductive member extends between the cleaning tool contact and the detecting means to convey signals from the detecting means to the cleaning tool contact.

In addition to extending along part of the transmission unit, the transmission path preferably also extends along part of the drive unit. The drive unit preferably comprises means for engaging the shaft, and the engaging means is preferably arranged to convey signals towards the controller. The drive unit is preferably arranged to move, more preferably rotate, the shaft away from an equilibrium position to move the cleaning tool relative to the handle against the force of the engaging means. The engaging means is arranged to urge the shaft back towards its equilibrium position when the driving force of the drive unit is removed. The engaging means preferably comprises a spring member, and in a preferred ~~embodiment~~example comprises a torsion spring. A wire, track or other conductive member extends between the spring member and the controller to convey signals from the spring member to the controller.

As mentioned above, the dental treatment system preferably comprises a fluid delivery system for delivering a working fluid to the oral cavity of the user. The fluid delivery system preferably comprises a fluid reservoir and a pump, with the controller being arranged to actuate the pump to draw working fluid from the fluid reservoir and eject working fluid towards the nozzle. The controller is preferably arranged to actuate the pump to eject a burst of working fluid towards the nozzle. The volume of each burst of working fluid which is generated by the fluid delivery system is preferably less than 1 ml, more preferably less than 0.5 ml. In a preferred ~~embodiment~~example, the volume of the burst of working fluid generated by the fluid delivery system is in the range from 0.1 to 0.4 ml. The fluid delivery system is preferably configured to deliver a burst of working fluid to the nozzle at a static pressure in the range from 3 to 10 bar.

The transmission unit preferably defines part of the fluid delivery system. The shaft preferably comprises a bore which defines part of the fluid delivery system.

The appliance preferably comprises a user interface for enabling a user to select a mode of operation of the appliance before the commencement of a treatment process. In this ~~embodiment~~example, the user interface is located on the handle of the appliance, and preferably comprises at least one user operable switch or button. The user interface may comprise a display located on the handle for displaying information about a chosen operating mode. Alternatively, the appliance may be connected wirelessly to a remote device having a display for displaying that information. The remote device may be in the form of a dedicated display or a personal device. The remote device may also include a user interface, such as a touch sensitive display, for enabling a user to select an operating mode for the appliance.

In a preferred ~~embodiment~~example, the appliance has a first operating mode and a second operating mode. In the first operating mode, the oral cavity is not treated by the dental treatment system in response to signals received from the detecting means, and so the appliance may be used as a conventional electric toothbrush with the brush unit moving relative to the handle during a cleaning process. In the second operating mode, the oral cavity is treated by the dental treatment system in response to signals received from the detecting means and so the appliance may be used as an electric toothbrush having the additional functionality of interproximal cleaning or other oral treatment taking place automatically during a cleaning process. In the second operating mode, the brush unit is moved relative to the handle during the cleaning process; in an optional third operating mode the brush unit remains stationary during the cleaning process and so the appliance operates as a dedicated oral treatment appliance.

During a treatment process, the user interface is preferably operable by the user to switch temporarily from the currently selected operating mode to the other operating mode. This can allow the user to switch as required between operating modes, for

example after the completion of a brushing stage of a cleaning process to enable, for example, interproximal cleaning to take place automatically during a treatment stage of a cleaning process. Switching between the operating modes can allow the user to temporarily suspend the treatment of the oral cavity during a cleaning process, or to temporarily initiate automatic treatment of the oral cavity during brushing.

In a sixth ~~aspect~~example the present ~~invention~~disclosure provides a dental treatment appliance comprising:

a handle;

a bristle carrier and a plurality of bristles mounted on the bristle carrier;

a drive mechanism for driving movement of the bristle carrier relative to the handle;

a dental treatment system for treating the oral cavity of a user, the dental treatment system comprising detecting means for transmitting a signal towards the oral cavity and for receiving a signal reflected from the oral cavity, and a controller for actuating the treatment of the oral cavity; and

a user interface;

wherein before a treatment process, the user interface is operable to place the appliance in a selected one of a first operating mode, during which the drive mechanism moves the bristle carrier relative to the handle, and a second operating mode, during which the controller actuates the treatment of the oral cavity depending on the received signal, and wherein, during a treatment process, the user interface is operable by the user to switch temporarily from the selected operating mode to the other operating mode.

The user interface preferably comprises a switch or button located on the handle. The switch or button may be slidable or depressible to switch between operating modes of the appliance. The switch or button may therefore have a first state, in which the appliance remains in the selected operating mode, and a second state in which the appliance is placed in the other operating mode by the controller. The switch or button is preferably biased towards the first state. The appliance is preferably placed in the other operating condition while the switch or button is maintained in its second state.

For example, where the user interface comprises a button, the appliance is placed in the other operating mode whilst the button is depressed by the user. Once the button is released by the user, the appliance is returned to the selected operating mode. The switch or button is preferably positioned so as to be operable by the thumb of a hand which is gripping the handle.

The appliance may be placed in the other operating mode as soon as the switch or button is placed in its second state by the user. In a preferred ~~embodiment~~example though, the appliance is placed in the other operating mode if the switch or button is placed in its second state for a duration which is greater than a preset period of time. This preset period of time is preferably in the range from 0.5 to 2 seconds. The appliance may be configured to generate an audible or visual alert to the user once it has been placed in the other operating mode. The appliance may also be configured to generate an audible or visual alert to the user once it has returned to the selected operating mode.

In the event that the switch or button is placed in its second state for a duration which is shorter than the preset period of time, the controller is preferably arranged to actuate a single treatment of the oral cavity. Where the dental treatment system is configured to deliver a working fluid to the oral cavity, the controller may be arranged to actuate the delivery of a single burst of working fluid, or a single series of bursts of working fluid, to the oral cavity.

Features described above in connection with the first aspect of the ~~invention~~disclosure are equally applicable to the second to sixth aspects of the ~~invention~~disclosure, and vice versa.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred features of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1(a) is a perspective view, from the front, of a dental cleaning appliance, and Figure 1(b) is a perspective view, from the rear, of the appliance of Figure 1(a);

CLAIMS

1. A dental treatment appliance comprising a dental treatment system for delivering a treatment to the oral cavity of a user, the dental treatment system comprising detecting means for transmitting a pulsed signal towards the oral cavity and for receiving a signal returned from the oral cavity, and a controller for actuating the treatment of the oral cavity of the user depending on a signal received from the detecting means and the detecting means is arranged to transmit a signal towards the oral cavity at the same frequency at which the controller is arranged to sample the signal returned from the oral cavity.

2. An appliance according to claim 1, comprising a handle and moving means for moving the detecting means relative to the handle.

3. An appliance according to claim 2, wherein the moving means is arranged to move the detecting means reciprocally relative to the handle.

4. An appliance according to claim 3, wherein the moving means is arranged to move the detecting means relative to the handle at a frequency in the range from 200 to 300 Hz.

5. An appliance according to claim 2 or claim 3, wherein the moving means is arranged to oscillate the detecting means relative to the handle at an oscillation frequency F, and the detecting means is arranged to transmit optical signals at a frequency nF/16, where n is an integer greater than or equal to 1.

6. An appliance according to any of claims 2 to 5, wherein the moving means is arranged to move the detecting means relative to the handle along a path which is arranged perpendicular to a longitudinal axis of the handle.

7. An appliance according to any of claims 2 to 6, wherein the moving means is arranged to move the detecting means relative to the handle reciprocally along a curved, preferably arcuate, path.

8. An appliance according to claim 7, wherein the detecting means is swept about the longitudinal axis of the handle by an angle in the range from 10 to 30°.

9. An appliance according to any of claims 2 to 8, wherein the moving means comprises a drive unit for driving movement of the detecting means relative to the handle.

10. An appliance according to claim 9, comprising a brush unit comprising a bristle carrier and a plurality of bristles mounted on the bristle carrier, and wherein the drive unit is arranged to drive movement of the bristle carrier relative to the handle.

11. An appliance according to claim 10, wherein the detecting means is arranged to move with the bristle carrier relative to the handle.

12. An appliance according to claim 10 or claim 11, wherein the detecting means is mounted on the bristle carrier.

13. An appliance according to any of claims 10 to 12, comprising a stem extending between the handle and the brush unit, and wherein the drive unit is arranged to move the stem relative to the handle.

14. An appliance according to any of claims 2 to 13, wherein the dental treatment system is configured to deliver a working fluid, preferably a liquid working fluid, to the oral cavity of the user.

15. An appliance according to claim 14, wherein the dental treatment system comprises a nozzle for delivering working fluid to the oral cavity of the user.

16. An appliance according to claim 15, wherein the nozzle is arranged to move with the detecting means relative to the handle.

17. An appliance according to any of claims 1 to 4, wherein the detecting means is arranged to transmit an optical signal towards the oral cavity.

18. An appliance according to any preceding claim, wherein the detecting means comprises an optical transceiver.

19. An appliance according to any of claims 1 to 17, wherein the detecting means comprises one or more light transmitters, and a camera for receiving light returned from the oral cavity and capturing an image of the oral cavity.