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(54) SYSTEM AND METHOD FOR DETECTION OF DENTAL TARTAR

SYSTEM UND VERFAHREN ZUR ERKENNUNG VON ZAHNSTEIN

SYSTEME ET PROCEDE DE DETECTION DE TARTRE DENTAIRE

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present relates to the detection of dental tartar and, more particularly, to the detection of subgingival tartar.

2. Description of the Prior Art

[0002] The removal of tartar, for instance with a scraper or a sonic or ultrasonic instrument, is important to prevent or to treat periodontal diseases, i.e. of tissues which surround the teeth, such as bone B, gums G, ligaments, etc. The tartar is calcified dental plaque that has accumulated on the tooth surface. Supergingival tartar and subgingival tartar S (see Figure 2) must be removed as tartar is a porous substance which contains bacteria and which favours the accumulation of these pathogenic bacteria on its structure. Moreover, tartar mechanically irritates the gums.

[0003] In a healthy periodontium (see Figure 1) there is no periodontal pocket. However, when there is a periodontal disease (Figure 2), such a periodontal pocket P is formed by an inner surface of the gums G and by the root R of the tooth T and which is closed apically by the periodontal ligaments L. Subgingival tartar S can thus be found in this periodontal pocket P.

[0004] Therefore, to prevent periodontal problems which can lead to severe health problems, it is important to remove tartar from the tooth surface as it is forming; on the other hand, the removal of tartar is done with difficulty and in a groping manner, subgingival tartar being normally invisible to the human eye in normal conditions as it is covered by the gums. To remove subgingival tartar (i.e. located behind the gum), the operator must try to locate tartar by tactile feeling using a probe, but one cannot actually view subgingival tartar to ensure a complete removal thereof without resorting to invasive surgical procedures.

[0005] The use of an endoscopic method and device for the removal of subgingival tartar is also known from U.S. Patents No. 5,230,621 and No. 5,328,365. In this system, an endoscopic probe is inserted in the gingival pocket or sulcus to endoscopically visualise the process of and/or effects of subgingival root planing, scaling or other plaque removal procedures carried out by other operative instruments. Alternatively, the endoscopic viewing apparatus may be incorporated in an operative instrument which itself is used to remove deposited material from subgingival tooth surfaces, whereby the operator may view and/or guide the instrument while using the plaque removal instrument itself. Therefore, the operator looks at a monitor that provides images of the endoscopic viewing and the operator detects the presence of subgingival tartar by looking at the monitor. This system is efficient, but somewhat cumbersome to use as the operator must stop looking into the mouth of the patient in order to look at the monitor. Moreover, this system is relatively expensive, as it requires a monitor and associated hardware.

[0006] DE 40 15 066 discloses a system in which a white light source such as a xenon lamp is used for illuminating a tissue, a spectrometer receives the light reflected by the tissue to yield a reflexion spectrum of the reflected light, which is compared to a data base of typical reflexion spectra of known substances so as to control a laser into illuminating this tissue for destructing it.

[0007] DE 297 05 934 discloses a system using a first light source for directing an excitation radiation to a tissue and detection means for detection of a resulting fluorescence radiation from the tissue.

[0008] Therefore, there is a need for a dental instrument which, using a probe or the like, can automatically, detect the presence of subgingival tartar, which does not require the use of a monitor, and which allows the operator to concentrate on his/her task In the patient's mouth by not having to look at a monitor and thus leave the patient's mouth from his/her sight. Such an instrument would facilitate the operator's task of removing subgingival tartar by providing a system which assists thee operator in the diagnostic.

SUMMARY OF THE INVENTION

[0009] It is therefore an aim of the present invention to provide a novel system for the detection of dental tartar, including subgingival tartar.

[0010] It is also an aim of the present invention to provide a novel system for the detection of dental subgingival tartar that automatically detects the tartar based on its spectral reflectance characteristics (of which colour is a special case).

[0011] It is a further aim of the present invention to provide a system in which a visual, sound-based, or other, signal is given following detection of subgingival tartar, wherein this detection results from measurements made in the subgingival region and taken in one or more predetermined ranges of wavelengths that are appropriate for discriminating the spectral reflectance characteristics that constitute a signature of tartar presence.

[0012] The invention provides a dental tarter detection system according to claim1. The other claims concern embodiments of claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Having thus generally described the nature of the invention, reference will now be made to the accompanying drawings, showing by way of illustration a preferred embodiment thereof, and in which:

Fig. 1a is a schematic vertical cross-sectional view of a tooth and its surrounding tissues;

Fig. 1 is an enlarged view of bubble 1-1 of Fig. 1a;
Fig. 2 is a schematic view similar to Fig. 1 but showing a periodontal pocket between the tooth's root and the gums, with subgingival tartar being shown lodged therein;
Fig. 3 is a schematic representation of a system for the detection of dental tartar in accordance with the present invention;
Figs. 4 and 4a are schematic enlarged partial detailed views of the detection system of Fig. 3;
Fig. 4b is a schematic detailed view of some components of the casing of Fig. 3;
Fig. 5 is a view similar to Fig. 2 but showing the detection of subgingival tartar in the periodontal pocket using the system of the present invention; and
Figs. 6a, 6b and 6c are schematic views of three methods for combining a number of light beams and coupling them into one or more optical fibres.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] The present invention is a system 10 for the automated detection of the presence of subgingival tartar S with an endoscopic-like exploration device using an optical method based or the spectral reflectance properties of tartar to discriminate the tartar present on the teeth from the healthy areas thereof, from the gums, from blood, and in fact from any artefact other than tartar that a probe may encounter when it is inserted between a tooth and the gums.

[0015] More particularly, the system 10 comprises three main mechanisms, that is (1) a buccal probe, (2) a casing containing optical components, light sources, and acquisition and signal processing electronics, as well as a water inlet capable of being connected to a water supply, and (3) a cable strand that includes optical fibres and a water supply tube and which connects the probe to the casing.

[0016] Indeed, the system 10 comprises a periodontal probe 12, containing optical fibres and, more particularly, one or more illumination fibres 14 used for illuminating the subgingival region and one or more detection fibres 16 for receiving the light reflected by the tooth T for the subsequent determination of the spectral reflectance characteristics in this region. It is contemplated that a single optical fibre could be used for both illumination and detection functions. The probe 12 has a curved pointy end section 60 with the illumination fibres 14 and detection fibres 16 being contained in the pointy end section 60 and extending up to an open free or distal end 36 thereof and having their respective distal ends thereat.

[0017] The probe 12 includes a handle 18 and may include an attachment mechanism 20 so that it may be installed on various apparatuses A used for removing dental tartar S by way of ultrasounds or any other suitable removal technique. It is possible to incorporate the spectral reflectance detection technique described herein which uses fibre optics technology in such tartar removing instruments A to further integrate together the diagnostic and the treatment in a single instrument. The probe 12 also includes a connector on the proximal end of the handle 18 and an irrigation micro-system 22 to clean the site, that is the subgingival region, by injecting water in the periodontal pocket P, in order to provide for further detection efficiency.

[0018] The irrigation micro-system 22 includes communicating first and second water supply tubes 24 and 26, respectively, a valve 28 on the first water supply tube 24 and water source 30. The second water supply tube 26 extends through the handle 18 with a distal section thereof 19 (made of stainless steel or other biocompatible material, e.g. plastic or other) extending outwardly of the handle 18. The distal section 19 of the second water supply tube 26 extends out of the handle 18 along the curved pointy end section 60 and terminates short or upstream of the distal end 36 of the curved pointy end section 60 and thus also of the distal ends of the illumination and detection fibres 14 and 16 such as to project water to the distal end 36 of the probe 12 so that blood or any other debris can be evacuated therefrom.

[0019] A cable strand 32 links the probe 12 to an electronic system that is provided in a casing 34 which could have the shape and size of a portable cassette player (i.e. a Walkman™) which would be adapted to be connected to an outside power supply (unless the casing 34 may be powered with batteries placed in it) and to the water source 30, thereby rendering the system 10 portable. The light propagated by distal sections of the illumination and detection fibres 14 and 16 in the probe 12 is thus further conveyed to or from the casing 34 by proximal sections of these fibres 14 and 16 that are part of the cable strand 32. The cable strand 32 carries and protects the illumination and detection fibres 14 and 16 and the first water supply tube 24. The cable strand 32 is detachably connected to the connector provided at a proximal end 33 of the handle 18 of the probe 12 so that the probe 12 can be detached from the cable strand 32 for allowing the probe 12 to be sent alone to an autoclave for its sterilisation. The probe 12 could also be of the single-use type and would thus be discarded instead of sterilised.

[0020] Each of the one or more illumination fibres 14 provided to illuminate the site (i.e. the periodontal pocket P) has one of its extremities facing a light source (which may be provided or not with an optical wavelength selective filter) and its other extremity at the distal free end 36 of the probe 12. Each such fibre 14 is interrupted (or sectioned) at the connector between the cable strand 32 and the probe 12.

[0021] Each of the one or more detection fibres 16 (which may be the same one as that or those optical fibres 14 used for illuminating the periodontal pocket P) is used for receiving the reflected light coming from the periodontal site. Each such detection fibre 16 has one of its extremities at the distal end 36 of the probe 12 and its other extremity facing a photodetector (or an electronic

light transducer) 38 (which may or not comprise an optical wavelength selective filter). Each such fibre 16 is interrupted (or sectioned) at the connector between the cable strand 32 and the probe 12.

[0022] This detector 38 is connected to an electronic system housed in the casing 34.

[0023] At the detector or from the signal delivered by the detector, there may be an electronic or physical (optical) filtration system to remove from the received wavelengths those that result from non-tartar structures. The signal obtained after this filtering is then analysed by an electronic processor to determine whether tartar is present at the distal end 36 of the probe 12 or not.

[0024] If tartar is detected, an indicator (luminous, sound, or any other means sensible by the operator) is actuated so that the operator is informed of the presence of tartar in the region being examined by the distal end of the probe 12. For instance, the indicator can take the form of a luminous indicator 42 located on the probe 12 to which light generated in the casing 34 is conveyed by one or more optical fibres 44 between the casing 34 and the handle 18 of the probe 12 such as to terminate at the indicator 42 provided on the handle 18, and such that the operator can see the light conveyed by the optical fibres 44 upon detection of tartar. Also, the luminous signal could come from a warning LED (light emitting diode) positioned on the handle 18 and electrically connected to a switch located in the casing 34 and triggered automatically upon detection of tartar.

[0025] A connector 46 at the end of the cable strand 32 provides a detachable connection mechanism between the handle 18 of the probe 12 and the cable strand 32 (see Figs. 4 and 4a). The cable strand 32 is again a flexible sheath for the illumination and detection optical fibre(s) 14 and 16, the first water supply tube 24 and the optical fibre(s) 44 for the luminous indicator 42 on the probe 12, if any.

[0026] The casing 34 includes an electrical input power supply 48 (the power supply can be internal or external), one or more light sources 50 (halogen bulb, laser or diode) which may be or not filtered by an optical wavelength selective filter, the photodetector 38, an electronic processor and memory chip with an input for an electronic card 40 (which could serve for example to store information), or the like, an interrupter or switch 54, and a speaker 56 with an amplifier 58 to emit sounds to warn the operator of the presence of tartar.

[0027] The valve 28 is provided on the first water supply tube 24, the latter being flexible and being connected at one end thereof to the handle 18 of the probe 12 and at another end thereof to the water source 30. The valve 28 allows for the flow of water to be adjusted.

[0028] Therefore, the system 10 can transmit light having an appropriate spectral composition via the illumination fibre(s) 14 onto the tooth's surface and can retrieve the light reflected by the tooth's surface via the detection fibre(s) 16 which may, or not, be distinct from the illumination fibre(s) 14. This reflected light is then detected by a photodetector present in the casing 34 such as to be analysed. Depending on how the spectral composition of the incident light is altered by the reflection thereof on the tooth's surface, an algorithm allows to determine from the photodetector signal if the probe 12 is viewing, or not, tartar. Therefore, if the spectral composition of the reflected light falls within the range or ranges previously determined for dental tartar, the algorithm sends a sensory signal to the operator, such as by actuating the luminous indicator 42 on the handle 18 via the optical fibre 44 which conveys light generated in the casing 34 to the indicator 42, although the signal could also be given in the form of sound, vibration, etc.

[0029] With reference particularly to Fig. 4b, the illumination fibre(s) 14 is (are) used to carry light from two LEDs 62 and 64, having different emission spectra and located in the casing 34, up to the distal end 36 of the probe 12. The light emitted by the two LEDs 62 and 64 is coupled into the illumination fibre(s) 14 and, for this coupling, a dichroic mirror is used, also called a dichroic beamsplitter, as it is selective in wavelengths in transmitting light to pass within a range of wavelengths while reflecting light in another range of wavelengths. Such a dichroic mirror or dichroic beamsplitter is also called hot mirror or cold mirror, depending on the wavelength ranges for which the mirror is reflective or transmissive. A set of lenses in a "Y" configuration, or any suitable means, may also be used instead of the dichroic mirror or dichroic beamsplitter to combine the light beams emitted by the LEDs 62 and 64 and couple them into the illumination fibre(s) 14. In Fig. 4b, which illustrates the coupling in the illumination fibre 14, numeral 66 refers to lenses while numeral 68 is for the dichroic beamsplitter which is at 45° and which transmits the light in the wavelength range emitted by LED 62 and reflects the light in the wavelength range emitted by LED 64.

[0030] The LEDs 62 and 64 are chosen based on the spectral bands in which the reflectance properties of tartar are different from the reflectance properties of the other artefacts which could possibly be encountered by a probe inserted between a tooth and its gum (healthy parts of the tooth and gum), and this even when blood is present. In fact, in these spectral bands, the spectral transmission of blood has minimal effect. The choice of the spectral bands was determined by a spectral study of the reflectance properties of tartar for the wavelength range of the electromagnetic spectrum between 400 nm and 1,000 nm. This spectral study was conducted in the presence and in the absence of blood. LED 62 emits in the red area of the spectrum and its emission spectrum has its peak at approximately 625 nm and extends from 600 nm to 650 nm. For LED 64, its emission spectrum extends between 800 nm and 920 nm. The LEDs 62 and 64, or any other appropriate light source, could also operate with other wavelengths that are appropriate for the discrimination of tartar, such as in the green region of the spectrum.

[0031] With respect to the detection principle used in

the present system 10, it operates on the basis of the following. The light reflected by the tooth T is received by the detection fibre 16 and is conveyed to a photodiode located in the casing 34 so as to be transduced into an electric signal. The electronic detection of the light reflected by the tooth and transmitted by the detection fibre (s) 16 operates under the "lock-in" detection principle (also referred to as phase-sensitive detection), although other signal processing approaches could be contemplated. Generally, this principle consists in modulating the intensity of a light source at a given and known modulation frequency (which should not be confused with the optical frequency of the light source). The modulated light is sent onto the medium being inspected and the light, resulting from the interaction with the medium, is detected with a photodetector that converts it into an electric signal. This electric signal is then demodulated such as to extract therefrom only its component having the frequency at which the light source was modulated. This principle allows for the detection of very small signals with great efficiency.

[0032] In the system 10, there are two light sources (i.e. the LEDs 62 and 64, although there could be more or less, e.g. 3 LEDs) that are modulated at different frequencies, thereby permitting the detection of the light emitted by both LEDs with a single photodiode by demodulating the electric signal of the photodiode at the two modulation frequencies of the LEDs to obtain a measurement of the amount of the light reflected by the tooth in the two spectral bands associated with the LEDs 62 and 64. These levels appear as signals V1 and V2 at the outputs of the two lock-in circuits associated with the emission channels of the LEDs 62 and 64, respectively, and are used by the processing algorithm. The lock-in detection is herein used for two purposes: (1) it allows to electronically separate (at the detection) the light of both chosen spectral bands impinging on a single detector, and (2) the light levels reflected by the tooth and then detected are very weak and the lock-in method is exploited for its sensitivity.

[0033] The signals V1 and V2 at the exits of the lock-in circuits are processed in real time by an electronic processor integrated with the rest of the electronic components of the casing 34. The processing algorithm is programmed in this processor. The processing algorithm produces the ratio of these two signals V1 and *V2,* y= V1/V2 (the order in which this ratio is taken is irrelevant). If this ratio is in a range of values associated with tartar (this range having been previously established using calibration measurements), then the probe 12 is located on tartar. In this case, the algorithm sends a signal to activate a warning sound (that can be deactivated by the operator, if desired) and to activate the warning LED in the casing 34 with the light of the warning LED being transmitted through the optical fibre(s) 44 and being visible through the indicator 42 located on the probe handle 18.

[0034] To determine the range of values of the ratio y associated with tartar, a large number of measurements are taken on teeth at various healthy locations thereof and where there is tartar, and this with different levels of blood. By knowing, for each of these measurements, if it was taken on a healthy part or where there is tartar, data are obtained for each of these two situations. By bringing the histograms of these data on a graphic, the range of values associated with tartar is determined.

[0035] In use, the operator mounts the probe 12 of the system 10 of the present invention on the tartar removing apparatus A (although both the detection system 10 and the removal apparatus A could be kept separate from each other during their use). The operator (1) uses the probe 12 to determine where there is tartar and then (2) proceeds to removing the tartar in a conventional manner in regions where tartar has been so detected. The operator then (3) verifies with the probe 12 that the removal of subgingival tartar is complete, and steps (2) and (3) are then repeated until no tartar is detected. To locate tartar with the present detection system 10 in both the above steps (1) and (3), the operator inserts the end section 60 of the probe 12 behind the gum G (i.e. in the periodontal pocket P). The operator then slides the free distal end 36 of the end section 60 of the probe 12 against the surface of the root R of the tooth E, sweeping this surface. The operator must also ensure adequate supply of water to the root R of the tooth E by adjusting the position of the valve 28, which may be manually operated via a foot pedal or a control provided on the handle 18 of the probe 12. When the operator receives a sensory stimulation or signal (e.g. from the illumination of the optical fibre 44, through the indicator 42, or any other means of indication in replacement or in addition to the indicator 42, such as a buzzer, vibrations, etc.) from the electronic system, the operator knows that there is some subgingival tartar at the location of the distal end 36 of the probe 12 and thus visually notes the position of the distal end 36 of the probe 12 such that the operator can then proceed with step (2) which again consists in using the tartar removing apparatus A, for removing the remaining tartar at that location.

[0036] Here, for coupling the light from the LEDs 62 and 64, a particular approach has been presented using a dichroic mirror and lenses, but any other configuration, such as a "Y" configuration, which allows to couple the light from the LEDs into the fibres would do as well, the fundamental point being the coupling of light into the fibres.

[0037] For instance, Fig. 6a illustrates a coupling 100 by fusion of two optical fibres 102 and 104 into a single fibre 106. Two LEDs 108 and 110 are used, each emitting light through a pair of lenses 112 and 114. Reference numeral 116 denotes a fused region. This method is commercially known as a WDM coupler.

[0038] Fig. 6b illustrates another coupling 200 which uses a "Y" configuration to couple the two lights. More particularly, two LEDs 202 and 204 are positioned each behind a pair of lenses 206 and 208 such as to emit light therethrough. The lenses 206 and 208 focalise the light

on the extremity of an optical fibre 210. Reference numeral 212 denotes the optical axis of the fibre 210.

[0039] Fig. 6c illustrates a further coupling 300 which also uses a "Y" configuration but here to couple four lights that are produced by four LEDs 302, 304, 306 and 308 positioned each Behind a pair of lenses 310 and 312 such as to emit light therethrough. The lenses 310 and 312 focalise the light on the extremity of an optical fibre 314. Reference numeral 316 denotes the optical axis of the fibre 314. It is noted that in a further coupling, also in a "Y" configuration, there could be three LEDs instead of the two and four LEDs found respectively in just-described couplings 200 and 300 of Figs. 6b and 6c.

[0040] Also, as regards the detection principle described above (i.e. the lock-in detection), other principles could be used as well. Any approach that can deliver signals that are sufficiently insensitive to noise to provide for discrimination between tartar and other artefacts that can be found in a periodontal pocket P can be considered. Furthermore, in a numeric system, there could be used for instance two LEDs having different wavelengths (but possibly of same frequency), which are activated repeatedly one after the other and with a delay therebetween.

[0041] As an alternative to the processing algorithm presented hereinabove, combinations of the signals *V1* and V2 other than the above ratio *y* could be considered. Indeed, the classification of the data into "is tartar" and "is not tartar" could be done in a two-dimensional space, for instance by plotting *V1* versus *V2,* or any other function of *V1* and *V2* versus another function of *V1* and *V2* that is independent from the previous function. Also, if more than two LEDs or other sources of light (such as lasers, halogen lamps, spectral lamps, filtered lamps, etc.) are used, information can be gathered and analysed in two or more dimensions.

[0042] Furthermore as an alternative to the approach just described, a spectrometer could be used to measure a spectrum of the light reflected by the tooth and this spectrum would then be analysed with an algorithm to determined if it corresponds to a spectrum of tartar or to a spectrum of another artefact. Any other suitable method may be used to analyse the spectrum received and compare it with the spectrum of tartar with a view to detesting the presence of tartar.

[0043] The system 10 could also include a recalibration function. A warning signal can also be provided to indicate when too much blood is present in the area being examined by the probe 12 and that the system 10 cannot make an adequate reading and thus cannot determine with sufficient precision if tartar is present on the tooth in this area.

[0044] A further feature could be included to indicate if the probe 12 or, more specifically, the illumination and/or detection fibres 14 and 16 thereof are too worn out to be efficiently used and should thus be replaced. Such a state could be detected by insufficient light being received in the electronic system provided in the casing 34.

[0045] In addition to providing to the operator the luminous (or other) signal that indicates the presence of tartar with an indicator (such as the illustrated optical fibre 44), the system 10 may also include a monitor that displays further information to the operator such as electronic signals within the system which would help his/her diagnostic.

[0046] There may also be included a means of collecting data from the electronic system (e.g. via a computer and software, including an electronic card 40, etc.), to be saved in any kind of storing medium for allowing the patient's history to be followed.

[0047] For the present embodiment of the system 10, the reflectance properties of tartar in the range between 400nm and 1,000nm have been studied, and light sources in that range are used (the two LEDs 62 and 64). However, use of light sources emitting below 400nm in the ultraviolet (UV) range or above 1,000nm in the far infrared could also be envisaged,

[0048] Also, as the spectral responses of various artefacts other than tartar are known, such as those of enamel, of the tooth's root surface, of the gum, of blood, of tooth decay (caries), of tooth fillings, etc., it is possible to adapt, e.g. program, the system 10 so that a tartar-presence signal is given to the operator as a result of the detection of spectral characteristics that are not representative of those of the aforementioned artefacts. Therefore, if the system 10 detects only spectral characteristics of these artefacts (wherein the term "artefacts" herein excludes tartar), there is no tartar in the region under examination.

[0049] As tartar does not respond to UV light, whereas other artefacts do, if UV light is directed onto the tooth, absence of fluorescence may be an indication of the presence of tartar.

[0050] Means other than optical fibres may be used to illuminate the teeth and to collect light reflected therefrom as long as the reflected light is of sufficient intensity to allow it to be analysed.

[0051] The illumination fibres 14 and detection fibres 16 and second water supply tube 26 could, instead of being part (downstream of the connector which connects the cable strand 32 to the handle 18) of the probe 12, be incorporated within a tartar removing instrument (using ultrasounds or other means) to further integrate together the tartar detection and removal processes. In such a case, the combined detection and removal instrument would include a switch for alternating between the tartar detection and tartar removing modes. Such a switch could be actuated by the operator or be actuated automatically for switching between the above two modes at an adjustable frequency, e.g. every 1/15 to 1/100 second. The combined detection and removal instrument could thus be displaced along the tooth while removing the tartar therefrom and indicating, for instance with a luminous or sound-based indicator, the presence of remaining tartar. This would continue until the indicator of the detection system of the instrument is not actuated.

Claims

1. A dental tartar (S) detection system (10) comprising a probe (12) adapted to be displaced along a tooth (T), illumination means (14) for illuminating with an incident light a region on the tooth (T), detection means (16) for collecting the light returned thereat, and an analysing system (34) for providing a signal (42, 56) to an operator of said probe (12), **characterised in that** two LEDs (62, 64) are provided for illuminating with the incident light at two predetermined ranges of wavelengths a region on the tooth (T), the dental tartar (5) detection system (10) is arranged in such a way that tartar (5) is detected when measurements of the reflected light in one or more predetermined ranges of wavelengths fall within any first predetermined range of values that are characteristic of tartar (S), or when said measurements do not fall within any second predetermined range of values that are characteristic of artefacts other than tartar, wherein at least one of said predetermined ranges of wavelengths includes spectral bands in which the reflectance properties of tartar (S) are different from the reflectance properties of the other artefacts encountered by a probe (12) inserted between a tooth and its gum, permitting detection of said dental tartar (S) in the presence of blood.

2. A dental tartar detection system as defined in Claim 1, wherein said first predetermined range of values cover wavelengths associated with spectral reflectance characteristics of tartar.

3. A dental tartar detection system as defined in any one of Claims 1 and 2, wherein said probe (12) comprises a distal end (36) with said illumination and detection means (14, 16) terminating substantially adjacent said distal end (36).

4. A dental tartar detection system as defined in Claim 3, wherein said illumination means (14) and said detection means (16) comprise at least one optical fibre (14, 16) having a distal end located adjacent said distal end (36) of said probe (12), said illumination means (14) also comprising a light source (50) at a proximal end of said optical fibre (14) such that said incident light emitted by said light source (50) Is transmitted by said optical fibre (14) to said distal end thereof and to the tooth.

5. A dental tartar detection system as defined in any one of Claims 1 to 4, wherein said predetermined range of values cover wavelengths associated with colours of tartar.

6. A dental tartar detection system as defined In Claim 4, wherein said predetermined range of values cover wavelengths associated with colours of tartar.

7. A dental tartar detection system as defined in Claim 6, wherein said analysing system (34) is adapted to analyse said reflected light and providing said signal.

8. A dental tartar detection system as defined in any one of Claims 4, 6 and 7, wherein said illumination means (14) and said detection means (16) each comprises one said optical fibre (14, 16), said distal end of each said optical fibre being located adjacent said distal end (36) of said probe (12).

9. A dental tartar detection system as defined in any one of Claims 1 to 8, further comprising an irrigation system (22) for delivering a fluid in the vicinity of the tooth.

10. A dental tartar detection system as defined in any one of Claims 4 and 6 to 8, further comprising an irrigation system (22) for delivering a fluid in the vicinity of the tooth.

11. A dental tartar detection system as defined in Claim 10, wherein said irrigation system (22) comprises a fluid supply tube (24) having a distal end thereof adjacent said distal end of each said optical fibre (14, 16), and a fluid source (50) in fluid communication with said supply tube (24) upstream of said distal end thereof.

12. A dental tartar detection system as defined in Claim 11, wherein each said optical fibre and said supply tube (24) have distal sections (19) thereof that are part of said probe (12).

13. A dental tartar detection system as defined in Claim 12, wherein each said optical fibre (14, 16) and said supply tube (24) comprise proximal sections that are detachably connected to said distal sections (19) for allowing said distal sections (19) and said probe (12) to be selectively detached from said proximal sections for discarding said distal sections (19) and said probe (12) and replacing with new ones, or for sterilising said distal sections (19) and said probe (12) before being returned to said proximal sections for further use thereof.

14. A dental tartar detection system as defined in any one of Claims 1 to 11, wherein said illumination and detection means (14, 16) each comprise proximal and distal sections that are detachably connected together for allowing said distal sections and said probe (12) to be selectively detached from said proximal sections for discarding said distal sections and said probe (12) and replacing with new ones, or for sterilising said distal sections and said probe (12) before being returned to said proximal sections for further use thereof.

15. A dental tartar detection system as defined in any one of Claims 1 to 14, wherein said probe (12) comprises attachment means (20) adapted for detachably mounting said probe (12) to a tartar removal apparatus (A) such that said detection system can be used jointly with the removal apparatus (A).

16. A dental tartar detection system as defined in any one of Claims 1 to 14, in combination with a tartar removal apparatus (A), wherein said probe (12) comprises distal ends of said illumination and detection means and of said removal apparatus (A) such that said detection system is integral with said removal apparatus (A).

17. A dental tartar detection system as define in any one of Claims 10 to 13, in combination with a tartar removal apparatus (A), wherein said probe (12) comprises distal ends of said illumination and detection means and of said removal apparatus (A) such that said detection system is integral with said removal apparatus (A).

18. A dental tartar detection system as defined in any one of Claims 16 and 17, in combination with a tartar removal apparatus (A), wherein said removal apparatus (A) comprises an ultrasound emitting system.

19. A dental tartar detection system as defined in any one of Claims 1 to 18, wherein said probe (12) comprises a handle (18) for the operator.

20. A dental tartar detection system as defined in Claim 11, wherein said irrigation system (22) comprises a valve (28) for controlling a flow of said fluid.

21. A dental tartar detection system as defined in Claim 20, wherein said probe (12) comprises a handle (18) for the operator and said irrigation system (22) comprises a valve (28) for controlling a flow of said fluid, said handle (18) being provided with a control means for operating said valve (28).

22. A dental tartar detection system as defined in any one of Claims 1 to 21, wherein there is provided an indicator means (42, 56) adapted to be actuated by said detection means (16) to indicate to the operator the presence of tartar substantially at a position of a distal end of said detection means (16).

23. A dental tartar detection system as defined in Claim 22, wherein said indicator means (42, 56) comprises at least one of a luminous, a sound and a vibratory indicator.

24. A dental tartar detection system as defined in Claim 22, wherein said indicator means (42) is provided on said probe (12) and comprises an optical fibre (44) extending between said detection means (16) and said probe (12) for providing a luminous indicator (42) on said probe (12) when tartar has been detected by said detection means (16).

25. A dental tartar detection system as defined in Claim 30, wherein said monitor means is adapted to show a schematic or graphic representation of a broad range of wavelengths with boundaries representative of said any predetermined range of values being indicated on said representation, said monitor means also being adapted to show readings of said reflected light on said representation such that positions of said readings thereon relative to said boundaries are indicative of the presence or absence of tartar.

26. A dental tartar detection system as defined in any one of Claims 15 to 18, wherein a manual switch means actuated by the operator is provided for switching between a removal mode and a detection mode of said removal apparatus and said detection means (16), respectively.

27. A dental tartar detection system as defined in any one of claims 15 to 18, wherein an automatic switch means is provided for automatically switching between a removal mode and a detection mode of said removal apparatus and said detection means, respectively, at an adjustable frequency.

28. A dental tartar detection system as defined in Claim 1, wherein said second predetermined range of values cover wavelengths associated with spectral reflectance characteristics of said artefacts.

29. A dental tartar detection system as defined in any one of Claims 1 to 28, wherein said analysing system (34) comprises software for storing and/or updating data relative to the patient's history.

30. A dental tartar detection system as defined in Claim 22, wherein said indicator means also comprises a monitor means adapted to display further information to the operator, said information including electronic signals which may be useful in detecting tartar.

Patentansprüche

1. Detektionssystem (10) für Zahnstein (S), umfassend eine Sonde (12), die dazu ausgelegt ist, einen Zahn (T) entlang verschoben zu werden, Beleuchtungsmittel (14) zum Beleuchten eines Bereichs auf dem Zahn (T) mit Auflicht, Detektionsmittel (16) zum Sammeln des hier zurückgekommenen Lichts, und Analysiersystem (34) zum Liefern eines Signals (42, 56) an einen Bediener der Sonde (12), **dadurch ge-**

kennzeichnet, dass zwei LEDs (62, 64) zum Beleuchten eines Bereichs des Zahns (T) mit dem Auflicht mit zwei vorbestimmten Bereichen von Wellenlängen vorgesehen sind, wobei das Detektionssystem (10) für Zahnstein (S) derart angeordnet ist, dass Zahnstein (S) detektiert ist, wenn Messungen des reflektierten Lichts in einem oder mehreren vorbestimmten Bereichen von Wellenlängen innerhalb eines ersten vorbestimmten Bereichs von Werten fallen, die für Zahnstein (S) charakteristisch sind, oder wenn die Messungen nicht innerhalb eines zweiten vorbestimmten Bereichs von Werten fallen, die für andere Artefakte als Zahnstein charakteristisch sind, wobei mindestens einer der vorbestimmten Bereiche von Wellenlängen Spektralbänder enthält, in denen sich die Reflexionseigenschaften von Zahnstein (S) von den Reflexionseigenschaften der anderen Artefakte unterscheiden, denen eine zwischen einem Zahn und dessen Zahnfleisch eingeführte Sonde (12) begegnet, wodurch die Detektion des Zahnsteins (S) in der Gegenwart von Blut ermöglicht wird.

2. Zahnsteindetektionssystem nach Anspruch 1, wobei der erste vorbestimmte Bereich von Werten mit spektralen Reflexionscharakteristika von Zahnstein assoziierte Wellenlängen abdeckt.

3. Zahnsteindetektionssystem nach Anspruch 1 oder 2, wobei die Sonde (12) ein distales Ende (36) mit den Beleuchtungs- und Detektionsmitteln (14, 16) umfasst, die im Wesentlichen neben dem distalen Ende (36) terminieren.

4. Zahnsteindetektionssystem nach Anspruch 3, wobei die Beleuchtungsmittel die Detektionsmittel (14) mindestens einen Lichtwellenleiter (14, 16) mit einem distalen Ende, das sich neben dem distalen Ende (36) der Sonde (12) befindet, umfasst, und das Beleuchtungsmittel (14) auch eine Lichtquelle (50) an einem proximalen Ende des Lichtwellenleiters (14) umfassen, so dass das von der Lichtquelle (50) abgegebene Auflicht von dem Lichtwellenleiter (14) an dessen distales Ende und zum Zahn übertragen wird.

5. Zahnsteindetektionssystem nach einem der Ansprüche 1 bis 4, wobei der vorbestimmte Bereich von Werten mit Farben von Zahnstein assoziierte Wellenlängen abdeckt.

6. Zahnsteindetektionssystem nach Anspruch 4, wobei der vorbestimmte Bereich von Werten mit Farben von Zahnstein assoziierte Wellenlängen abdeckt.

7. Zahnsteindetektionssystem nach Anspruch 6, wobei das Analysiersystem (34) zum Analysieren des reflektierten Lichts und Bereitstellung des Signals ausgelegt ist.

8. Zahnsteindetektionssystem nach einem der Ansprüche 4, 6 und 7, wobei die Beleuchtungsmittel (14) und die Detektionsmittel (16) jeweils einen Lichtwellenleiter (14, 16) umfassen, wobei sich das distale Ende jedes Lichtwellenleiters neben dem distalen Ende (36) der Sonde (12) befindet.

9. Zahnsteindetektionssystem nach einem der Ansprüche 1 bis 8, ferner umfassend ein Bewässerungssystem (22) zur Lieferung eines Fluids in der Nähe des Zahns.

10. Zahnsteindetektionssystem nach einem der Ansprüche 4 und 6 bis 8, ferner umfassend ein Bewässerungssystem (22) zur Lieferung eines Fluids in der Nähe des Zahns.

11. Zahnsteindetektionssystem nach Anspruch 10, wobei das Bewässerungssystem (22) einen Fluidzufuhrschlauch (24) mit einem distalen Ende davon neben dem distalen Ende jedes Lichtwellenleiters (14, 16) und eine Fluidquelle (50) in Fluidverbindung mit dem Zufuhrschlauch (24) stromaufwärts des distalen Endes davon umfasst.

12. Zahnsteindetektionssystem nach Anspruch 11, wobei jeder Lichtwellenleiter und der Zufuhrschlauch (24) distale Abschnitte (19) davon, die Teil der Sonde (12) sind, aufweisen.

13. Zahnsteindetektionssystem nach Anspruch 12, wobei jeder Lichtwellenleiter (14, 16) und der Zufuhrschlauch (24) proximale Abschnitte umfassen, die ablösbar mit den distalen Abschnitten (19) verbunden sind, damit sich die distalen Abschnitte (19) und die Sonde (12) selektiv von den proximalen Abschnitten ablösen lassen, um die distalen Abschnitte (19) und die Sonde (12) zu verwerfen und mit neuen zu ersetzen oder um die distalen Abschnitte (19) und die Probe (12) zu sterilisieren, bevor sie wieder zu ihrer weiteren Verwendung an den proximalen Abschnitten angebracht werden.

14. Zahnsteindetektionssystem nach einem der Ansprüche 1 bis 11, wobei die Beleuchtungs- und Detektionsmittel (14, 16) jeweils proximale und distale Abschnitte umfassen, die ablösbar miteinander verbunden sind, damit sich die distalen Abschnitte und die Sonde (12) selektiv von den proximalen Abschnitten ablösen lassen, um die distalen Abschnitte und die Sonde (12) zu verwerfen und mit neuen zu ersetzen oder um die distalen Abschnitte und die Probe (12) zu sterilisieren, bevor sie wieder zu ihrer weiteren Verwendung an den proximalen Abschnitten angebracht werden.

15. Zahnsteindetektionssystem nach einem der Ansprüche 1 bis 14, wobei die Sonde (12) Befestigungsmittel (20) umfasst, die zur ablösbaren Anbringung der Sonde (12) an eine Zahnsteinentfernungsvorrichtung (A) ausgelegt ist, so dass das Detektionssystem zusammen mit der Entfernungsvorrichtung (A) verwendet werden kann.

16. Zahnsteindetektionssystem nach einem der Ansprüche 1 bis 14, in Kombination mit einer Zahnsteinentfernungsvorrichtung (A), wobei die Sonde (12) distale Enden der Beleuchtungs- und Detektionsmittel und der Entfernungsvorrichtung (A) umfasst, so dass das Detektionssystem integral mit der Entfernungsvorrichtung (A) ist.

17. Zahnsteindetektionssystem nach einem der Ansprüche 10 bis 13, in Kombination mit einer Zahnsteinentfernungsvorrichtung (A), wobei die Sonde (12) distale Enden der Beleuchtungs- und Detektionsmittel und der Entfernungsvorrichtung (A) umfasst, so dass das Detektionssystem integral mit der Entfernungsvorrichtung (A) ist.

18. Zahnsteindetektionssystem nach Anspruch 16 oder 17, in Kombination mit einer Zahnsteinentfernungsvorrichtung (A), wobei die Entfernungsvorrichtung (A) ein ultraschallabgebendes System umfasst.

19. Zahnsteindetektionssystem nach einem der Ansprüche 1 bis 18, wobei die Sonde (12) einen Griff (18) für die Bedienperson umfasst.

20. Zahnsteindetektionssystem nach Anspruch 11, wobei das Bewässerungssystem (22) ein Ventil (28) zur Regelung eines Stroms des Fluids umfasst.

21. Zahnsteindetektionssystem nach Anspruch 20, wobei die Sonde (12) einen Griff (18) für die Bedienperson umfasst und das Bewässerungssystem (22) ein Ventil (28) zur Regelung eines Stroms des Fluids umfasst, wobei der Griff (18) mit einem Steuerungsmittel zum Bedienen des Ventils (28) versehen ist.

22. Zahnsteindetektionssystem nach einem der Ansprüche 1 bis 21, wobei ein Anzeigermittel (42, 56) vorgesehen ist, das dazu ausgelegt ist, von dem Detektionsmittel (16) betätigt zu werden, um der Bedienperson die Gegenwart von Zahnstein im Wesentlichen an einer Position eines distalen Endes des Detektionsmittels (16) anzuzeigen.

23. Zahnsteindetektionssystem nach Anspruch 22, wobei das Anzeigermittel (42, 56) einen Leucht-, Klang - und/oder einen vibrierenden Anzeiger umfasst.

24. Zahnsteindetektionssystem nach Anspruch 22, wobei das Anzeigermittel (42) auf der Sonde (12) vorgesehen ist und einen Lichtwellenleiter (44) umfasst, der sich zwischen dem Detektionsmittel (16) und der Sonde (12) erstreckt, um einen Leuchtanzeiger (42) auf der Sonde (12) vorzusehen, wenn Zahnstein von dem Detektionsmittel (16) erfasst wurde.

25. Zahnsteindetektionssystem nach Anspruch 30, wobei das Überwachungsmittel dazu ausgelegt ist, eine schematische oder graphische Repräsentation eines breiten Bereichs von Wellenlängen mit Grenzen zu zeigen, die für einen vorbestimmten Bereich von Werten, angezeigt auf der Repräsentation, repräsentativ sind, wobei das Überwachungsmittel auch dazu ausgelegt ist, Ausleseangaben des reflektierten Lichts auf der Repräsentation zu zeigen, so dass Positionen der Ausleseangaben darauf relativ zu den Grenzen auf die Anwesenheit oder Abwesenheit von Zahnstein schließen lassen.

26. Zahnsteindetektionssystem nach einem der Ansprüche 15 bis 18, wobei ein von der Bedienperson betätigtes manuelles Schaltmittel vorgesehen ist, um zwischen einem Entfernungsmodus und einem Detektionsmodus der Entfernungsvorrichtung bzw. des Detektionsmittels (16) zu schalten.

27. Zahnsteindetektionssystem nach einem der Ansprüche 15 bis 18, wobei ein automatisches Schaltmittel vorgesehen ist, um zwischen einem Entfernungsmodus und einem Detektionsmodus der Entfernungsvorrichtung bzw. des Detektionsmittels bei einer einstellbaren Frequenz automatisch zu schalten.

28. Zahnsteindetektionssystem nach Anspruch 1, wobei der zweite vorbestimmte Bereich von Werten mit spektralen Reflexionscharakteristika der Artefakte assoziierte Wellenlängen abdeckt.

29. Zahnsteindetektionssystem nach einem der Ansprüche 1 bis 28, wobei das Analysiersystem (34) Software zum Speichern und/oder Aktualisieren von Daten bezüglich der Patientengeschichte umfasst.

30. Zahnsteindetektionssystem nach Anspruch 22, wobei das Anzeigermittel auch ein Überwachungsmittel umfasst, das dazu ausgelegt ist, weitere Informationen für die Bedienperson anzuzeigen, wobei die Informationen elektronische Signale enthalten, die bei der Detektion von Zahnstein nützlich sein können.

Revendications

1. Système de détection (10) de tartre dentaire (S) comprenant une sonde (12) conçue pour être déplacée le long d'une dent (T), des moyens d'éclairage (14) pour éclairer avec une lumière incidente une région sur la dent (T), des moyens de détection (16)

pour collecter la lumière qui y est renvoyée, et un système d'analyse (34) pour fournir un signal (42, 56) à un opérateur de ladite sonde (12), **caractérisé en ce que** deux DEL (62, 64) sont prévues pour éclairer avec la lumière incidente dans deux plages prédéterminées de longueurs d'onde une région sur la dent (T), le système de détection (10) de tartre dentaire (S) est agencé d'une manière telle que le tartre (S) est détecté lorsque des mesures de la lumière réfléchie dans une ou plusieurs plages prédéterminées de longueurs d'onde tombent dans une quelconque première plage prédéterminée de valeurs qui sont caractéristiques du tartre (S), ou lorsque lesdites mesures ne tombent pas dans une quelconque deuxième plage prédéterminée de valeurs qui sont caractéristiques d'artéfacts autres que le tartre, dans lequel au moins l'une desdites plages prédéterminées de longueurs d'onde comprend des bandes spectrales dans lesquelles les propriétés de réflectance du tartre (S) sont différentes des propriétés de réflectance des autres artefacts rencontrés par une sonde (12) insérée entre une dent et sa gencive, permettant la détection dudit tartre dentaire (S) en présence de sang.

2. Système de détection de tartre dentaire selon la revendication 1, dans lequel ladite première plage prédéterminée de valeurs couvre les longueurs d'onde associées aux caractéristiques de réflectance spectrale du tartre.

3. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 et 2, dans lequel ladite sonde (12) comprend une extrémité distale (36), lesdits moyens d'éclairage et de détection (14, 16) se terminant sensiblement adjacents à ladite extrémité distale (36).

4. Système de détection de tartre dentaire selon la revendication 3, dans lequel lesdits moyens d'éclairage (14) et lesdits moyens de détection (16) comprennent au moins une fibre optique (14, 16) ayant une extrémité distale située adjacente à ladite extrémité distale (36) de ladite sonde (12), lesdits moyens d'éclairage (14) comprenant également une source de lumière (50) à une extrémité proximale de ladite fibre optique (14) de sorte que ladite lumière incidente émise par ladite source de lumière (50) est transmise par ladite fibre optique (14) à ladite extrémité distale de celle-ci et à la dent.

5. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 à 4, dans lequel ladite plage prédéterminée de valeurs couvre les longueurs d'onde associées aux couleurs du tartre.

6. Système de détection de tartre dentaire selon la revendication 4, dans lequel ladite plage prédéterminée de valeurs couvre les longueurs d'onde associées aux couleurs du tartre.

7. Système de détection de tartre dentaire selon la revendication 6, dans lequel ledit système d'analyse (34) est conçu pour analyser ladite lumière réfléchie et fournir ledit signal.

8. Système de détection de tartre dentaire selon l'une quelconque des revendications 4, 6 et 7, dans lequel lesdits moyens d'éclairage (14) et lesdits moyens de détection (16) comprennent chacun une dite fibre optique (14, 16), ladite extrémité distale de chaque dite fibre optique étant située adjacente à ladite extrémité distale (36) de ladite sonde (12).

9. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 à 8, comprenant en outre un système d'irrigation (22) pour délivrer un fluide dans le voisinage de la dent.

10. Système de détection de tartre dentaire selon l'une quelconque des revendications 4 et 6 à 8, comprenant en outre un système d'irrigation (22) pour délivrer un fluide dans le voisinage de la dent.

11. Système de détection de tartre dentaire selon la revendication 10, dans lequel ledit système d'irrigation (22) comprend un tube d'alimentation en fluide (24) ayant une extrémité distale de celui-ci adjacente à ladite extrémité distale de chaque dite fibre optique (14, 16), et une source de fluide (50) en communication fluidique avec ledit tube d'alimentation (24) en amont de ladite extrémité distale de celui-ci.

12. Système de détection de tartre dentaire selon la revendication 11, dans lequel chaque dite fibre optique et ledit tube d'alimentation (24) ont leurs sections distales (19) qui font partie de ladite sonde (12).

13. Système de détection de tartre dentaire selon la revendication 12, dans lequel chaque dite fibre optique (14, 16) et ledit tube d'alimentation (24) comprennent des sections proximales qui sont reliées de manière détachable auxdites sections distales (19) pour permettre que lesdites sections distales (19) et ladite sonde (12) soient détachées de manière sélective desdites sections proximales pour jeter lesdites sections distales (19) et ladite sonde (12) et les remplacer par des nouvelles, ou pour stériliser lesdites sections distales (19) et ladite sonde (12) avant de les rattacher auxdites sections proximales pour une autre utilisation de celles-ci.

14. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 à 11, dans lequel lesdits moyens d'éclairage et de détection (14, 16) comprennent chacun des sections proximale et dis-

tale qui sont reliées de manière détachable, ensemble, pour permettre que lesdites sections distales et ladite sonde (12) soient détachées de manière sélective desdites sections proximales pour jeter lesdites sections distales et ladite sonde (12) et les remplacer par des nouvelles, ou pour stériliser lesdites sections distales et ladite sonde (12) avant de les rattacher auxdites sections proximales pour une autre utilisation de celles-ci.

15. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 à 14, dans lequel ladite sonde (12) comprend des moyens de fixation (20) conçus pour monter ladite sonde (12) de manière détachable sur un appareil d'élimination de tartre (A) de sorte que ledit système de détection puisse être utilisé conjointement avec l'appareil d'élimination (A).

16. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 à 14, en combinaison avec un appareil d'élimination de tartre (A), dans lequel ladite sonde (12) comprend les extrémités distales desdits moyens d'éclairage et de détection et dudit appareil d'élimination (A) de sorte que ledit système de détection est d'un seul tenant avec ledit appareil d'élimination (A).

17. Système de détection de tartre dentaire selon l'une quelconque des revendications 10 à 13, en combinaison avec un appareil d'élimination de tartre (A), dans lequel ladite sonde (12) comprend les extrémités distales desdits moyens d'éclairage et de détection et dudit appareil d'élimination (A) de sorte que ledit système de détection est d'un seul tenant avec ledit appareil d'élimination (A).

18. Système de détection de tartre dentaire selon l'une quelconque des revendications 16 et 17, en combinaison avec un appareil d'élimination de tartre (A), dans lequel ledit appareil d'élimination (A) comprend un système d'émission d'ultrasons.

19. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 à 18, dans lequel ladite sonde (12) comprend une poignée (18) pour l'opérateur.

20. Système de détection de tartre dentaire selon la revendication 11, dans lequel ledit système d'irrigation (22) comprend une valve (28) pour réguler un écoulement dudit fluide.

21. Système de détection de tartre dentaire selon la revendication 20, dans lequel ladite sonde (12) comprend une poignée (18) pour l'opérateur et ledit système d'irrigation (22) comprend une valve (28) pour réguler un écoulement dudit fluide, ladite poignée (18) étant pourvue de moyens de commande pour actionner ladite valve (28).

22. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 à 21, dans lequel des moyens formant indicateur (42, 56) sont prévus, qui sont conçus pour être actionnés par lesdits moyens de détection (16) pour indiquer à l'opérateur la présence de tartre sensiblement à une position d'une extrémité distale desdits moyens de détection (16).

23. Système de détection de tartre dentaire selon la revendication 22, dans lequel lesdits moyens formant indicateur (42, 56) comprennent au moins l'un d'un indicateur lumineux, d'un indicateur sonore et d'un indicateur vibrant.

24. Système de détection de tartre dentaire selon la revendication 22, dans lequel lesdits moyens formant indicateur (42) sont prévus sur ladite sonde (12) et comprennent une fibre optique (44) s'étendant entre lesdits moyens de détection (16) et ladite sonde (12) pour fournir un indicateur lumineux (42) sur ladite sonde (12) lorsque du tartre a été détecté par lesdits moyens de détection (16).

25. Système de détection de tartre dentaire selon la revendication 30, dans lequel lesdits moyens de surveillance sont conçus pour montrer une représentation schématique ou graphique d'une large plage de longueurs d'onde avec les frontières représentatives de ladite quelconque plage prédéterminée de valeurs indiquées sur ladite représentation, lesdits moyens de surveillance étant également conçus pour montrer les lectures de ladite lumière réfléchie sur ladite représentation de sorte que les positions desdites lectures sur celle-ci par rapport auxdites frontières soient indicatives de la présence ou de l'absence de tartre.

26. Système de détection de tartre dentaire selon l'une quelconque des revendications 15 à 18, dans lequel des moyens de commutation manuelle actionnés par l'opérateur sont prévus pour commuter entre un mode d'élimination et un mode de détection dudit appareil d'élimination et desdits moyens de détection (16), respectivement.

27. Système de détection de tartre dentaire selon l'une quelconque des revendications 15 à 18, dans lequel des moyens de commutation automatique sont prévus pour commuter automatiquement entre un mode d'élimination et un mode de détection dudit appareil d'élimination et desdits moyens de détection, respectivement, à une fréquence ajustable.

28. Système de détection de tartre dentaire selon la re-

vendication 1, dans lequel ladite deuxième plage prédéterminée de valeurs couvre les longueurs d'onde associées aux caractéristiques de réflectance spectrale desdits artefacts.

29. Système de détection de tartre dentaire selon l'une quelconque des revendications 1 à 28, dans lequel ledit système d'analyse (34) comprend un logiciel pour mémoriser et/ou mettre à jour des données relatives à l'historique du patient.

30. Système de détection de tartre dentaire selon la revendication 22, dans lequel lesdits moyens formant indicateur comprennent également des moyens de surveillance conçus pour afficher des informations supplémentaires pour l'opérateur, lesdites informations comprenant des signaux électroniques qui peuvent être utiles pour la détection de tartre.

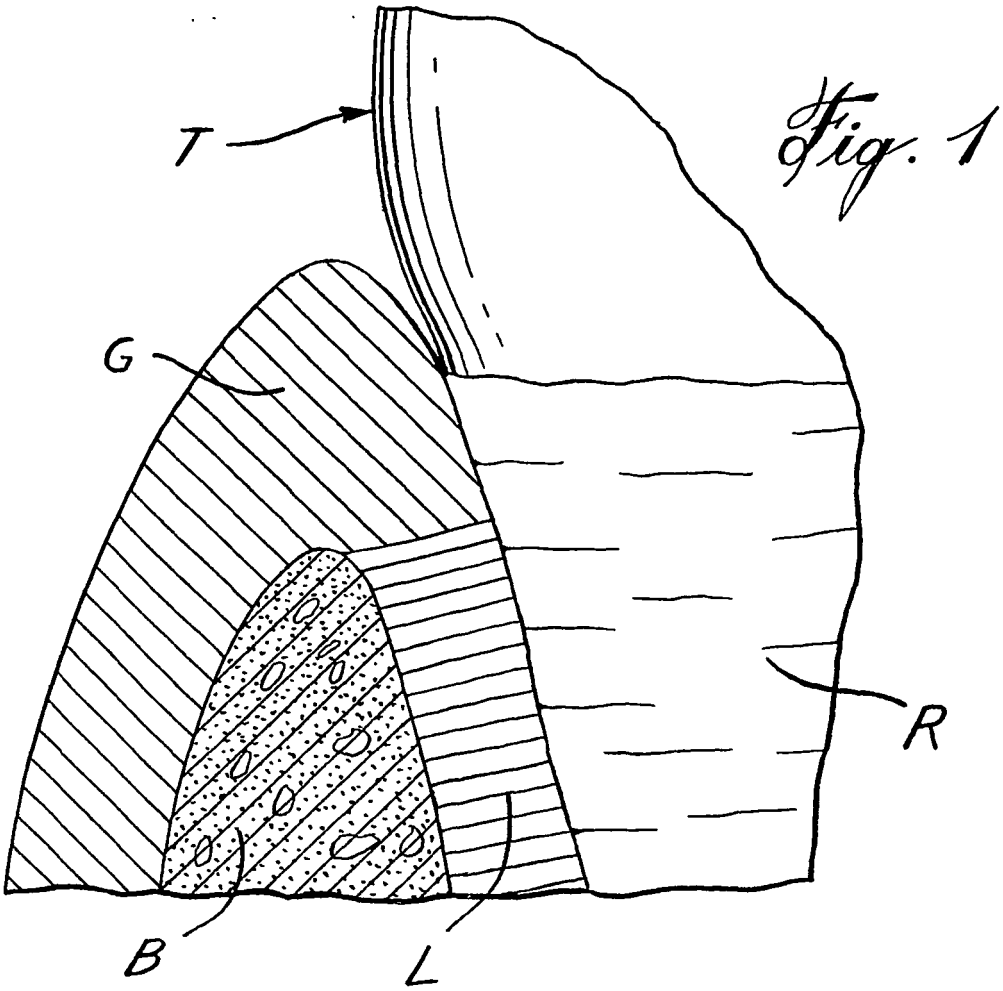
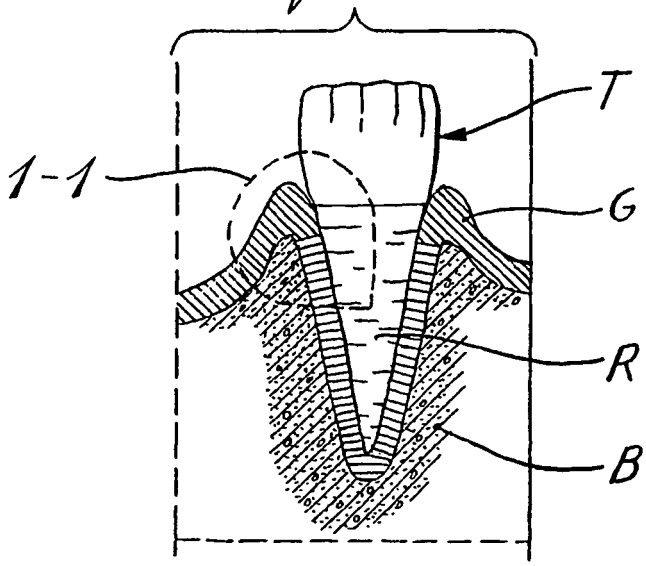


Fig. 1

Fig. 1a



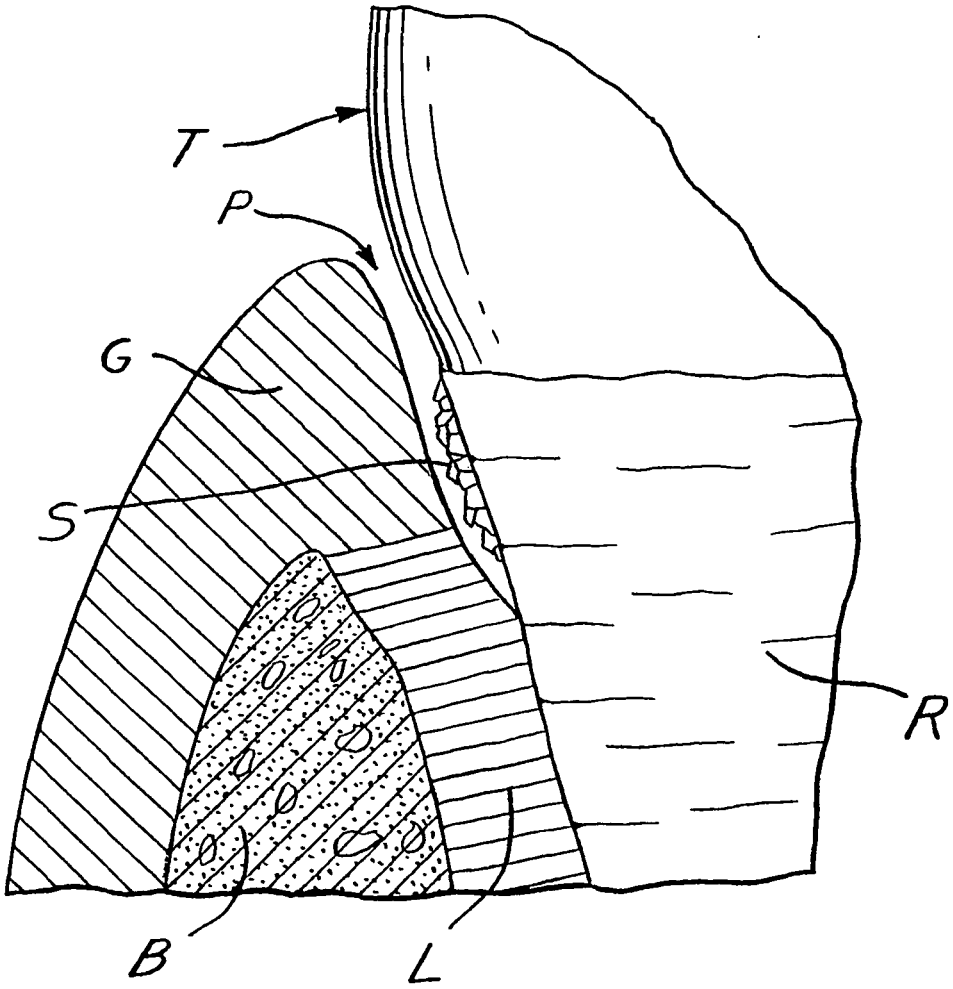


Fig. 2

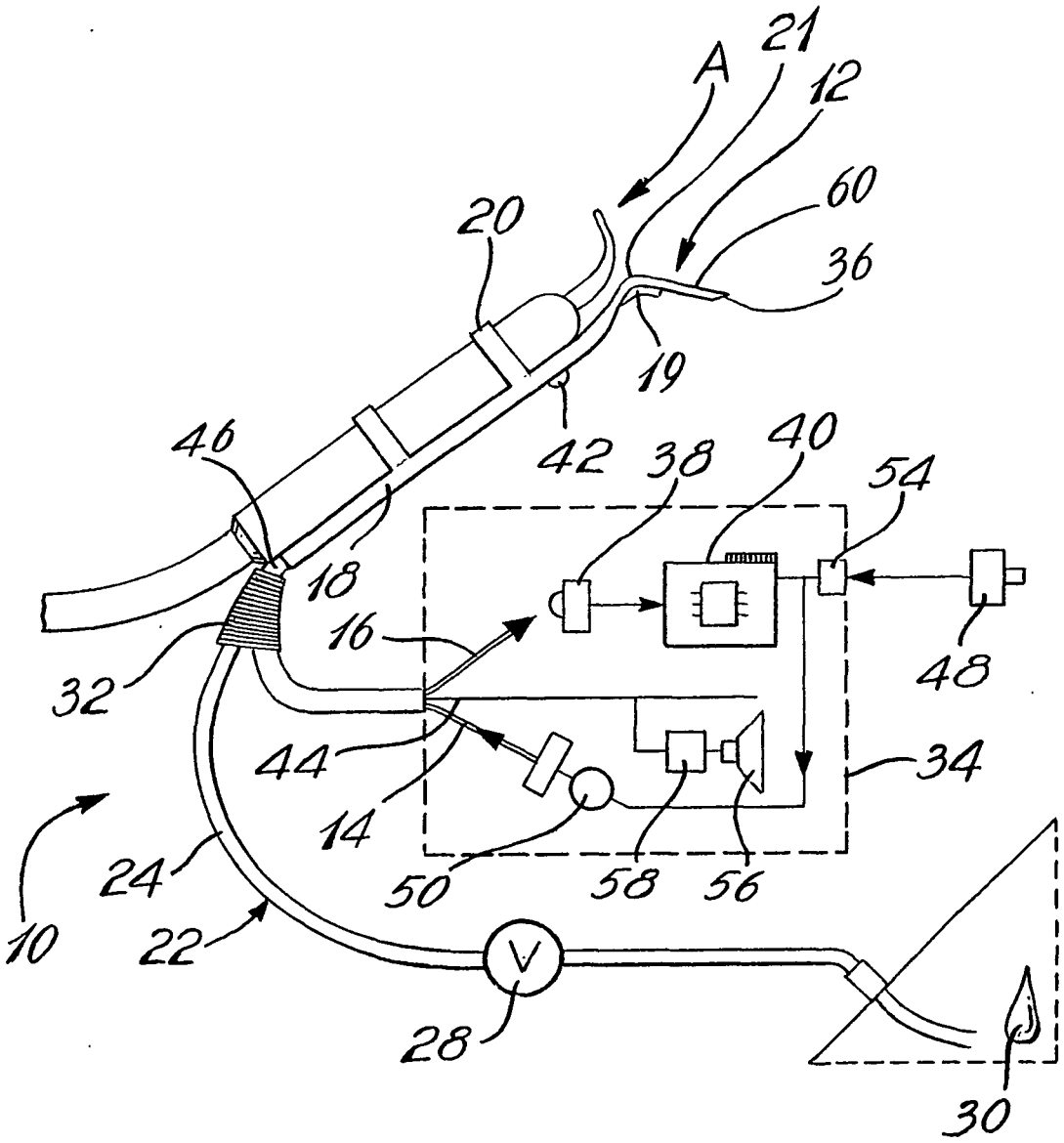

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Fig. 3

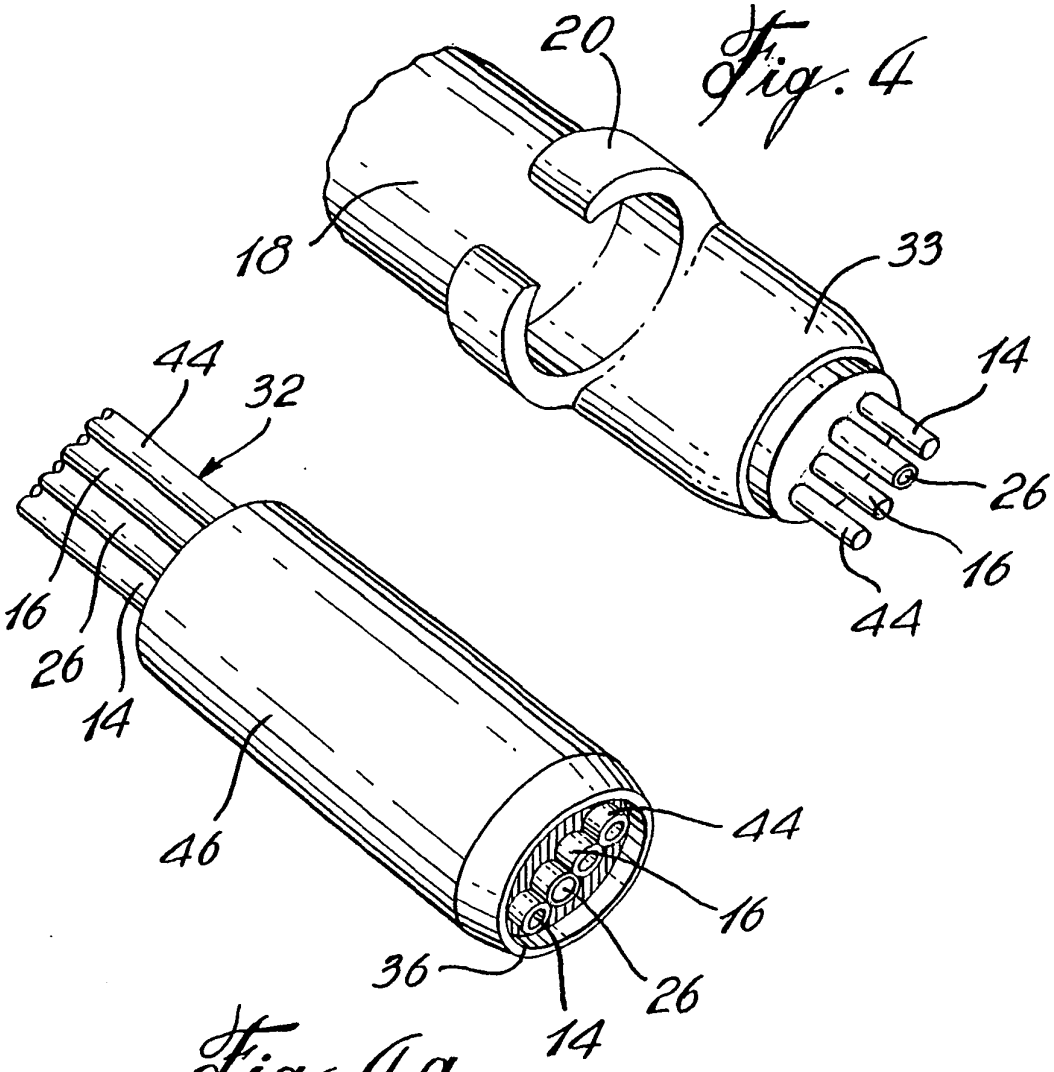

Fig. 4

Fig. 4a

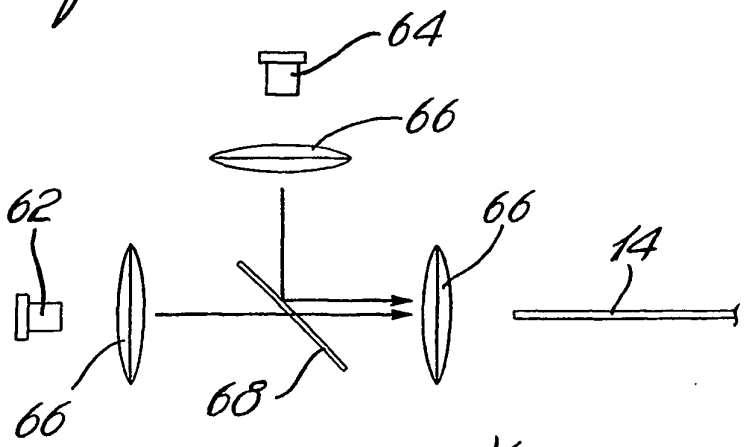

Fig. 4b

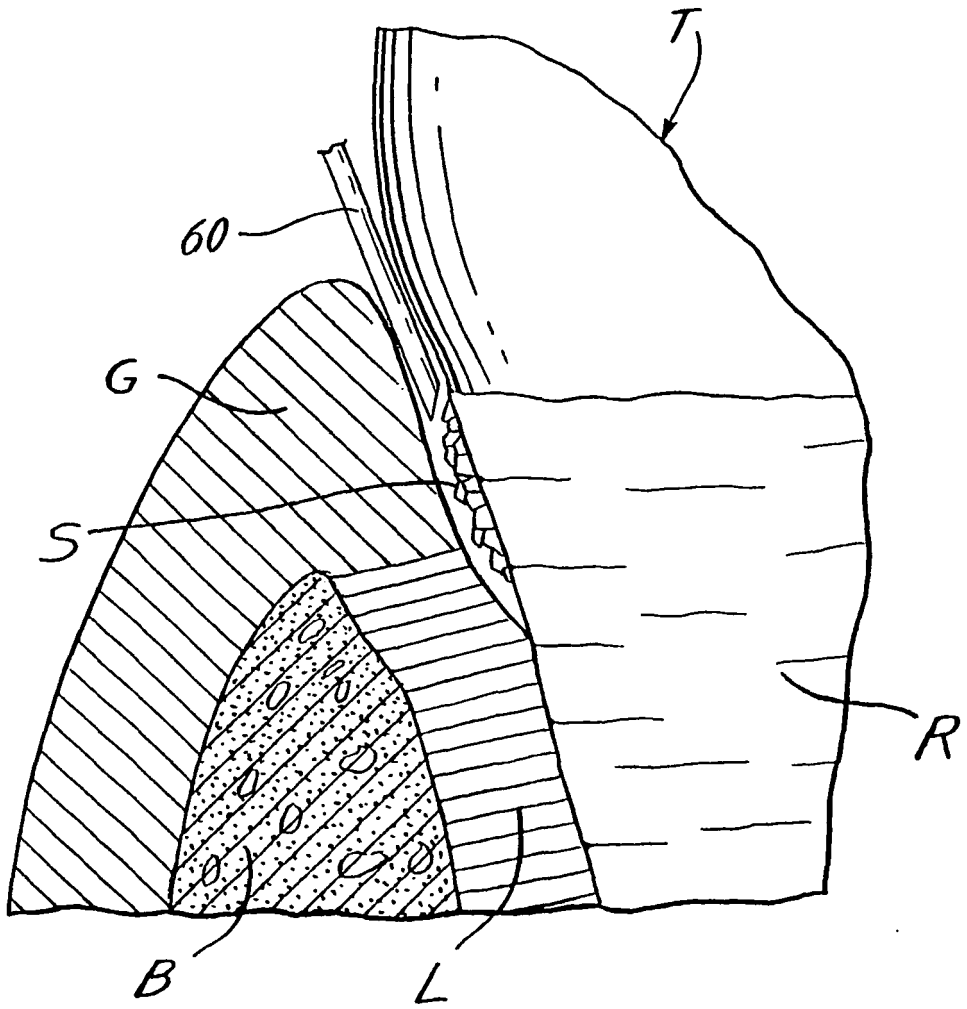

Fig. 5

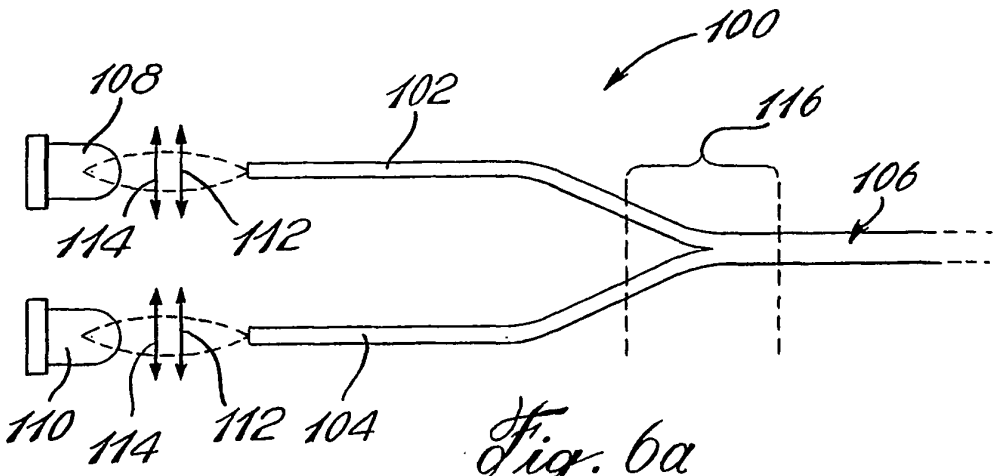

Fig. 6a

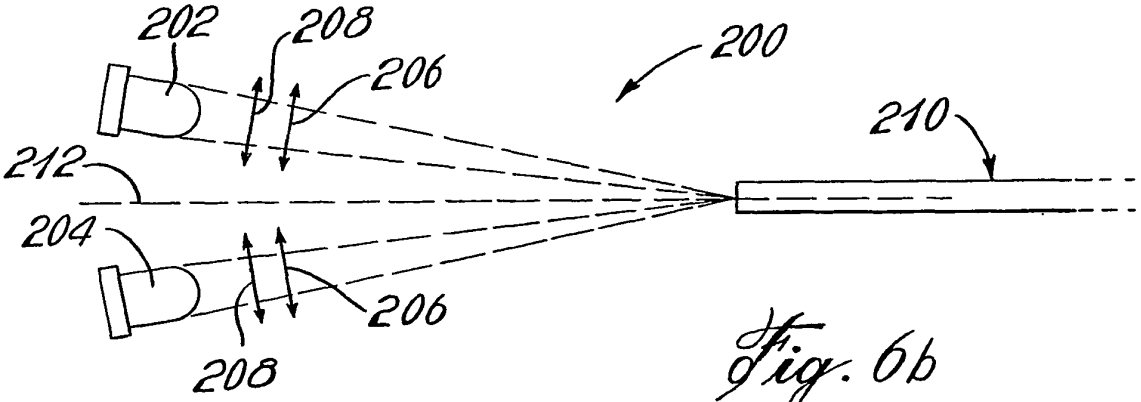

Fig. 6b

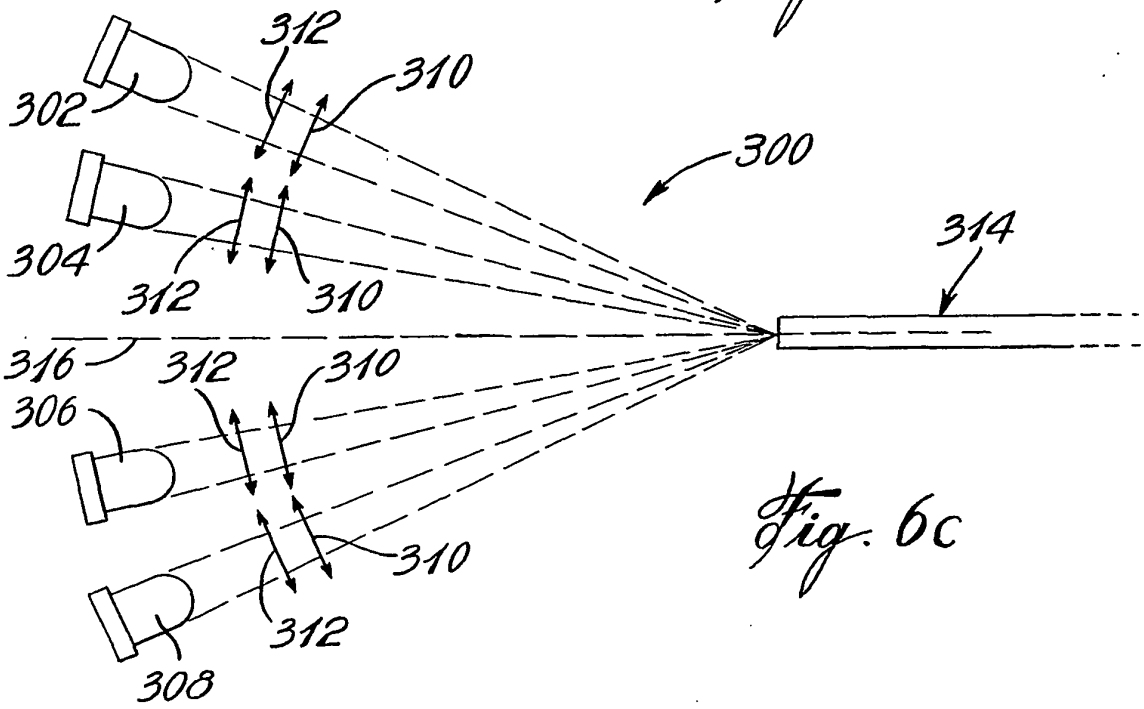

Fig. 6c

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5230621 A **[0005]**
- US 5328365 A **[0005]**
- DE 4015066 **[0006]**
- DE 29705934 **[0007]**

专利名称(译)	用于检测牙垢的系统和方法		
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申请号	EP2001942525	申请日	2001-01-22
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当前申请(专利权)人(译)	登士柏CANADA LTD		
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CPC分类号	A61B5/0088		
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其他公开文献	EP1248557A1		
外部链接	Espacenet		

摘要(译)

一种牙科牙垢检测系统（10），特别是用于检测龈下牙垢（S）的牙垢检测系统（10）包括适于沿着牙齿（T）移位的探针（12），用于利用入射光照射区域在所述牙齿（T）上，用于收集在其上反射的光的检测系统（16），以及用于在对所述探头（12）的操作者的一个或多个预定波长范围落入牙垢（S）的特征的值的任何预定范围内。通常，基于牙垢（S）可能具有的可能的颜色实现牙垢（S）的检测，使得上述一个或多个预定范围的值覆盖与牙垢（S）的颜色相关联的波长。