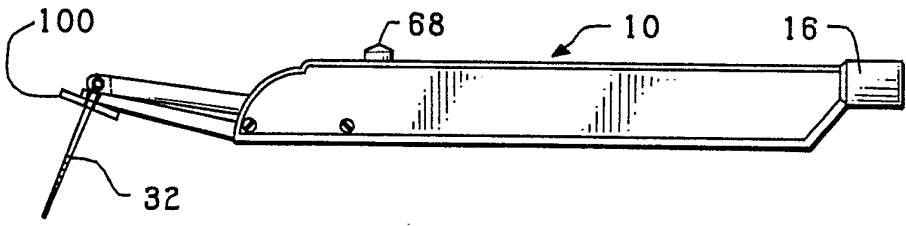


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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| <b>(51) International Patent Classification <sup>5</sup> :</b><br><br><b>A61B 5/10</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>A1</b> | <b>(11) International Publication Number:</b> <b>WO 90/11046</b><br><br><b>(43) International Publication Date:</b> 4 October 1990 (04.10.90)                                                                                                                                                                                                                                      |
| <b>(21) International Application Number:</b> PCT/US90/01306<br><b>(22) International Filing Date:</b> 16 March 1990 (16.03.90)<br><br><b>(30) Priority data:</b><br>324,813                      17 March 1989 (17.03.89)                      US<br><br><b>(71)(72) Applicants and Inventors:</b> LOW, Samuel, B. [US/US]; 2435 N.W. 35 Terrace, Gainesville, FL 32601 (US). HIRSCHFELD, John, W. [US/US]; 1404 NE 16 Place, Gainesville, FL 32609 (US). GIBBS, Charles, H. [US/US]; 1918 SW 48 Avenue, Gainesville, FL 32608 (US). LEE, James, G. [US/US]; 6517 NW 30 Terrace, Gainesville, FL 32601 (US).<br><br><b>(74) Agent:</b> SCHELLIN, Eric, Paul; Suite 704, 2121 Crystal Drive, Arlington, VA 22202 (US). |           | <b>(81) Designated States:</b> AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent).<br><br><b>Published</b><br><i>With international search report.</i> |
| <b>(54) Title:</b> PERIODONTAL PROBE WITH DISC<br><br><div style="text-align: center;">  </div><br><br><b>(57) Abstract</b><br><br><p>A periodontal probe (10) for measuring the distance from an occlusal surface of a tooth to the base of the gingival sulcus in a gum in which a disc (100) is movably mounted on the probe (10), said measurement being taken from the disc (100) on the surface of the tooth to the base of the gingival sulcus pocket.</p>                                                                                                                                                                  |           |                                                                                                                                                                                                                                                                                                                                                                                    |

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PERIODONTAL PROBE WITH DISC  
BACKGROUND OF THE INVENTION

This invention relates to a periodontal probe and recording apparatus of the type used by dentists to detect changes in the level of tissues attached to the tooth as an indicator of active periodontitis (gum disease). In this invention, measurement of tissue attachment level is referenced to an occlusal surface (top) of the teeth with a disk, in contrast to common pocket depth probes which reference tissue attachment level to the gingival margin (top of gum).

The recognition of most recently active periodontal lesions requires sensitive, unbiased, reproducible and reliable measurement of the level of the attached tissues (i.e., junctional epithelium and connective tissue. (See for example JM Goodson et al., Patterns of progression and regression of advanced destructive periodontal disease, Journal of Clinical Periodontology 9:472-481, 1982).

The most widely used diagnostic tool for the clinical assessment of attachment level is still the common periodontal probe (See for example, AM Polson and JM Goodson, Periodontal diagnosis-current status and future needs. Journal of Periodontology 56:25-34, 1985.

Measurements made with common periodontal probes are subject to error because of variations in probing force, low precision of measurement (i.e., 1 millimeter or wider spaced markings are read visually), poor communication between operator and recording assistant, and because of the use of an unstable reference such as the gingival margin (the gums swell with inflammation, shrink with improved hygiene and often permanently recede with gum disease), or because of a reference such as the cemento-enamel junction (CEJ), which is often angled, ill defined or obscured by plaque.

Recent inventions have overcome some of these problems by regulating probing force, using precise electronic measurement, and computer recording of the data (see for example, Grenfell et al., U.S. Patent # 3,943,914; Ackerman et al., U.S. Patent # 4,665,621, the "Florida Probe" (TM) by Hirschfeld, Gibbs and Lee, U.S. Patent #4,791,940), and

Jeffcoat et al., A new periodontal probe with automated cemento-enamel junction detection, Journal of Clinical Periodontology, 13:276-280, 1986.

5 Stents, which reference the probe measurement to the occlusal surfaces of the teeth, have been shown to be an accurate method of monitoring attachment level, (for use with the common probe - see Badersten et al., Reproducibility of probing attachment level measurements, Journal of Clinical Periodontology 11:475-485, 1984, for  
10 use with the "Florida Probe" (TM) see Magnusson et al., Attachment level measurements with a constant force electronic probe, Journal of Clinical Periodontology 15:185-188, 1988).

15 Stents, although usually accurate, have drawbacks including the cost of their fabrication, storage problems, tooth movements or loss of teeth altering the fit of the stent.

Stents may be eliminated, if the probe measurement may be referenced directly to an occlusal surface (top) of the  
20 tooth. Birek, et al. have demonstrated the viability of this concept using a circular shaped surface as a tooth top reference, employed in an automated periodontal probe of their own design (See Birek et al., Gingival attachment level measurements with an automated periodontal probe, Journal of Clinical Periodontology 14:472-477, 1987). In  
25 an effort to keep reproducibility high, Birek et al. used leveling sensors to help maintain the same orientation of the probe from session to session.

Another periodontal probe which references  
30 measurements to an occlusal tooth surface was described by A. Mombelli and H. Graf in an article title Depth-force-patterns in periodontal probing, Journal of Clinical Periodontology 13:126-130, 1986. This probe  
utilized an elliptical shaped transparent disk for making  
35 contact with the occlusal surface.

SUMMARY OF THE PRESENT INVENTION

The present invention is a modification to the "Florida Probe" TM (Hirschfeld, Gibbs and Lee- U.S. Patent #4,791,940) to adapt it for referencing periodontal probing measurement to an occlusal surface (top) of a tooth.

The current Florida Probe handpiece includes a tip which reciprocates through a sleeve. The edge of the sleeve is used to reference measurements to the gingival margin for pocket depth or to reference measurement to a ledge on an occlusal stent for monitoring changes in attachment level. The Florida Probe handpiece may be adapted for referencing measurements to an occlusal surface by substituting a Disk for the sleeve. Like the sleeve, the Disk is attached to the fixed arm. The plane of the Disk is perpendicular to the tip. The tip reciprocates through the disk.

The disk may be relatively small, ie., 5 millimeters in diameter, or relatively large, ie., 11 millimeters in diameter. During straight buccal and straight lingual measurements the probe tip is inserted into the sulcus, parallel to the root of the tooth. The Disk, being perpendicular to the tip, is held away from the crown of bulbus teeth. In these circumstances, the larger diameter Disk has the advantage of reaching an occlusal surface, whereas a small diameter disk will contact the side of the tooth. The side of the tooth would not be as reproducible a reference as an occlusal surface. Too large a Disk would obscure the operators view, be awkward to position in the mouth and become more sensitive to variation in angular positioning of the tip.

The Disk can be made elliptical in shape to accommodated a wide range of occlusal conditions and can be made transparent so as not to obscure the operator's view.

First Embodiment - Measures attachment level - No Lever

In the First embodiment, the tip extends approximately 20 millimeters below the disk. This tip is approximately twice as long as common pocket depth tips, so that it will reach from the bottom of a deep (ie., 10 millimeter) sulcus to an occlusal surface of a tooth. The end of the tip is

the same diameter as common probe tips (ie., 0.4 millimeter diameter) and tapers to about 0.8 millimeter diameter in the first 10 millimeters of its length similar to common probe tips. In operation, the tip is placed at the base of the gingival sulcus and aligned approximately parallel to the root of the tooth, the disk is lowered until it contacts an occlusal surface and then the foot switch is pressed to record the distance from the occlusal surface to the bottom of the sulcus.

10 Second Embodiment - Measures Attachment Level - Includes Lever

In the second embodiment, a lever is attached to the movable arm so that the tip may be withdrawn from the sulcus without moving the disk from its resting point against an occlusal surface. In operation, the tip is placed at the bottom of the gingival sulcus, the disk is lowered until it contacts an occlusal surface and the foot switch is pressed a first time to record the distance from the occlusal surface to the bottom of the sulcus (same procedure as for the first embodiment). Then the level is slowly pressed, lifting the tip from the sulcus until the tip is adjacent to the gingival margin. Then the foot switch is pressed a second time to record the distance from the occlusal surface to the top of the pocket (gingival margin). The computer can then compute pocket depth by subtracting the second measurement from the first. The tip can be raised again, this time to the cemento-enamel junction, CEJ, (if visible), then the foot switch is pressed a third time to record the distance from the occlusal surface to the CEJ. The computer can then compute the amount of gingival recession by subtracting the third measurement from the second.

A potential problem is that the disk may obscure the probe tip for view of the operator. The visibility can be improved by making the disk transparent or by reducing the size of the disk.

Third Embodiment - Measures Gingival Margin

In the third embodiment, a shorter, larger diameter tip is utilized. This tip is approximately 1.25 millimeter

diameter, projects about 10 millimeters below the disk, has a flat bottom and not taper. In operation, the tip is placed at the gingival margin (top of gum), the disk is lowered until it contacts an occlusal surface and the foot switch is pressed to record the distance from the occlusal surface to the gingival margin. This third embodiment would be used in conjunction with the first embodiment for calculation of pocket depth. That is, the operator would first measure all sites with the first embodiment. Then he would change probes to the third embodiment and again record all sites. The first recording would provide a baseline for monitoring changes in attachment level and the difference in the first and second recordings would yield pocket depth. The advantage of this third embodiment over the pocket depth probe is that it would be more comfortable for the patient.

Except for the Disk substituted for the sleeve, the "Disk-Florida Probe" is similar to the Florida Probe as described in U.S. Patent No. 4,791,940. The Disk-Florida Probe has an elongated body (handle) with a movable probe tip connected to a movable arm, an electronic measuring transducer removable attached to the probe body and an electrical cable extending from the electronic transducer to a remote recording apparatus such as a computer with a printer. Affixed to the probe tip end of the body is the stationary "Disk" of this invention, through which the tip reciprocates.

Incorporated into the electronic transducer device is a spring mechanism for applying a selected, constant force to the probe tip. In the previous patent, 4,791,940 either a coil spring or leaf spring was shown in the handle of the probe body for applying this force to the probe tip. No spring is shown in this current description of the Disk probe because it is preferable to deliver this force from the electronic transducer device and not internally from the probe handpiece. A spring device inside the probe handpiece must withstand repeated heat sterilization, which over time, may reduce the spring force. Also, since many probe handpieces can be used of one transducer device, it

is more economical to place a spring in the one transducer device and not place a spring in each handpiece.

The probe is removable and can be detached from the electronic displacement transducer for sterilization after each use. While the probe is being sterilized, another sterile probe can be attached and the system can continue to be used. In this manner, a single remote recording apparatus can be used to measure the periodontal pockets of more than one patient with a minimum of delay between each patient.

The electrical cable from the electronic transducer is multi-conductor for connecting to a computer interface. The computer interface, in turn, connects (for example, by a serial communications, RS232-C, port) to a computer. The computer serves to store the probing data, to compare the current data with previously stored data and to print a visual record.

A foot switch controller with three foot switches is also connected to the computer interface. One of the switches is depressed each time it is desired to record the probe measurement. Therefore, an accurate measurement can be obtained without the operator having to lose eye contact with the teeth or having to hand-record each measurement or having to employ an assistant to do so. Two additional foot switches are provided to allow other data to be recorded, including; bleeding, suppuration, tooth mobility and plaque and to allow backing up and advancing in the program for making corrections.

THE OBJECTIVES OF THIS INVENTION INCLUDE:

1. To create a visual and printed record of attachment level, pocket depth, recession, bleeding, suppuration, plaque, furcation involvement, tooth mobility, missing teeth and other data related to periodontal health.
2. Provide a constant probing force.
3. Provide a periodontal probe and recording apparatus that can be used by a single unassisted operator. Multiple foot switches and/or voice control can be used for controlling the system without losing eye contact with the mouth and without touching a non-sterile device with the

hands.

4. Maintain asepsis while recording the data.

5. Provide a disk for referencing attachment level, gingival margin and CEJ measurements to an occlusal surface of a tooth.

6. Provide a lever for raising the probe tip so that a single probe can be used to measure several anatomical points (ie., sulcus bottom, gingival margin, CEJ).

7. Provide instantaneous comparison to previous data to determine if attachment level, pocket depth, recession, etc. have become better or worse.

8. Provide a protective cover which includes zones of standard width for checking the accuracy of the periodontal probe.

The foregoing objectives are not stated in an order of importance and there may be other objectives and advantages of equal importance not stated that will become apparent from the following detailed description of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side view of an illustrative embodiment of the periodontal probe of the present invention.

Figure 2 is a top view of the periodontal probe of Figure 1.

Figure 3 is a side cross-sectional view of the periodontal probe of Figure 1.

Figure 4 is an expanded side view of the disk and tip portions of the periodontal probe of Figure 1.

Figure 5 is an expanded view of the connector for attaching a displacement transducer to the periodontal probe of Figure 1.

Figure 6 is a perspective view of an illustrative embodiment of the periodontal probe, displacement transducer, computer interface, recording computer apparatus and foot switch controller of the present invention.

Figure 7 is an expanded view of the disk and large diameter, flat bottomed tip used in measuring from an occlusal surface to the gingival margin.

Figure 8A shows a lever attached to the movable arm of the periodontal probe of Figure 1. The lever is in the up position and the tip is fully extended through the disk.

Figure 8B shows the periodontal probe of Figure 8A with the lever in the down position with the end of the tip withdrawn into the disk.

Figure 9 shows a side view of the protective cover a zone of accurate dimension.

Figure 10 shows the tip end of the periodontal probe of Figure 4 in position for measurement. The tip end is positioned at the bottom of the pocket (level of tissue attachment) and the disk is in contact with an occlusal surface.

Figure 11 shows the tip end of the periodontal probe of Figure 7 in position for measurement. The larger diameter, short, flat bottomed tip is positioned at the gingival margin and the disk is in contact with an occlusal surface.

#### DESCRIPTION OF THE PRESENT INVENTION

Referring to the drawings, there is shown in Figures 1-4, an instrument embodying the periodontal probe of the present invention.

Figure 1 shows a periodontal probe 10 consisting of a body 12 having at one end a probe tip 32 and a coupling 16 at the other end, which connects to an electronic displacement transducer 64, Figure 6.

Looking at Figure 3, a cross-section exposes the interior of the periodontal probe 10. The body 12 has a cavity 20. A rod 30 reciprocates in cavity 20 to activate a displacement transducer attached at coupling 16. Rod 30 also serves to apply a force, from the displacement transducer 64 (Figure 6), to the probe tip 32.

The tip end of the probe 14 of Figure 4 has a tapered probe tip 32 pivotally attached to a movable arm 34. In Figure 2, movable arm 34 has a slotted end 38 in which the probe tip 32 is pivotally attached by a pin 46. The movable arm is pivotally connected to the probe body 12 at pin 36. The probe tip 32 may (or may not) have graduation marks 44 in millimeters. The first 10 millimeters of tip

32 is similar to tips of common probes. The tip end is 0.4 millimeters in diameter. The tip tapers to 0.8 millimeters in diameter over the first 10 millimeters. Unlike common probe tips, however, the tip of the present invention  
5 extends another 10 or more millimeters at a constant diameter of 0.8 millimeters. The pivotal end of tip 32 has a circular loop which connects to slotted end 38 by a pin 46.

The probe tip 32 reciprocates through a disk 100,  
10 Figures 1-4. Disk 100 is rigidly attached to and is part of fixed arm 52. Fixed arm 52 is fixed to body 12 at 54. The probe tip 32 reciprocates through a clearance hole 57 in fixed arm 52 and also through a center bore 101 in disk 100. The center bore 101 in disk 100 serves as a guide for  
15 tip 32.

As pressure is applied to the end of tip 32, it slides upward in disk 100 against the constant spring force applied by rod 30 from a spring (not shown) in the displacement transducer attached at 16, Figure 6.

20 The rod 30 is pivotally connected at one end to the movable arm 34 at 62. The other end of rod 30 has a cylindrical shaped element for mechanically acting on the displacement transducer to produce electrical signals which can be transmitted through an electrical cable to a  
25 computer 66, Figure 6 (or remote digital readout display).

Displacement transducer are commercially available for converting the mechanical displacement of rod 30 into an electrical signal for entry to a computer (or remote digital readout display). The linear variable differential  
30 transformer (LVDT), potentiometer and optical encoder are three common types of displacement transducers which could be used by someone skilled in the art. A non-contact capacitive displacement transducer with digital readout has been described previously for this purpose in U.S. Patent  
35 # 4,791,940.

A housing would be constructed to support the displacement transducer and a means provided to attach it to coupling 16 at the end of the probe body 12, Figure 5. A means would be provided to connect rod 30 to the

displacement transducer such that movement of rod 30 would activate the displacement transducer such that movement of rod 30 would activate the displacement transducer 64 (Figure 6). The output of the displacement transducer 64 would be connected to a computer interface 103, Figure 6. A foot switch controller 80, would also be connected to computer interface 103 and when one of this foot switches (P1, P2, or P3) is pressed, the electrical signal from the displacement transducer is recorded to computer 66, Figure 6. The foot switch controller can include a heel riser 105 for the operator's comfort. The use of displacement transducers, computer interfaces and foot switches is obvious to someone skilled in the art and some examples have been described previously in U.S. Patent 4,791,940.

The rod 30 may be locked against movement by pressing the lock button 68 which reciprocates vertically on body 12, Figure 3. By pressing down on lock button 68, the rod 30 is pushed against the wall of cavity section 20 locking rod 30, movable arm 34 and probe tip 32 against movement.

The periodontal probe of Figures 1-4 can be modified for measuring the distance from the gingival margin to an occlusal surface by increasing the diameter of the tip 32, as in 32a of Figure 7, to approximately 1.25 millimeters in diameter, by making the end of the probe tip flat 32b and by shortening the length of the tip to about 10 millimeters. In order to accommodate the larger diameter tip 32a, the clearance hole 57a and the central bore 101a in disk 100 are made larger in diameter than their corresponding counterparts 57 and 101 (Figure 4).

The periodontal probe of Figures 1-4 may include a lever 102 rigidly attached and part of movable arm 34, Figures 8a and 8b. The lever 102 may be pressed, with a finger, to elevate the tip 32 through the disk 100, Figure 8b. Lever 102 may be held in the up position, Figure 8a, and serve to lock tip 32 in the fully extended position.

In operation, a protective cover 7 (Figure 9) is removed from the periodontal probe 10 exposing the probe end 14. The displacement transducer 64 is screwed in to the coupling 16 and the cable is connected between the

displacement transducer 64 and the computer interface 103. The computer interface 103 is in turn connected (for example to an RS232-C serial communications port) to the computer 66.

5       The probe tip 32 is placed at the bottom of the periodontal pocket C (Figure 10) between tooth B and gum A. Then disk 100 is pushed down, in the direction of tip 32, against the preset probing force, until the lower edge of disk 100 contacts an occlusal surface 104 of a tooth. (The  
10       occlusal surface 104 in contact with the disk 100 may be part of the tooth where the attachment level is being measured or it may be part of an adjacent tooth. The position and angulation of the probe tip will determine which occlusal surface of the particular dentition makes  
15       contact with disk 110).

      The measurement from the bottom of the pocket to the occlusal surface may be observed visually on the computer monitor 83 (Figure 6) and be permanently recorded on computer 66 when a foot pedal (P1, P2 or P3) of foot switch  
20       controller 80 is pushed. A printer 82 is electrically connected to the computer 66. Audio sounds from the computer via a tone generator or a voice synthesizer 84 can also be incorporated into the computer to remind and reassure the dentist that he is probing in the proper  
25       sequence or to alert him to a problem site.

      Voice recognition circuits 84 can also be incorporated into the computer to allow the operator to make voice commands to the computer. Voice recognition, synthesizer electronics and software 84 for use with computers for this  
30       purpose are commercially available and have been described previously in U.S. patent 4,791,940.

      The dentist may lock the probe tip 32 to the body 12 by pushing the lock button 68. With the probe tip 32 locked to the handle 12, the dentist can probe and feel the  
35       pocket as he would with common probes.

      The periodontal probe 10 can be checked for accuracy by measuring the thickness zone 8 on the protective cover 7, Figure 9. The protective cover 7 is sterilized with the periodontal probe 10 and therefore would not violate the

sterility of the probe tip end 14 during measurement of the thickness zone.

5 The periodontal probe 10 could be equipped with a fiber optic illuminating system (not shown) to increase light to the tip area 14. This illumination would be an aid to the dentist in placing the tip 32 in to the sulcus by increasing visibility in the mouth.

10 The operation of the periodontal probe with the larger diameter, flat bottom, shorter tip 32a (Figure 7) differs from the operation described above, for tip 32, in that the end of the tip 32b is placed at the gingival margin. Figure 11, instead of being placed at the bottom of the pocket. Then disk 100 is pushed down, in the direction of the tip 32a, against the preset probing force, until the  
15 disk 100 contacts an occlusal surface 104 of a tooth. The measurement from the occlusal surface to the gingival margin can be visually observed on the computer monitor 83 (Figure 6) and can be permanently recorded on computer 66 when a foot pedal (P1, P2 or P3) of foot switch controller  
20 80 is pushed. This measurement subtracted (ie by the computer 66) from the previously described measurement of the distance from the occlusal surface to the bottom of the pocket would yield pocket depth.

25 In other words, if the dentist were to probe the bottom of the pocket with periodontal probe 10 equipped with tip 32 (Figure 10) and then later probe to the gingival margin, at the same site, using periodontal probe 10 equipped with tip 32a, Figure 11, (while contacting the same occlusal surface with disk 100) pocket depth could be  
30 calculated by subtracting the two measurements. Changes in attachment level at the bottom of the pocket and changes in position of the gingival margin (ie., recession) would be monitored over time by making subsequent recordings.

35 The operation of the periodontal probe 10 modified with lever 102 (Figures 8a and 8b) begins by placing the tip 32 to the base of the pocket C (Figure 10) between tooth B and Gum A. Then disk 100 is pushed down, in the direction of tip 32, against the preset probing force, until disk 100 contacts an occlusal surface 104 of a tooth.

Then a foot pedal (P1, P2 or P3) of foot switch controller 80 is pressed to record the distance from the occlusal surface to the bottom of the pocket. Up to this point, the procedure is the same as previously described for the periodontal probe 10 with tip 32 and no lever. From this point on, the procedure differs. With the probe body 12 stabilized by contact of disk 100 with the occlusal surface 104, lever 102 is depressed, elevating tip 32, until the end of tip 32 is visually observed to be positioned adjacent to the gingival margin. Then a foot pedal of foot switch controller 80 is pressed and the distance from the occlusal surface to the gingival margin is recorded to computer 66. Finally, lever 102 is depressed further, with the finger, until tip 32 is elevated and observed visually to be positioned adjacent to the cemento-enamel junction (CEJ) of the tooth. Then a foot pedal is pressed so that the distance from the occlusal surface of the tooth to the CEJ is recorded to computer 66.

If the CEJ is below the gingival margin and not visible, the end of tip 32 could be elevated to the operators best judgement for the ideal location of the gingival margin and then the proper foot pedal pressed.

Computer 66 could then calculate pocket depth by subtracting the second measurement from the first and could calculate the amount of gingival recession by subtracting the third measurement from the second.

In a complete examination, size points on each tooth would be probed. A patient with all thirty two teeth requires a total of 192 sites to be recorded. The probing order is pre-selected on the computer 66 so that the data are labeled properly. Missing teeth are accounted for by the computer. A visual picture on the computer monitor 83 reminds the dentist which site should be probed next. The computer can be controlled by the foot switch controller 80 to back up and to move ahead in the sequence so that corrections can be made.

The data are stored on hard and/or floppy disks by the computer 66 and a hard copy for the patient's file (chart) can be printed. Additional copies for the patient,

insurance company, referring dentist etc may also be printed. The stored data are available for recall to compare with later recordings to monitor the patient's changes in status over many years.

- 5           The terms and expressions which can be employed in the foregoing abstract and specification are used therein as terms of description and not of limitation, and there is no intention, in the use of such terms and expressions, of excluding equivalents of the features shown and described,
- 10 or portions thereof, it is recognized that the scope of the invention is defined and limited only by the claims which follow.

CLAIMS

We claim:

1           1. A periodontal probe for measuring the distance  
2           from an occlusal surface of a tooth to the base of the  
3           gingival sulcus in a gum comprising:

4           a. a probe body;

5           b. a rigid probe tip for insertion in a periodontal  
6           pocket, said tip pivotally connected to a movable arm, said  
7           movable arm being pivotally connected to the probe body;  
8           and

9           c. a disk partially ensheathing said probe tip, said  
10          disk being fixed to said probe body, the probe tip being  
11          reciprocally movable in a bore in said disk.

1          2. The periodontal probe of Claim 1 where said  
2          movable arm includes a pivot joint to which a rod is  
3          pivotally connected, said rod being guided by a groove in  
4          the probe body and reciprocates in this groove when the  
5          probe tip reciprocates in its sheathing disk.

1          3. The periodontal probe of Claim 2, where said probe  
2          includes a means for locking the probe tip to the probe  
3          body.

1          4. The periodontal probe of Claim 3, wherein said  
2          locking means includes a locking button which, when  
3          activated, presses the rod against the probe body,  
4          frictionally locking the rod to the probe body.

1          5. The periodontal probe of Claim 2, wherein said  
2          probe includes a displacement transducer for converting the  
3          reciprocating movement of said probe tip relative to said  
4          disk into an electrical signal representing the distance  
5          between an occlusal surface of the tooth and a) the base of  
6          the gingival sulcus, the gingival margin and the  
7          cemento-enamel junction.

1          6. The periodontal probe of claim 5, wherein said  
2          displacement transducer includes a spring mechanism for  
3          applying a preselected, constant force to said probe tip  
4          via said rod.

1          7. The periodontal probe of claim 5, wherein said  
2          probe includes means for converting said signal into a  
3          permanent record, a visual display and audio tones

1 representing the distance between the end of the probe tip  
2 and the disk.

± 8. The periodontal probe of Claim 5 including means  
2 for actuating said signal on command to produce said record  
3 of said distance.

1 9. The periodontal probe of Claim 8 wherein said  
2 means for actuating said signal is a foot switch.

1 10. The periodontal probe of Claim 8 wherein said  
2 means for actuation said signal includes a voice  
3 recognition circuit.

1 11. The periodontal probe of Claim 1 wherein said  
2 probe includes a lever rigidly attached to said movable  
3 arm.

1 12. The periodontal probe of Claim 11 wherein said  
2 lever is shaped so that movement of said lever toward the  
3 said probe body will move the end of said probe tip closer  
4 to said disk.

1 13. The periodontal probe of Claim 1 wherein said  
2 body is fabricated from a single piece of material in a  
3 channel shape.

1 14. The periodontal probe of Claim 1 wherein the end  
2 of said probe tip is made larger in diameter than common  
3 probe tips and with a flat bottom so that said probe tip is  
4 adapted for remaining stationary while being pressed  
5 against the gingival margin.

1 15. The periodontal probe of Claim 1 where said disk  
2 is fabricated of a transparent material.

1 16. A protective cover for a periodontal probe which  
2 includes single or multiple thickness zones of accurate  
3 dimension for use in checking the accuracy of said  
5 periodontal probe.

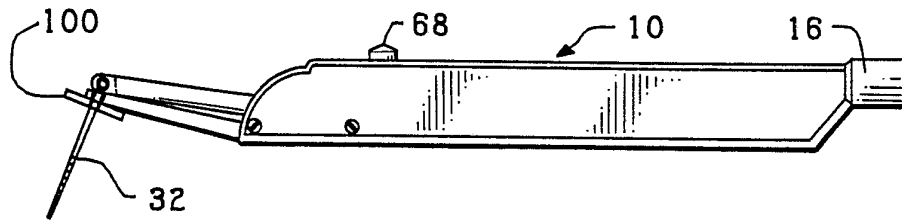
1 17. The protective cover to Claim 16 wherein said  
2 thickness zones include markings indicting the thickness of  
3 said zones.

1 18. The periodontal probe of Claim 1 wherein said  
2 disk is circular in shape.

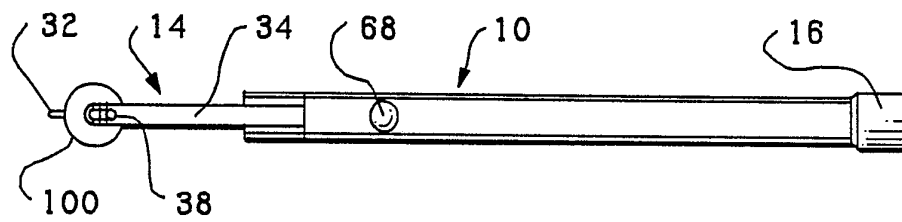
1 19. The periodontal probe of Claim 1 wherein said  
2 disk is elliptical in shape.

- 1           20. The periodontal probe of Claim 13 wherein said
- 2   channel shaped body allows for easy cleaning of said probe.

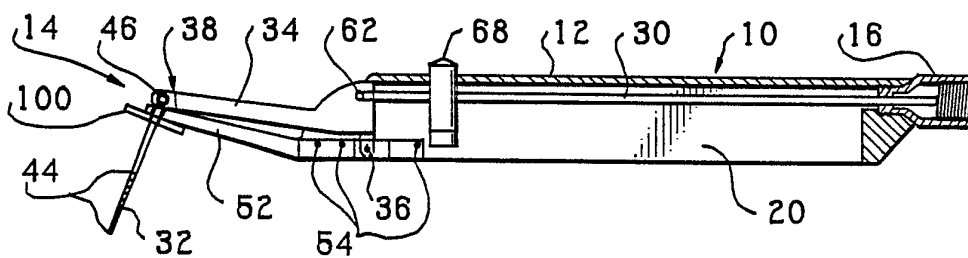
1/6



**Fig. 1**

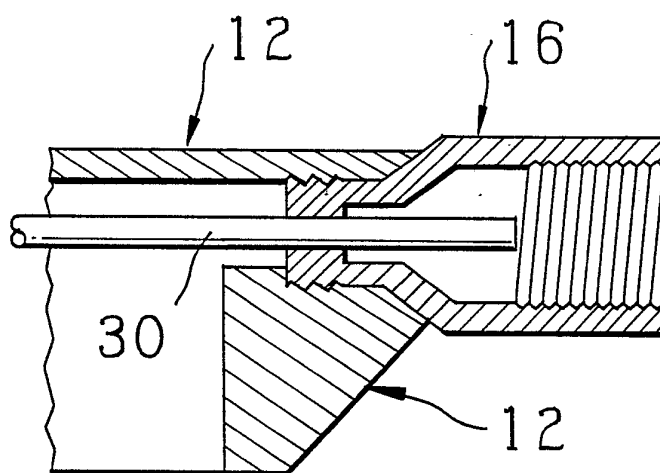
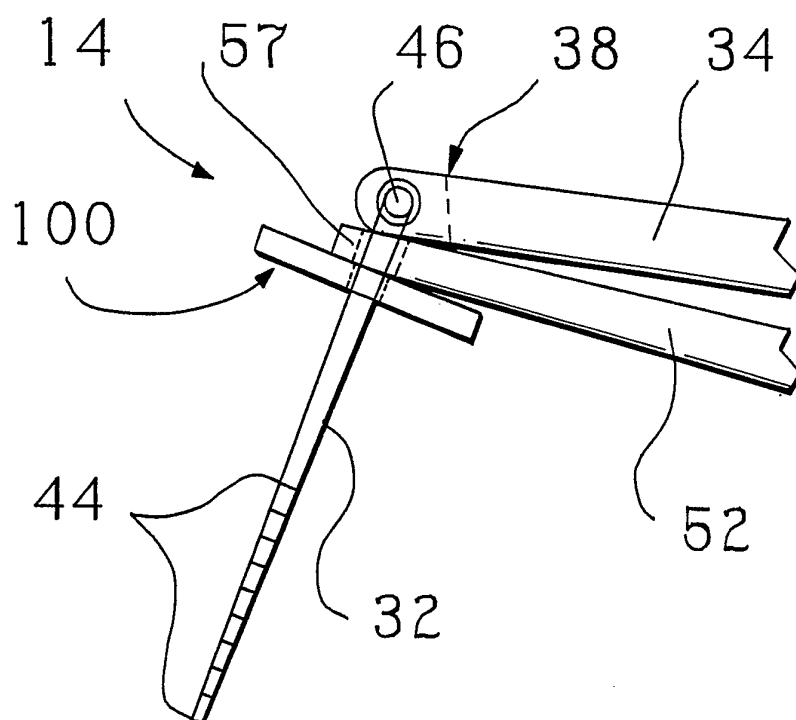


**Fig. 2**



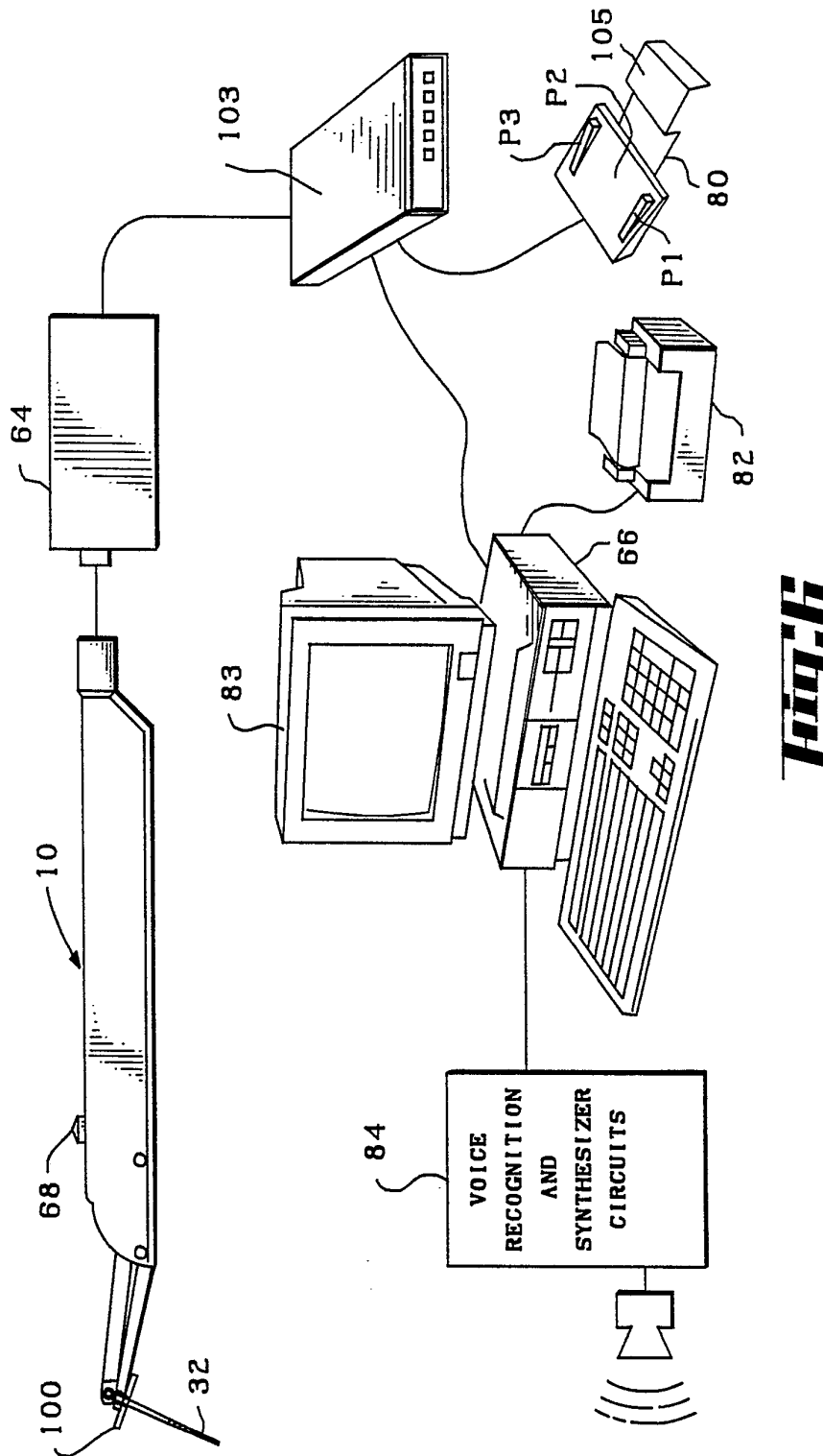
**Fig. 3**

2/6

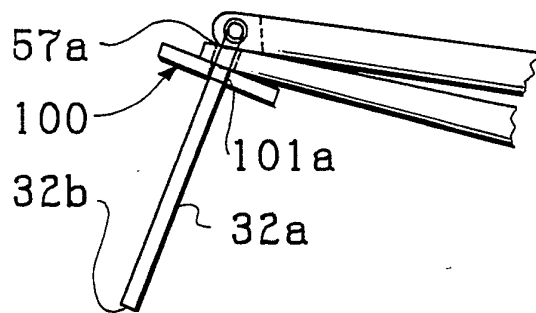
**Fig. 4****Fig. 5**

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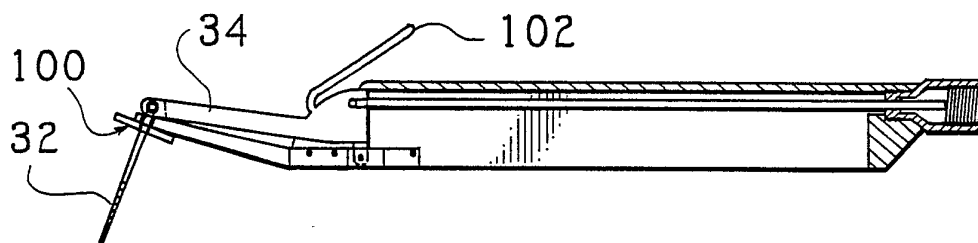
3/6



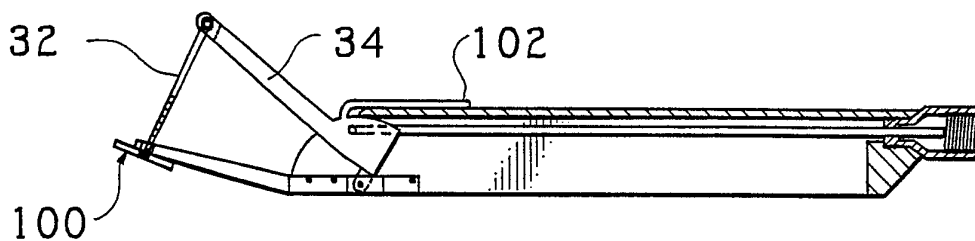
SUBSTITUTE SHEET



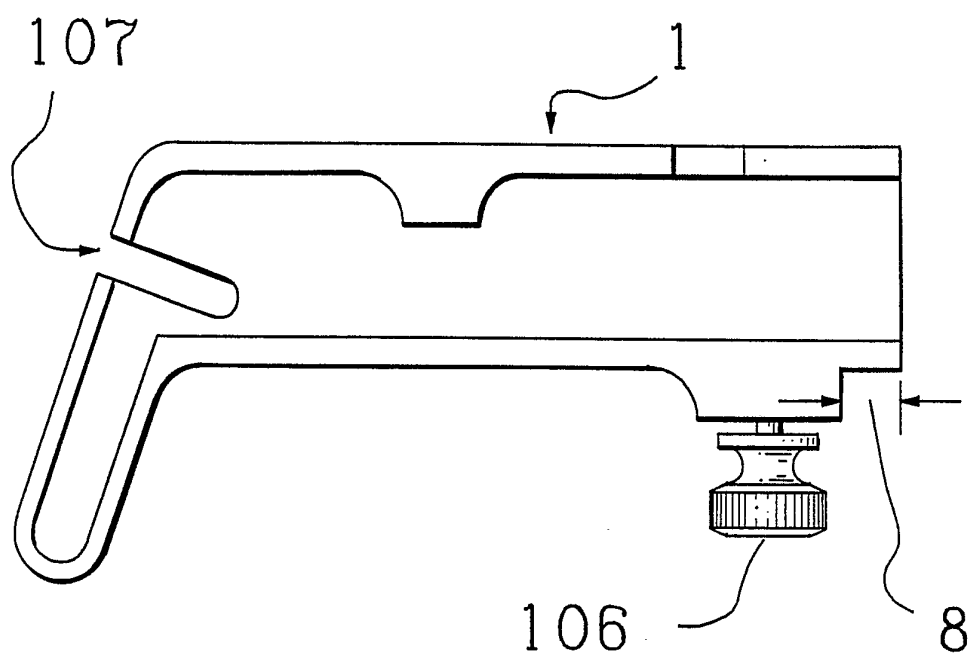
**Fig. 7**



**Fig. 8 A**

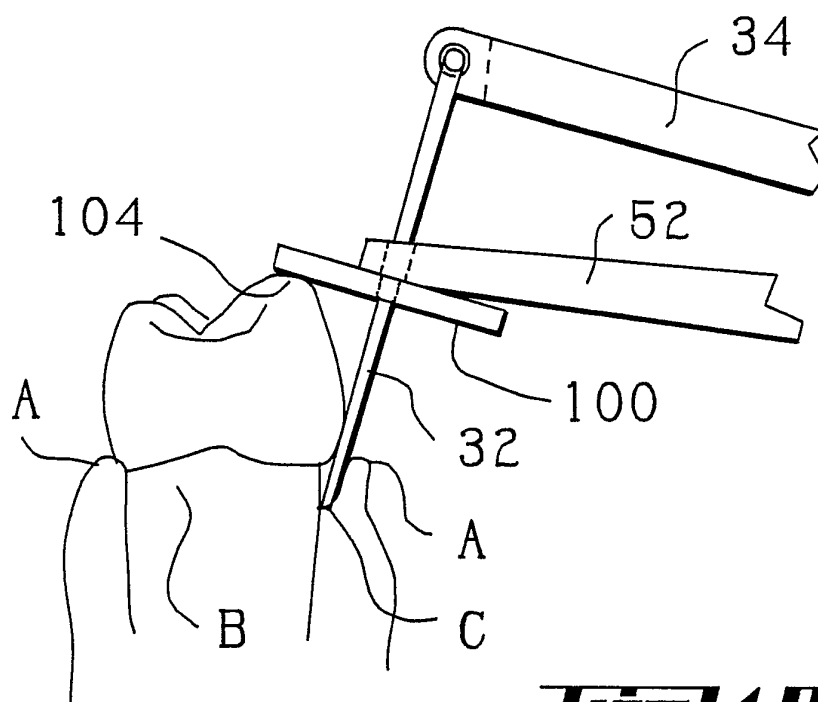


**Fig. 8 B**

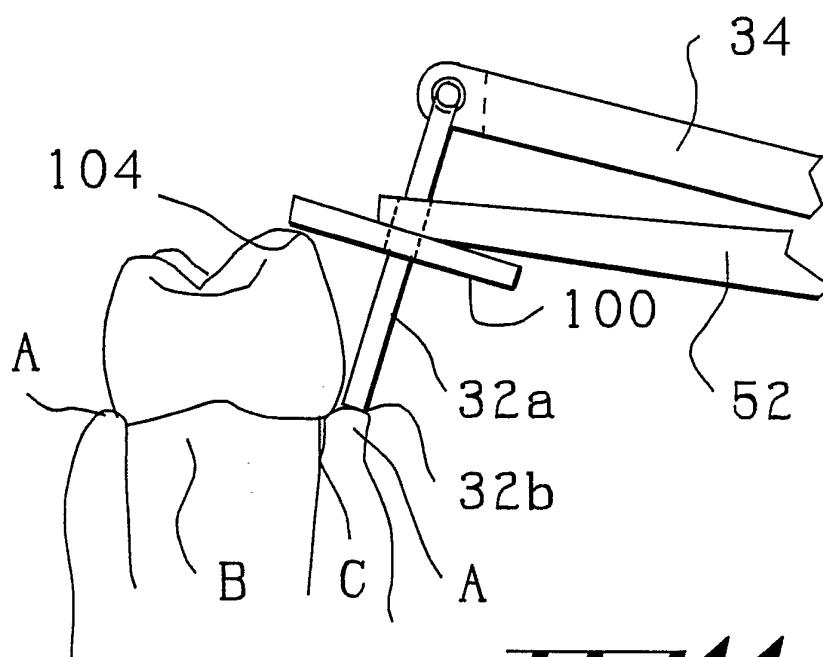


**Fig. 9**

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***Fig. 10***



***Fig. 11***

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# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US90/01306

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) \*

According to International Patent Classification (IPC) or to both National Classification and IPC  
 EPG(5): A61B 5/10  
 U.S. CL 128/776

## II. FIELDS SEARCHED

| Classification System | Minimum Documentation Searched *     | Classification Symbols |
|-----------------------|--------------------------------------|------------------------|
| U.S.                  | 128/776, 777<br>433/32, 72, 141, 215 | 33/513, 514            |

Documentation Searched other than Minimum Documentation  
 to the extent that such Documents are Included in the Fields Searched \*

## III. DOCUMENTS CONSIDERED TO BE RELEVANT \*

| Category * | Citation of Document, ** with indication, where appropriate, of the relevant passages **                                                                           | Relevant to Claim No. *  |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| X<br>Y     | US, A, 4,791,940 (HIRSCHFIELD ET AL)<br>20 DECEMBER 1988, see entire document                                                                                      | 16<br>1-10, 13-15, 18-20 |
| Y          | Journal of Clinical Periodontology, vol. 13, 1986,<br>Mombelli et al, "Depth-force Patterns in Periodontal<br>Probing," pages 126-130                              | 1-10, 13-15, 18-         |
| Y          | US, A, 4,353,693 (DERY ET AL) 12 October 1982<br>see the abstract                                                                                                  | 7                        |
| Y          | Journal of Clinical Periodontology, vol. 14, 1987,<br>Birek et al., "Gingival Attachment Level Measurements<br>with an Automated Periodontal Probe," pages 472-477 |                          |

### \* Special categories of cited documents: \*\*

- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

Date of Mailing of this International Search Report

19 April 1990

13 JUN 1990

International Searching Authority

Signature of Authorized Officer

ISA/US

Randy Shay