United States Patent [19]

Senia et al.

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[54] **ENDODONTIC INSTRUMENT**

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[73] Assignee: **Board of Regents, The University of Texas System**, Austin, Tex.

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[51] **Int. Cl.**[4] **A61C 5/02**
[52] **U.S. Cl.** **433/102**
[58] **Field of Search** 433/102

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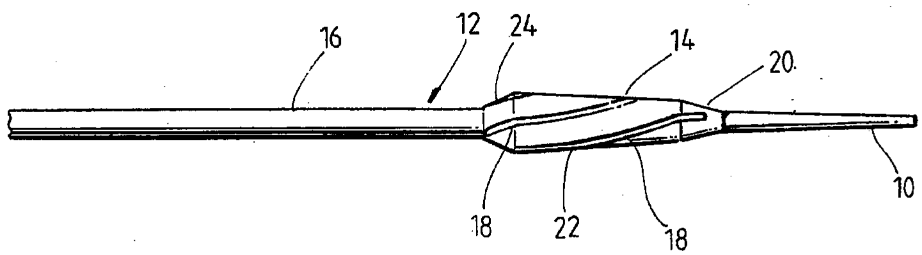
[57] **ABSTRACT**

An endodontic instrument in accordance with the present invention includes a substantially non-cutting pilot segment, a relatively short cutting segment, and a flexible shaft segment, which can have a handle at its distal end for manual manipulation, or an adapter for attachment to a mechanical handpiece. The non-cutting pilot, the short length of the cutting segment, and the flexibility of the shaft combine to allow the instrument to be used in curved root canals without causing undue change in the natural root canal contours.

13 Claims, 3 Drawing Sheets



GOLD STANDARD EXHIBIT 2005

Fig. 1A
(PRIOR ART)

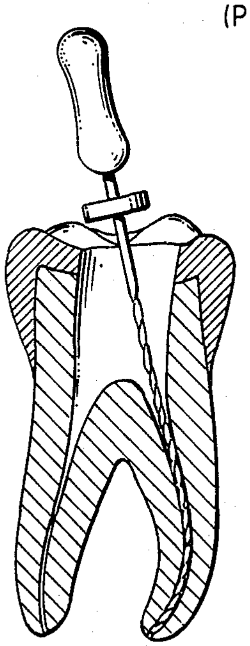
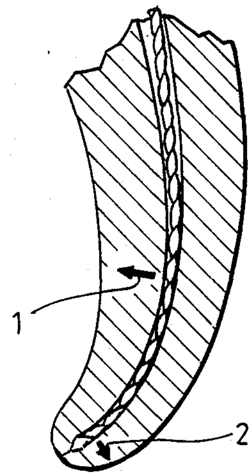


Fig. 1B
(PRIOR ART)



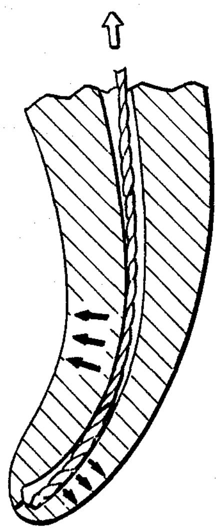


Fig. 1C
(PRIOR ART)

Fig. 2A
(PRIOR ART)

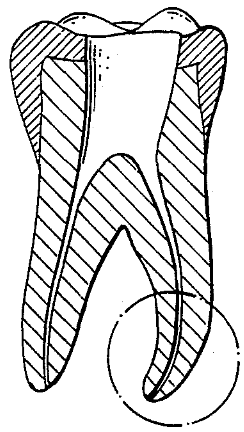


Fig. 2B
(PRIOR ART)

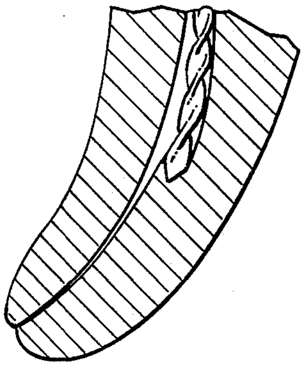
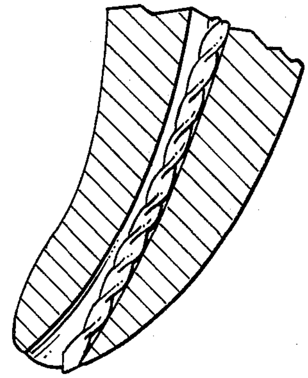


Fig. 2C
(PRIOR ART)



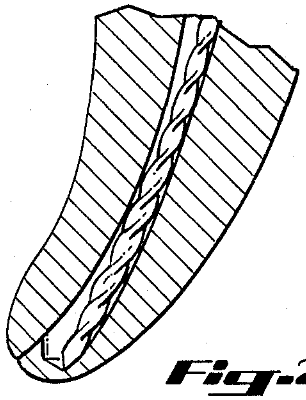
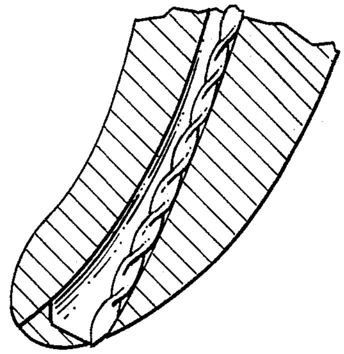


Fig. 2D
(PRIOR ART)

Fig. 2E
(PRIOR ART)



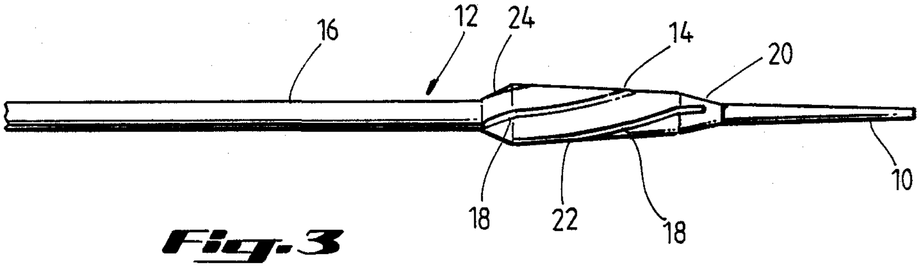


Fig. 3

and therefore cause much less unintended cutting of dentin and change of the natural curvature.

A variation of the present invention comprises a cutting segment whose length is no greater than about 14 mm; and a shaft whose proximal end is attached to the distal end of the cutting segment. This particular variation is suited for cleaning the apical 0.75 mm of the root canal of a human tooth, i.e., the most apical part of the root canal not cleaned by the non-cutting pilot of the previous embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows the use of a prior art endodontic instrument and an inherent problem in its use.

FIG. **2** shows four different problems caused by prior art instruments.

FIG. **3** shows an endodontic instrument in accordance with the present invention.

FIG. **4** shows an endodontic instrument in accordance with the present invention with a handle mounted on its distal end.

FIG. **5** shows an end view of an instrument such as that shown in FIG. **4**, with the instrument's proximal end being frontmost.

FIG. **6** shows an endodontic instrument in accordance with the present invention which does not have at its proximal end a non-cutting pilot segment.

DETAILED DESCRIPTION OF A SPECIFIC EMBODIMENT

FIG. **1** shows how a prior art endodontic instrument is inserted into the root canal of a tooth. In FIG. **1**A, the instrument has a small enough diameter so that it is sufficiently flexible to bend around the curvature of the root canal. FIG. **1**B illustrates the forces at work when the instrument is at rest in a curved root canal. Under basic lever and fulcrum principles, the inherent rigidity of the instrument causes a force **1** to be exterted on the root canal wall in its middle. A corresponding forcre **2** is exerted on the opposite root canal wall near the apex of the canal. When the instrument is withdrawn, as shown in FIG. **1**C, these forces are effectively increased and applied in a way that causes undesired cutting of the root canal walls. The force **3** acting near the middle of the root canal causes greatly enhanced cutting at that point during withdrawal. Even worse, the lever arm length below this fulcrum point is being decreased as the instrument is withdrawn, thereby increasing the force acting at the lower end. This increased force **4** digs away dentin at the apical end of the root canal, as can be seen in FIG. **1**C.

FIG. **2** shows several problems that result from prior art instruments. FIG. **2**A shows a typical curved root canal. FIG. **2**B shows that instruments which have insufficient flexibility in relation to the diameter of their cutting segment, as mahy prior art instruments do, tend to form a ledge. Once such a ledge is formed, it is very difficult to advance an instrument beyond it. In FIG. **2**C, the phenomenon shown in FIG. **1** has caused transportation of the apical foramen. This tends to make the filling that will be inserted into the tooth spill out into the surrounding tissue, which is very undesirable. In FIG. **4**D, a similar effect known as zipping has occurred. In FIG. **4**E the zipping is so pronounced that the side of the root has actually been perforated, which again will cause filling to spill out into the surrounding tissue.

An endodontic instrument in accordance with the present invention can include three principle parts: a substantially non-cutting pilot tip segment, a cutting segment, and a flexible shaft segment. The pilot segment can be either totally non-cutting, with a smooth surface, or it can have some minimal cutting or abrasive surface to give it a very minor cutting effect. The term "substantially non-cutting" is intended to cover both of these possibilities.

In FIG. **3**, the non-cutting pilot segment **10** is a smooth tapered cylinder located at the proximal end of the instrument **12**. The distal end of the pilot segment **10** is attached to the proximal end of the cutting segment **14**. The distal end of the cutting segment **14** is attached to the shaft segment **16**. The shaft segment **16** will normally have a circular cross section.

The substantially non-cutting pilot segment **10** is preferably a smooth tapered cylinder with a blunt or rounded (bullet shaped) proximal end. However, it would also be possible to use a pilot segment which has some raised edges or other projections on its surface, as long as they do not cause the pilot segment to have a substantial cutting effect. A goal of the pilot segment **10** is to serve as a guide for the cutting segment **14**, not to perform a significant amount of cutting itself.

The cutting segment **14** depicted in FIG. **3** includes a plurality of spiral cutting edges **18**, similar to the cutting portion of a K-type file. This embodiment of the cutting segment can have any number of configuration of cutting edges, preferably from 1–12 such edges. The cutting segment **14** could also be flattened, rather than cylindrical. In a flattened cutting segment, the two outer edges and the front edges would normally do the cutting. The cross section of such a cutting segment would be a relatively thin rectangle. The tightness of the spiral can also be increased, or decreased, even to the point of having no spiral. The cutting segment **14** could also be flattened, rather than cylindrical. In a flattened cutting segment, the two outer edges and the front edges would normally do the cutting. The cross section of such a flattened cutting segment would be a relatively thin rectangle. The cutting segment **14** could alternatively employ any cutting apparatus known to those skilled in this field, such as a K-flex cutting configuration, an H-type cutting configuration, a diamond cutting surface, or other cutting or abrasive materials.

The dimensions of the instrument are very important in achieving the desired results. The diameter of the pilot segment at its widest point is preferably about 0.17 mm but can range between about 0.009 and 1.0 mm. The diameter of the cutting segment at its widest point is preferably between about 0.01 and 2.0 mm, most preferably between about 0.20 and 1.4 mm. The diameter of the shaft segment should preferably be less than the diameter of the cutting segment at the latter's widest point, in order to increase flexibility and provide space for pulp and dentin debris to be removed from the canal. However, the diameter of the shaft segment could be equal to or greater than the diameter of the cutting segment. The shaft diameter will usually be between about 0.2 and 0.8 mm.

The pilot segment is preferably between about 0.01 and 14 mm long, most preferably between about 0.75 and 3 mm. The cutting segment is preferably between about 0.5 and 14 mm long, most preferably between about 0.5 and 4.0 mm long. The shaft is preferably between about 10 and 28 mm long.