CLAIMS

1. A dental instrument comprising:

a positioning member having a channel configured to deliver a high-velocity liquid jet to a cavity in a tooth, the positioning member having a proximal end portion and a distal end portion, the distal end portion configured to be disposed in, near, or on a portion of the tooth during treatment; ~~and~~

an impingement member disposed near the distal end portion of the positioning member, the impingement member having an impingement surface, wherein the instrument is configured such that the high-velocity liquid jet impacts the impingement surface during operation of the high-velocity liquid jet~~,~~; and

~~wherein~~ a plurality of openings through the distal end portion of the positioning member ~~comprises a plurality of openings disposed near the impingement member~~, the openings configured to allow outflow of liquid from the liquid jet after impact with the impingement surface,

wherein the impingement member comprises one or more angled or curved ~~surfaces~~ portions that angle or curve back towards the proximal end portion of the positioning member, wherein the one or more angled or curved portions extend distally beyond a distal end of the openings.

2. The dental instrument of Claim 1, wherein the positioning member comprises an elongated member having a longitudinal axis.

3. The dental instrument of Claim 2, wherein at least a portion of the elongated member has a cross-section perpendicular to the longitudinal axis that is substantially circular or substantially polygonal.

4. The dental instrument of Claim 2, wherein the elongated member is substantially straight between the proximal end portion and the distal end portion.

5. The dental instrument of Claim 2, wherein the channel has a channel axis, and the channel axis is substantially parallel to the longitudinal axis of the elongated member.

6. The dental instrument of Claim 5, wherein the high-velocity liquid jet propagates along a jet axis, the jet axis substantially parallel to the channel axis or the longitudinal axis of the elongated member.

7. The dental instrument of Claim 1, further comprising a nozzle configured to output a high-velocity liquid jet.

8. The dental instrument of Claim 7, wherein the nozzle comprises a proximal surface and a distal surface, the nozzle further comprising an orifice extending from the proximal surface to the distal surface and comprising at least one side wall, the orifice having a width, wherein at least one of the proximal surface, the distal surface, or the side wall has a surface roughness less than about 0.01 times the width of the orifice.

9. The dental instrument of Claim 8, wherein the orifice has a corner disposed between the side wall and the proximal surface, and a ratio of a curvature of the corner to the width of the orifice is less than about 0.1.

10. The dental instrument of Claim 8, wherein the orifice has a length between the proximal surface and the distal surface, and the ratio of the length to the width of the orifice is less than about 4.

11. The dental instrument of Claim 7, wherein the nozzle is disposed near the proximal end portion of the positioning member.

12. The dental instrument of Claim 7, wherein the nozzle is disposed near the distal end portion of the positioning member.

13. The dental instrument of Claim 7, wherein the channel has a channel axis, and the nozzle is disposed relative to the positioning member at a non-zero angle to the channel axis.

14. The dental instrument of Claim 7, wherein the channel has a channel axis, and the nozzle is configured to output the high-velocity liquid jet at an angle to the channel axis.

15. The dental instrument of Claim 1, wherein the impingement member is oriented at a non-zero angle to a channel axis of the channel or a longitudinal axis of the positioning member.

16. The dental instrument of Claim 1, wherein the impingement surface of the impingement member is concave.

17. The dental instrument of Claim 1, wherein the impingement surface of the impingement member is convex.

~~18. The dental instrument of Claim 1, wherein the impingement surface of the impingement member comprises one or more angled or curved portions~~

~~19. The dental instrument of Claim 18, wherein the one or more angled or curved portions of the impingement surface are configured to at least partially direct at least a portion of the liquid jet toward the proximal end portion of the positioning member.~~

~~20~~18. The dental instrument of Claim ~~18~~1, wherein the one or more angled or curved portions of the impingement ~~surface~~ member are configured to at least partially direct at least a portion of the liquid jet away from the proximal end portion of the positioning member.

~~21~~19. The dental instrument of Claim ~~18~~1, wherein the one or more angled or curved portions of the impingement ~~surface~~ member are configured to impart vorticity or circulation to at least a portion of the liquid jet that impacts the impingement surface.

~~22~~20. The dental instrument of Claim 1, wherein the impingement member is configured to produce a spray of liquid upon impact of the liquid jet.

~~23~~21. The dental instrument of Claim ~~22~~20, wherein the spray of liquid comprises a first spray directed in a first direction and a second spray directed in a second direction, the second direction substantially different from the first direction.

~~24~~22. The dental instrument of Claim 1, wherein the impingement member comprises one or more flexible members.

~~25~~23. The dental instrument of Claim 1, wherein at least a portion of the impingement member comprises a material that is at least partially permeable to the liquid jet.

~~26~~24. The dental instrument of Claim ~~25~~23, wherein the material that is at least partially permeable to the liquid jet comprises mesh.

~~27~~25. The dental instrument of Claim 1, wherein the distal end portion of the positioning member comprises a pointed, rounded, or textured region.

~~28~~26. The dental instrument of Claim 1, further comprising a flow tube configured to deliver a low-velocity stream of fluid to the cavity in a tooth.

~~29~~27. The dental instrument of Claim ~~28~~26, wherein the positioning member is at least partially disposed in the flow tube.

~~30~~28. The dental instrument of Claim 1, further comprising a backflow restrictor configured to be applied to the tooth and to inhibit backflow of fluid out of an opening in the tooth during operation of the liquid jet, at least a portion of the backflow restrictor disposed between the proximal end portion and the distal end portion of the positioning member~~,~~.

~~31~~29. The dental instrument of Claim ~~30~~28, wherein the backflow restrictor is disposed substantially around the positioning member.

~~32~~30. The dental instrument of Claim ~~1~~28, wherein at least a portion of the backflow restrictor is disposed near or along the proximal end portion of the positioning member.

~~33~~31. The dental instrument of Claim ~~1~~28, wherein the backflow restrictor comprises a material that is at least partially porous or at least partially absorbent.

~~34~~32. The dental instrument of Claim ~~1~~28, wherein the backflow restrictor comprises a material that is capable of deforming to contours of the tooth.

~~35~~33. The dental instrument of Claim 1, wherein the positioning member is configured to be coupled to a handpiece positionable by an operator of the dental instrument.

~~36~~34. The dental instrument of Claim ~~35~~33, further comprising the handpiece.

~~37~~35. The dental instrument of Claim 1, wherein the distal end portion of the positioning member is sized and shaped such that the distal end portion can be positioned in a pulp cavity of the tooth and such that the one or more openings are submerged in liquid in the tooth.

~~38~~36. The dental instrument of Claim ~~37~~35, wherein the dental instrument is configured to generate a hydroacoustic field in the tooth by the impingement of the high-velocity liquid jet on the impingement member.

~~39~~37. The dental instrument of Claim ~~38~~36, wherein the hydroacoustic field generated by the dental instrument includes acoustic power over a broad range of acoustic frequencies.

~~40~~38. The dental instrument of Claim ~~38~~36, wherein the hydroacoustic field generated by the dental instrument detaches organic material in the tooth.

~~41~~39. An apparatus for treating a tooth, the apparatus comprising:

a pressure wave generator having a positioning member ~~and a~~, distal portion of the positioning member having ~~with~~ an impingement surface, the positioning member being arranged relative to the impingement surface so as to direct a beam of energy along a beam axis onto the impingement surface to produce acoustic pressure waves,

~~wherein the apparatus is configured such that the beam of energy impacts the impingement surface at a portion of the impingement surface that is substantially perpendicular to a longitudinal axis of the positioning member,~~

wherein the impingement ~~surface~~ member comprises one or more angled or curved ~~surfaces~~ portions that angle or curve back towards a proximal ~~end~~ portion of the positioning member, the one or more angled or curved portions being disposed symmetrically relative to the beam axis.

~~42~~40. The apparatus of Claim ~~41~~39, wherein the beam of energy comprises a fluid jet beam.

~~43~~41. The apparatus of Claim ~~42~~40, wherein the fluid jet beam comprises degassed liquid.

~~44~~42. The apparatus of Claim ~~42~~40, wherein the positioning member comprises the distal portion.

4543. The apparatus of Claim 4240, wherein the positioning member comprises a guide tube having a channel with an opening on the distal portion of the guide tube.

~~46. The apparatus of Claim 45, wherein the pressure wave generator is configured to output sufficient energy so as to cause at least some fluid cavitation within the tooth chamber.~~

4744. An apparatus for treating a tooth, the apparatus comprising:

a pressure wave generator having a fluid beam forming portion including an orifice and an impact surface, the impact surface being spaced from the orifice and positioned such that an axis through the orifice extends to the impact surface, the impact surface being configured to be inserted into a tooth chamber in a tooth,

wherein the impact surface comprises a concave surface facing the orifice, the concave surface substantially symmetric about the axis,

wherein the impact surface comprises one or more angled or curved surfaces that angle or curve back towards a proximal portion of the pressure wave generator.

~~48. The apparatus of Claim 47, wherein the fluid beam forming portion is configured to form a fluid jet beam that will substantially impact the impact surface.~~

~~49. The apparatus of Claim 48, wherein the fluid beam forming portion is configured to form a fluid jet beam having sufficient energy to cause at least some cavitation within the tooth chamber when the fluid jet beam impacts the impact surface.~~

5045. The apparatus of Claim 4944, further comprising a guide tube having a channel extending along the axis and configured to permit ~~the~~ a fluid jet beam to flow therethrough.

5146. The apparatus of Claim 5045, further comprising a flow restrictor positioned around the pressure wave generator.

~~52~~47. The apparatus of Claim ~~51~~46, wherein the flow restrictor is configured to retain at least some fluid within the tooth chamber.

~~53~~48. The apparatus of Claim ~~47~~44, the apparatus further comprising a handpiece coupled to the fluid beam forming portion.