CLAIMS

~~What is claimed is:~~

1. A dynamic coolant delivery system ~~(200, 400)~~ for delivering coolant to a cutting tool ~~(390)~~ coupled to a spindle ~~(120)~~ of a computer numerical control ("CNC") machine ~~(100)~~, comprising:

a platform ~~(270, 456)~~ adapted to be coupled to the spindle and rotatable about a first axis ~~(271, 508)~~;

a turret ~~(290)~~ supported by the platform and rotatable ~~at least 360 degrees~~ about a second axis ~~(291)~~; and

a nozzle ~~(310, 510)~~ supported by the turret and pivotable about a third axis ~~(311, 520)~~, the nozzle being in fluid communication with a coolant reservoir and adapted to deliver coolant from the coolant reservoir to the cutting tool.

2. The dynamic coolant delivery system of claim 1, further comprising a housing ~~(220, 428)~~ adapted to be coupled to the spindle of the CNC machine, the housing supporting the platform.

3. The dynamic coolant delivery system of claim 2, wherein the housing is adapted to be removably coupled to the spindle of the CNC machine.

4. The dynamic coolant delivery system of claim 1, wherein the third axis is non-parallel to the first axis.

5. The dynamic coolant delivery system of claim 4, wherein the third axis is orthogonal to the first axis.

6. The dynamic coolant delivery system of claim 1, further comprising:

a first ring ~~(224)~~ supported within the housing and rotatable about the first axis, the first ring being operatively coupled to the nozzle such that rotation of the first ring about the first axis is capable of pivoting the nozzle about the third axis; and

a second ring ~~(230)~~ supported within the housing and rotatable about the first axis, the second ring operatively coupled to the platform such that rotation of the second ring about the first axis results in rotation of the platform about the first axis.

7. The dynamic coolant delivery system of claim 6, wherein the second ring is arranged adjacent the platform and the first ring is axially spaced apart from the second ring along the first axis.

8. The dynamic coolant delivery system of claim 6, wherein the first ring includes a radial flange and an axial flange generally orthogonal to the radial flange, the axial flange including a

plurality of engagement features and a helical surface extending along an inner surface of the axial flange.

9. The dynamic coolant delivery system of claim 8, wherein the first ring is operatively coupled to the nozzle through an actuator shaft, the actuator shaft having a base supported on the helical surface of the first ring, and rotation of the first ring relative to the base of the actuator shaft results in a displacement of the actuator shaft along a fourth axis ~~(570)~~ parallel to the first axis, the displacement of the actuator shaft resulting in the pivoting of the nozzle about the third axis.

10. The dynamic coolant delivery system of claim 6, wherein each of the first ring and the second ring is configured to be capable of rotating about the first axis at different rotational speeds relative to one another.

11. The dynamic coolant delivery system of claim 6, wherein relative motion between the first ring and the second ring results in the nozzle pivoting about the third axis.

12. The dynamic coolant delivery system of claim 6, wherein rotation of the first ring and the second ring with zero relative motion results in the platform and the nozzle rotating about the first axis.

13. The dynamic coolant delivery system of claim 6, wherein each of the first ring and the second ring include a plurality of engagement features.

14. The dynamic coolant delivery system of claim 13, wherein the plurality of engagement features comprises gear teeth.

15. The dynamic coolant delivery system of claim 1, further comprising:
a first electric motor ~~(544a)~~ operatively coupled to the platform; and
a second electric motor ~~(544b)~~ operatively coupled to the nozzle.

16. The dynamic coolant delivery system of claim 15, further comprising a motor mounting bracket ~~(542)~~ coupled to the housing, the motor mounting bracket supporting the first electric motor and the second electric motor within the housing.

17. The dynamic coolant delivery system of claim 16, wherein the first electric motor is operatively coupled to the platform using a first belt, and the second electric motor is operatively coupled to the nozzle using a second belt.

18. The dynamic coolant delivery system of claim 17, wherein the first electric motor includes a first pulley operatively coupled to the first belt, and the second electric motor includes a second pulley operatively coupled to the second belt.

19. The dynamic coolant delivery system of claim 1, further includes a light source ~~(356)~~ adapted to be coupled to the spindle, the light source being capable of illuminating at least one of the cutting tool or a workpiece removably supported in a workspace of the CNC machine.

20. The dynamic coolant delivery system of claim 19, wherein the light source includes a plurality of light emitting diodes ("LEDs").

21. The dynamic coolant delivery system of claim 1, further comprising a light ring ~~(350)~~ adapted to be coupled to the spindle, the light ring being capable of illuminating at least one of the cutting tool or a workpiece removably supported in a workspace of the CNC machine, the light ring surrounding a portion of the cutting tool.

22. The dynamic coolant delivery system of claim 21, wherein the light ring is arranged coaxially with the first axis.

23. The dynamic coolant delivery system of claim 21, wherein the light ring includes a plurality of light sources.

24. The dynamic coolant delivery system of claim 23, wherein each of the plurality of light sources comprises a light emitting diode ("LED").

25. The dynamic coolant delivery system of claim 1, further comprising a drum ~~(566)~~ supporting a coolant tube coupled to the nozzle.

26. The dynamic coolant delivery system of claim 25, wherein the drum is configured to rotate about a fourth axis ~~(570)~~, the fourth axis spaced apart from and parallel to the first axis.

27. A method of dynamically delivering coolant to a cutting tool ~~(390)~~ coupled to a spindle ~~(120)~~ of a computer numerical control ("CNC") machine ~~(100)~~ for rotation about a first axis ~~(271, 508)~~, comprising:

providing a coolant delivery nozzle ~~(310, 510)~~ fluidly coupled to a coolant reservoir, the coolant delivery nozzle supported by a turret ~~(290)~~ adapted to rotate ~~at least 360 degrees~~ about a second axis ~~(291)~~, the coolant delivery nozzle adapted to pivot about a third axis ~~(311, 520)~~ non-parallel to the first axis, and the turret supported by a platform ~~(270, 456)~~ coupled to the spindle, the platform adapted to rotate about the first axis;

delivering coolant to a first axial location of the cutting tool from a first orientation of the coolant delivery nozzle relative to the cutting tool, the first orientation defined by an angular position of the coolant delivery nozzle relative to the first axis; and

rotating the coolant delivery nozzle about the first axis such that the coolant delivery nozzle delivers coolant to the first axial location of the cutting tool from a second orientation of the coolant delivery nozzle relative to the cutting tool, the second orientation being angularly displaced from the first orientation.

28. The method of claim 27, further comprising providing the cutting tool supported for rotation by the spindle.

29. The method of claim 27, further comprising cyclically rotating the coolant nozzle in a first rotational direction and a second rotational direction about the first axis between the first orientation and the second orientation to provide a sweeping delivery of coolant to the cutting tool.

30. The method of claim 27, further comprising pivoting the coolant delivery nozzle about the third axis such that the coolant delivery nozzle delivers coolant to a second axial location of the cutting tool, the second axial location of the cutting tool being spaced axially apart from the first axial location along the first axis.

31. The method of claim 30, further comprising cyclically pivoting the coolant nozzle in a first rotational direction and a second rotational direction about the third axis such that coolant is delivered along at least a portion of an axial length of the cutting tool.

32. The method of claim 27, wherein rotating the coolant delivery nozzle occurs in response to a control signal from the CNC machine.

33. The method of claim 27, further comprising providing a workpiece removably supported in a workspace of the CNC machine, at least one of the workpiece or the cutting tool being moveable relative to the other of the workpiece or the cutting tool, and wherein rotating the coolant delivery nozzle occurs in response to a current motion vector of the cutting tool relative to the workpiece.

34. A method of dynamically adjusting the orientation of a coolant delivery nozzle ~~(310, 510)~~ configured to supply coolant to a cutting tool ~~(390)~~ supported for rotation by a spindle ~~(120)~~ of a computer numerical control ("CNC") machine ~~(100)~~ about a first axis ~~(271, 508)~~, comprising:

providing a coolant delivery system ~~(200, 400)~~ including a first ring ~~(544a)~~ rotatable about the first axis and operatively coupled to the coolant delivery nozzle adapted to deliver the

coolant to the cutting tool and a second ring ~~(544b)~~ rotatable about the first axis and operatively coupled to a platform ~~(270, 456)~~ supporting the coolant delivery nozzle;

rotating the first ring about the first axis so as to develop relative motion between the first ring and the second ring, wherein developing relative motion between the first ring and the second ring results in the coolant delivery nozzle pivoting about a second axis ~~(311, 520)~~, the second axis being non-parallel to the first axis; and

rotating the second ring about the first axis, wherein rotating the second ring about the first axis results in the platform and the nozzle rotating about the first axis.

35. The method of claim 34, wherein the first ring and the second ring are configured to rotate about the first axis at different speeds relative to one another.

36. A method of dynamically delivering coolant to a cutting tool ~~(390)~~ coupled to a spindle ~~(120)~~ of a computer numerical control ("CNC") machine ~~(100)~~ for rotation about a first axis ~~(271, 508)~~, comprising:

providing a coolant delivery nozzle ~~(310, 510)~~ fluidly coupled to a coolant reservoir, the coolant delivery nozzle supported by a turret ~~(290)~~ adapted to rotate ~~at least 360 degrees~~ about a second axis ~~(291)~~, the coolant delivery nozzle adapted to pivot about a third axis ~~(311, 520)~~ non-parallel to the first, and the turret supported by a platform ~~(270, 456)~~ coupled to the spindle, the platform adapted to rotate about the first axis;

delivering coolant to a first axial location of the cutting tool from a first orientation of the coolant delivery nozzle relative to the cutting tool, the first orientation defined by an angular position of the coolant delivery nozzle relative to the first axis; and

pivoting the coolant delivery nozzle about the third axis such that the coolant delivery nozzle delivers coolant to a second axial location of the cutting tool, the second axial location of the cutting tool being spaced axially apart from the first axial location of the cutting tool along the first axis.

37. The method of claim 36, further comprising rotating the coolant delivery nozzle about the first axis such that the coolant delivery nozzle delivers coolant to at least one of the first axial location or the second axial location of the cutting tool.

38. The method of claim 37, wherein pivoting the coolant delivery nozzle about the third axis and rotating the coolant delivery nozzle about the first axis occurs simultaneously.

39. The method of claim 36, further comprising cyclically pivoting the coolant nozzle in a first rotational direction and a second rotational direction about the third axis such that coolant is delivered along at least a portion of an axial length of the cutting tool.