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Grabbe

(54) **FIBER OPTIC FERRULE POLISHING DEVICE**

(76) Inventor: **Dimitry G. Grabbe**, Middletown, PA (US)

Correspondence Address:
Bruce J. Wolstoncroft, Esquire
Barley, Snyder, Senft & Cohen, LLC
126 East King Street
Lancaster, PA 17602 (US)

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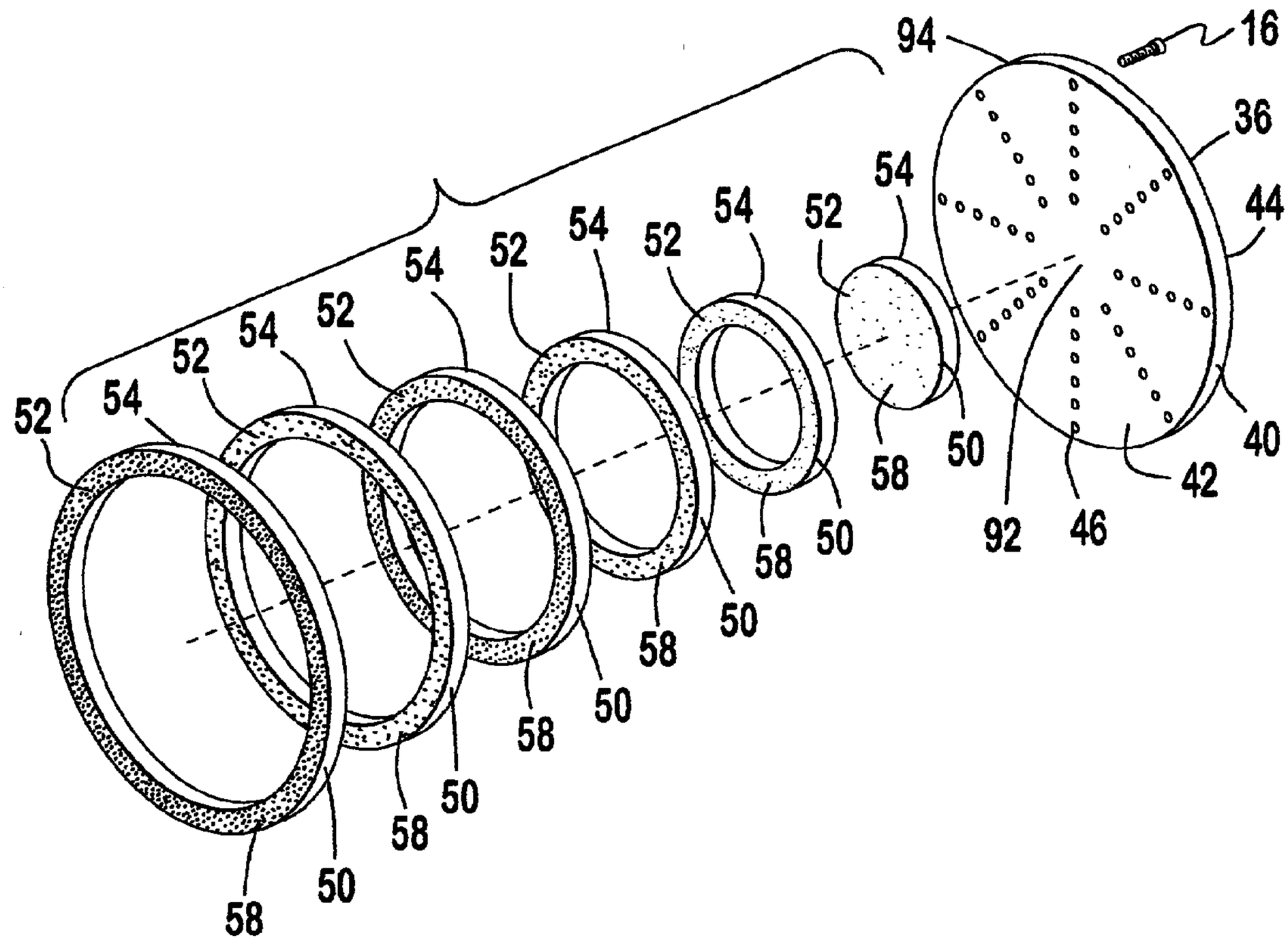
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(57) **ABSTRACT**

A fiber optic ferrule polishing devise comprising a disk having an outer periphery and a center. Rings having a polishing surface coated with varying degrees of abrasive and attached to the disk such that the courseness of abrasive on the rings decreases from the outer periphery to the center. A ferrule holder having a ferrule holding recess adjacent to the polishing surface, a water injecting recess and an attachment arm pivotally attached to the ferrule holder such that the arm is positioned adjacent to the ferrule holding recess. A holding plate having a ferrule end face receiving recess having a smaller diameter than the ferrule holding recess and positioned adjacent to the ferrule holding recess and polishing surface. A mounting plate for mounting the ferrule holder a predetermined distance from the polishing surface. The arm biases a ferrule toward the polishing surface when a ferrule is received in the ferrule holding recess.



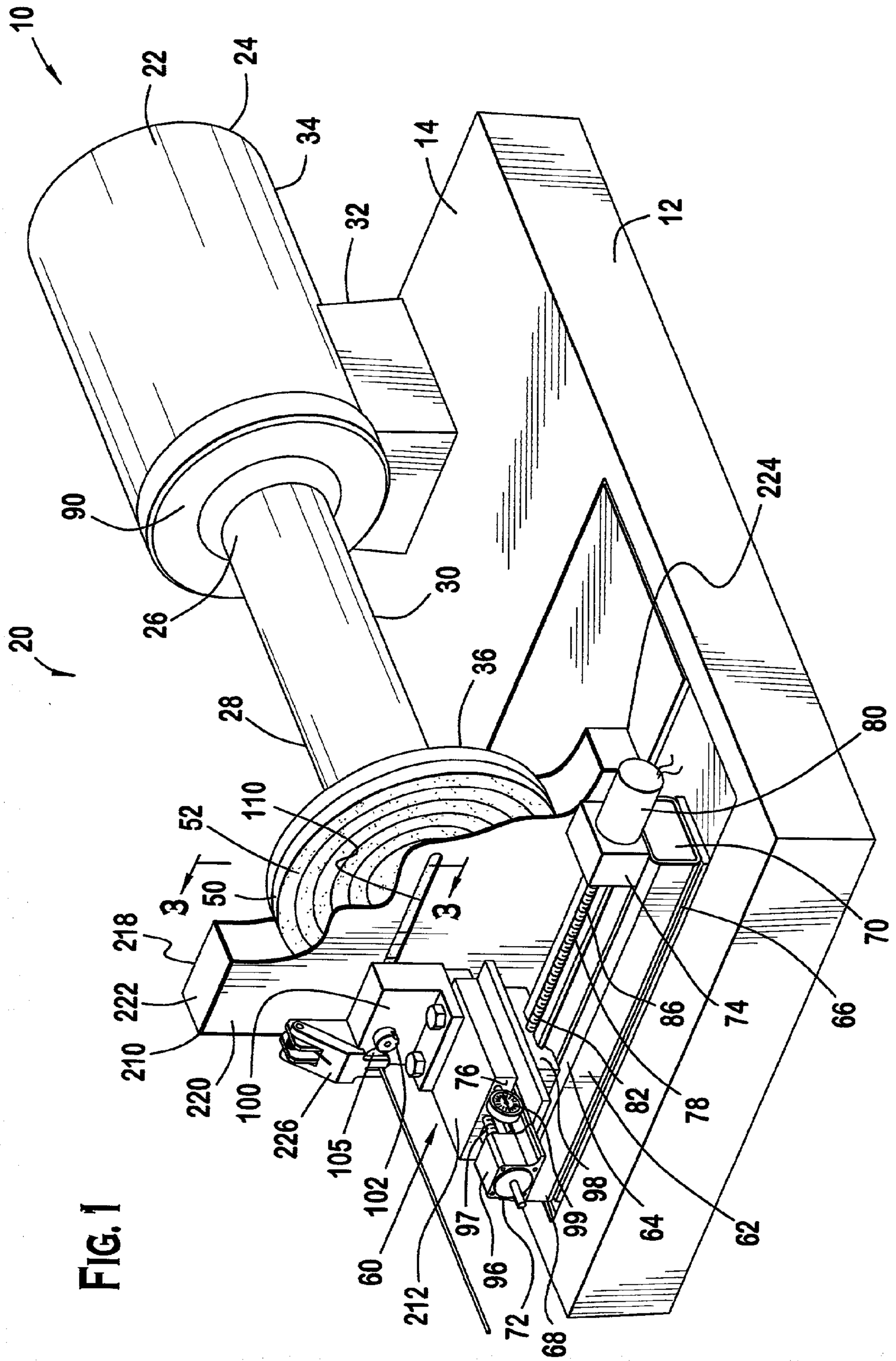

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FIG. 1

FIG. 2

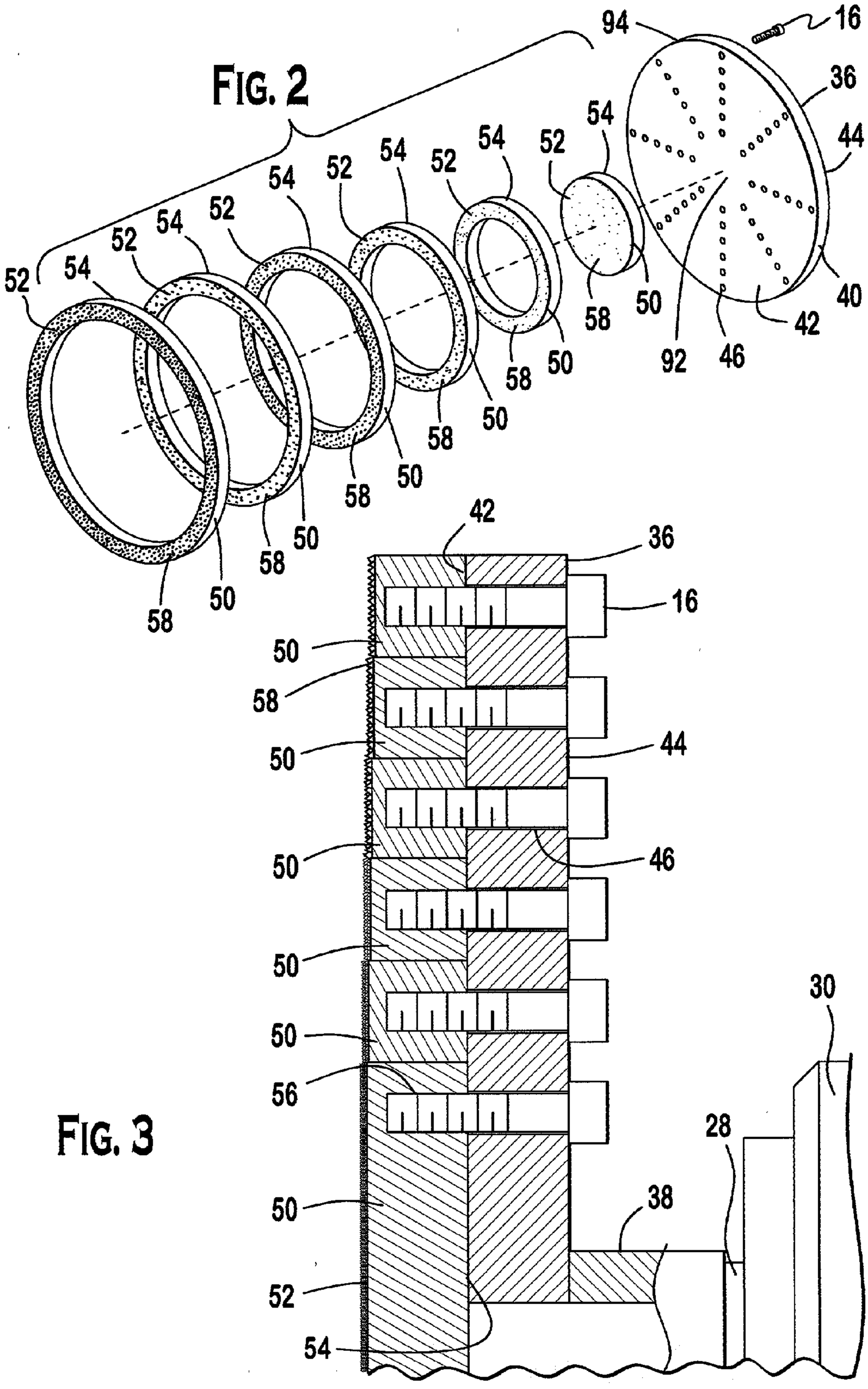


FIG. 3

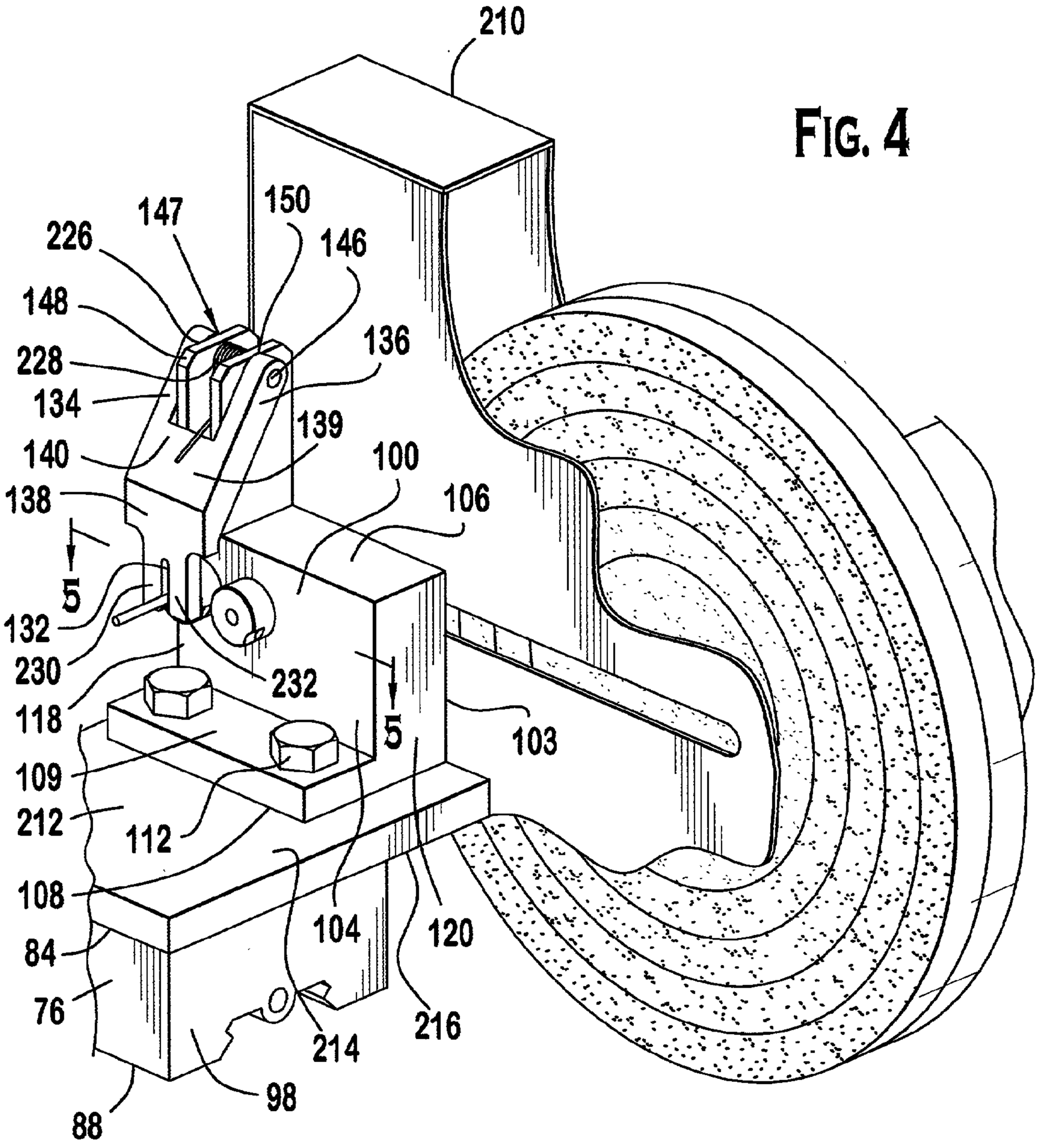
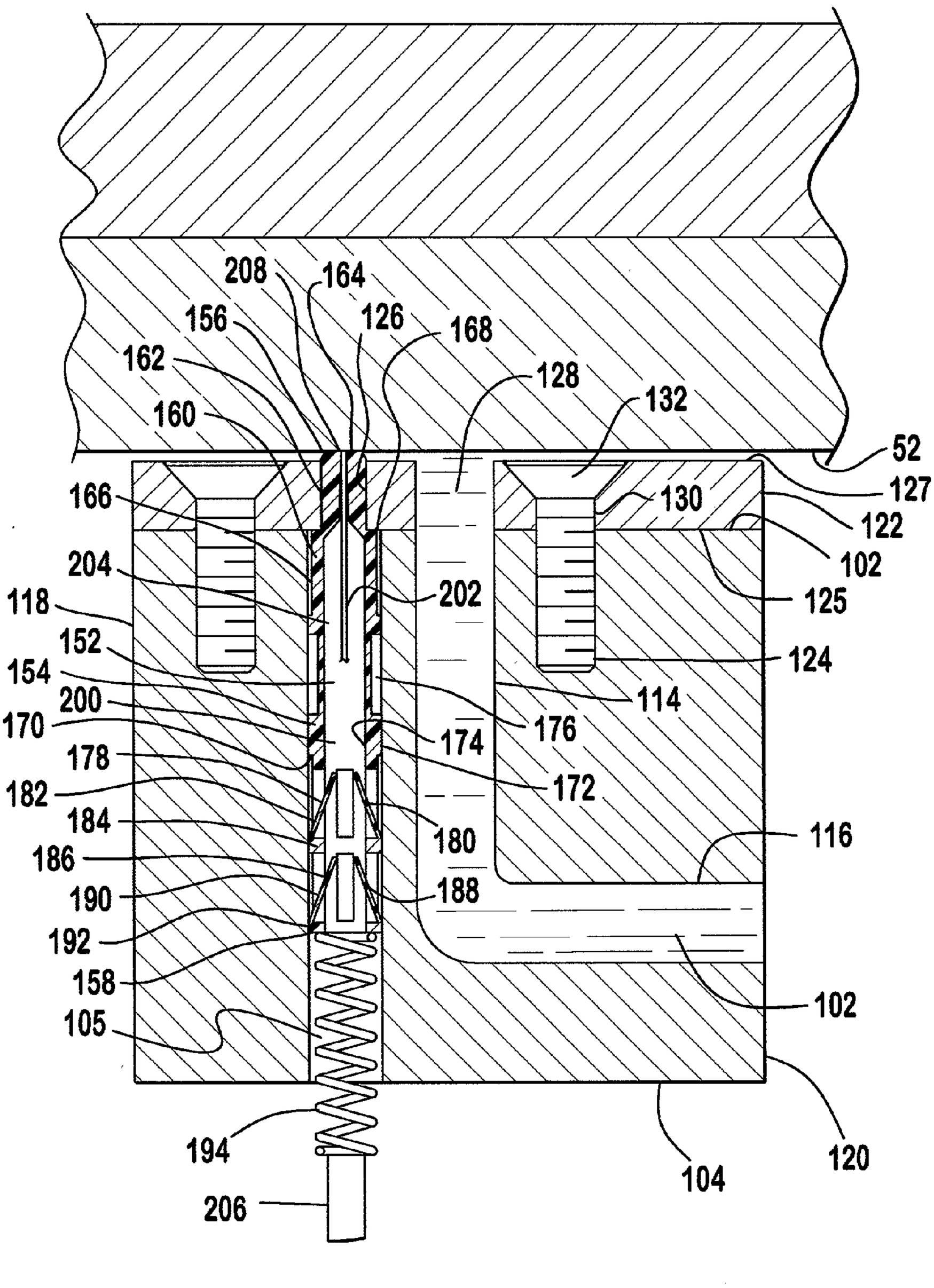

210
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FIG. 4

FIG. 5


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FIBER OPTIC FERRULE POLISHING DEVICE

FIELD OF THE INVENTION

[0001] The invention relates to a polishing device and, more particularly, to a device for polishing fiber optic ferrules.

BACKGROUND OF THE INVENTION

[0002] Fiber optic connectors typically consist of a ferrule having a fiber optic cable comprising an optical fiber encompassed by a buffer extending therethrough. The ferrule has a substantially flat end face through which projecting segments of the optical fiber are inserted and bonded by an adhesive. To prepare the ferrule for connection, the projecting segments of the optical fiber are polished flush with the surface of the end face of the ferrule. First, the surface of the end face is rough polished to remove the projecting segments. Then, the surface of the end face is final polished to remove processing strain layers or any other surface irregularities.

[0003] Because the polishing is required to be done with high precision in order to insure an optimal optical connection between two abutting end face surfaces, it is known to secure the ferrule in a fixture and position the end face against a grinding or polishing wheel. One such ferrule polishing device is disclosed in U.S. Pat. No. 5,503,590 issued to Saitoh et al. Saitoh et al. teaches an elastic film polishing plate for a fiber optic connector having an adhesive removing ring area along an outer area of a polishing wheel. A rough polishing ring area is disposed inward of the adhesive removing ring area, and a final polishing ring area is located concentrically on the polishing wheel. Each of the ring areas is formed of an elastic film to which an abrasive liquid is applied during rotation. The abrasive liquid is varied in each section in order to achieve either a rough or fine polishing. A plurality of partition rings are each disposed between the each ring section to prevent the abrasive liquids from mixing with each other. This device requires the injection of several abrasive liquids and containment of these various abrasives over various ring areas to achieve either the rough or final polishing desired at that specific ring area. These abrasive liquids are costly and the consumables of the process further add to process costs. Further, this device does not have a continuos abrasive surface to allow a single pass polishing of the end face.

[0004] It is therefore desirable to develop a fiber optic ferrule polishing device that is less intricate reduces the consumables cost and has a continuous abrasion surface to allow single pass polishing of a ferrule end face and efficient manufacturing of the ferrule.

SUMMARY OF THE INVENTION

[0005] The invention relates to a fiber optic ferrule polishing devise comprising a disk, a plurality of rings and a ferrule holder. The disk having an outer periphery and a center. The plurality of rings each having a polishing surface coated with varying degrees of abrasive and an attachment surface. The attachment surface is attached to the disk such that the courseness of abrasive on the rings decreases from the outer periphery to the center. The ferrule holder has a ferrule holding recess substantially adjacent to the polishing surface and an attachment arm pivotally attached to the ferrule holder such that the arm is positioned substantially adjacent to the ferrule holding recess. The attachment arm biases the fiber optic ferrule toward the disk polishing surface when a fiber optic ferrule is received in the ferrule holding recess.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The invention will now be described by way of example with reference to the accompanying figures in which:

[0007] **FIG. 1** is an isometric view of the fiber optic ferrule polishing device.

[0008] **FIG. 2** is a schematic view of the attachment of the rings to the disk.

[0009] **FIG. 3** is a partially-sectioned exploded view of the rings attached to the disk taken along line **3-3** in **FIG. 1**.

[0010] **FIG. 4** is a partial isometric view of the ferrule holder and the rings.

[0011] **FIG. 5** is a top cross-sectional view of the fixture assembly taken along line **5-5** in **FIG. 4**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] **FIG. 1** shows a fiber optic ferrule polishing device **10** comprising a polishing assembly **20** and a fixture assembly **60** attached to a base **12**. The polishing assembly **20** comprises an axially preloaded spindle motor **22** having a spindle **30** extending therefrom that is received in a hub **36**. The hub **36** has an attached polishing surface **52** comprising a plurality of rings **50**. A shroud **210** is positioned about the hub **36** and the attached polishing surface **52**. The fixture assembly **60** comprises a fiber optic ferrule holder **100** attached to a mounting plate **212** that is attached to a mounting structure **76**. The ferrule holder **100** has a water injecting recess **102**, a ferrule holding recess **105** and an attached holding arm **226**. The mounting structure **76** is moveably mounted on a slide base **62** and has a threaded shaft **78** extending therefrom that is received in a motor **80**. Alternatively, a linear slide motor assembly may be used instead of the threaded shaft **78** and motor **80**.

[0013] The main components of the fiber optic ferrule polishing device **10** will now be described in greater detail beginning with the polishing assembly **20** as shown in **FIGS. 1 through 3**. Referring to **FIG. 1**, the axially preloaded spindle motor **22** is contained in a housing **24**. A supporting structure **32** extends from a bottom surface **34** of the housing **24** and is attached to a top surface **14** of the base **12**. A first end **26** of the spindle **30** extends substantially parallel to the base **12** from a front surface **90** of the housing **24**. A second end **28** of the spindle **30** is received in the hub **36**.

[0014] Shown in **FIGS. 2 and 3**, the hub **36** is made out of a material such as steel, aluminum, or other materials having similar properties and comprises a mating portion **38** and a disk **40**. The mating portion **38** is substantially cylindrical in shape and is dimensioned for receipt of the second end **28** of the spindle **30**. The disk **40** has a front side **42** and a back side **44**. A plurality of securing apertures **46** extends through the disk **40** from the front side **42** to the back side **44**. The securing apertures **46** are positioned

radially from the disk center **92** to the disk outer periphery **94**. Attached to the front side **42** of the disk is a plurality of rings **50**. Each ring **50** is preferably made out of a magnetic material such as steel and has an attachment surface **54** and a polishing surface **52**. A magnetic material facilitates manufacturing in that the rings **50** can be magnetically retained during a grinding operation. The attachment surface **54** has a plurality of threaded ring apertures **56** that correspond to the securing apertures **46** on the back side **44** of the disk **40**. The ring apertures **56** are positioned on the attachment surface **54** and do not extend through to the polishing surface **52** of the rings **50**. Each ring **50** is formed to slip fit into each other. Cap screws **16** or other suitable fastening means are positioned in the securing apertures **46** on the back side **44** of the disk **40**. The cap screws **16** extend through the front side **42** of the disk **40** and are received into the threaded ring apertures **56** of the attachment surface **54**.

[**0015**] The polishing surface **52** of each of the rings **50** is coated with diamond grit **58** or other suitable abrasive such as man made diamond grit, ceramic, or carborundum. The diamond grit **58** or other suitable abrasive has a different size and number of particles disposed per unit area on each ring **50**. The ring **50** located at the disk outer periphery **94** is coated with the coarsest abrasive. Moving inward from the disk outer periphery **94** toward the disk center **92**, each ring is progressively less coarse and protrudes further outward from the hub **36** wherein the ring located at the disk center **92** is coated with the finest abrasive and protrudes farthest from the hub **36**.

[**0016**] As shown in **FIG. 1**, the shroud **210** has a shroud first side **220**, a shroud second **218** side, a shroud top **222** and a shroud bottom **224**. The shroud bottom **224** is positioned adjacent to the top surface **14** of the base **12**. The shroud first side **220** is positioned substantially parallel to the polishing surface **52**. The shroud first side **220** has a slot **110** that extends substantially parallel and adjacent to the polishing surface **52** from substantially near the disk outer periphery **92** to substantially near the disk center **94**. The shroud second side **218** is positioned substantially parallel to the disk **40**. The shroud second side **218** has an opening (not shown) substantially adjacent to the mating portion **38** of the hub **36**. It will be appreciated by those skilled in the art that the shroud **210** can take a variety of shapes and forms to achieve a substantially similar result.

[**0017**] The main components of the fixture assembly **60** will now be described in greater detail with reference to **FIGS. 1, 4** and **5**. Shown in **FIG. 1**, the slide base **62** is a substantially flat elongated member having a plate top surface **64**, a plate bottom surface **66**, and first and second plate ends **68**, **70**, respectively. The plate bottom surface **66** is positioned adjacent to and is attached to the top surface **14** of the base **12**. A first plate wall **72** extends substantially perpendicular and adjacent to the first plate end **68**. A second plate wall **74** extends substantially perpendicular and adjacent to the second plate end **70**.

[**0018**] Positioned adjacent to the plate top surface **64** is the mounting structure **76**. The mounting structure **76** is substantially rectangular in shape and has a mounting structure bottom surface **88**, and a mounting structure top surface **84**. The mounting structure bottom surface **88** is attached to the plate top surface **64**. A first portion **82** of a threaded shaft **78** extends through a side **98** of the mounting structure **76** and is positioned substantially parallel to the slide base **62**. A second portion **86** of the threaded shaft **78** extends through a wall aperture (not shown) in the second plate wall **74** and is received in a motor **80**.

[**0019**] Positioned adjacent to the mounting structure **76** is the mounting plate **212**. As shown in **FIG. 4**, the mounting plate **212** is substantially rectangular in shape and has a mounting plate top surface **214** and a mounting plate bottom surface **216**. The mounting plate bottom surface **216** is attached to the mounting structure top surface **84**. The mounting plate top surface **21** has mounting plate apertures (not shown). The mounting plate **212** is movable toward and away from the polishing surface **52** by a threaded shaft **97** extending therethough. The threaded shaft is optionally driven by a motor **96** or manually driven. A positional indicator **99** is provided to indicate travel in the direction toward and away from the polishing surface **52**.

[**0020**] Positioned adjacent to the mounting plate **212** is a ferrule holder **100**. As shown in **FIG. 4**, the ferrule holder **100** has a polishing end **103**, a receiving end **105**, a holder top surface **106**, a holder bottom surface **108**, and holder first and second sides, **118**, **120**, respectively. The holder bottom surface **108** is positioned adjacent to the mounting plate top surface **214**. The polishing end **103** of the ferrule holder **100** extends beyond the mounting plate top surface **214** and is positioned substantially adjacent to the polishing surface **52** of the rings **50**. The receiving end **104** of the ferrule holder **100** has an attachment member **109**. The attachment member has an attachment member aperture (not shown). A bolt **112** or other suitable fastening means extends through the attachment member aperture and into the mounting plate aperture (not shown).

[**0021**] Substantially near the holder top surface **106** is a ferrule holding recess **105**. As shown in **FIG. 5**, the ferrule holding recess **105** is positioned toward the holder first side **118** and extends from the polishing end **103** through to the receiving end **105** of the ferrule holder **100**. Substantially near the holder top surface **106** is also a water injecting recess **102**. The water injecting recess **102** is positioned toward the holder second side **120** and has a first portion **114** and a second portion **116**. The first portion **114** extends substantially parallel to the ferrule holding recess **105** from the polishing end **103** to substantially near the receiving end **105**. The second portion **116** extends substantially perpendicular to the ferrule holding recess **105** from the end of the first portion **114** substantially near the receiving end **114** to the holder second side **120**. Ferrule holder apertures **124** extend substantially parallel to and flank the water injecting recess **102** and the ferrule holding recess **105**. It will be appreciated by those skilled in the art that while the water injecting recess **102** is positioned toward the holder second side **120** and the ferrule holding recess **105** is positioned toward the holder first side **118**, the positions may be interchanged or varied to achieve substantially similar results.

[**0022**] As shown in **FIGS. 4 and 5**, a holding plate **122** is positioned adjacent to the polishing end **103** of the ferrule holder **100**. The holding plate **122** has a holding plate first side **125** positioned adjacent to the polishing end **103** and a holding plate second side **127** positioned substantially parallel to the polishing surface **52**. The holding plate **122** has a ferrule end face receiving recess **126** extending from the

holding plate first side **125** through to the holding plate second side **127**. The ferrule end face receiving recess **126** has a slightly smaller diameter than the ferrule holding recess **105** and is positioned adjacent to the ferrule holding recess **105**. A water ejecting recess **128** is positioned substantially parallel to the ferrule end face holding recess **126** and extends from the holding plate first side **125** through to the holding plate second side **127**. The water ejecting recess **128** is positioned adjacent to the first portion **114** of the water injecting recess **102**. Holding plate apertures **130** flank the ferrule end face receiving recess **126** and the water ejecting recess **128** and are positioned adjacent to the ferrule holder apertures **124**. Bolts **132** or other suitable fastening means extend from the holding plate first side **125** through the holding plate apertures **130** and into the ferrule holder apertures **124**.

[**0023**] As shown in **FIG. 4, a** holding arm **226** is positioned adjacent to the holder top surface **106** substantially above the ferrule holding recess **105** and substantially near the holder first side **118**. The holding arm **226** has an arm **140** and first and second arm mounts **148, 150**, respectively. The first arm mount **148** and second arm mount **150** are positioned substantially perpendicular to the holder top surface **106** and substantially parallel to each other. A spring **228** extends substantially perpendicular to and between the first and second arm mounts **148, 150**.

[**0024**] The arm **140** has a first flange **134** and a second flange **136** positioned at an arm top end **139**. The first flange **134** is positioned toward the holder first side **118** and extends adjacent to the first arm mount **148**. A first tip end **147** of the first flange **134** is pivotally attached to the first arm mount **148**. The second flange **136** is positioned toward the holder second side **120** and extends adjacent to the second arm mount **150**. A second tip end **146** of the second flange **136** is pivotally attached to the second arm mount **150**. Substantially centered at an arm bottom end **138** is a cable receiving recess **132**. The cable receiving recess **132** is positioned substantially parallel to the ferrule holding recess 1S and extends from the arm bottom end **138** toward the arm top end **139** to form first and second legs **230, 232**, respectively.

[**0025**] **FIG. 5** shows a fiber optic cable connector **200** comprising a fiber optic cable **152** and a ferrule assembly **154**. The fiber optic cable **152** has a central optical fiber **202** that is surrounded by a buffer **204** encompassed with a flexible jacket **206**. The ferrule assembly **154** comprises a ferrule **160** having an outer surface **172** and an inner surface **174**. Moving from the front end **156** of the ferrule assembly **154** toward the rear end **158**, the ferrule **160** has a first section **162** having an end face **164**. Adjacent the first section **162** of the ferrule **160** and opposite of the end face **164** is a second section **166**. The second section **166** has a shoulder **168** having a diameter slightly larger than the diameter of the first section **162**. The outer surface **172** of the second section **166** has a plurality of raised portions **170** and recessed portions **176**. Adjacent the second section **166** of the ferrule **160** and opposite of the shoulder **168** is a first holding portion **178**. The first holding portion **178** has first holding portion first and second flanges **180, 182** that extend from a first base portion **184** and substantially converge adjacent to the second section **166**. Adjacent the first holding portion **178** is a second holding portion **186**. The second holding portion **186** has second holding portion first and second flanges **188, 190** that extend from a second base portion **192** and substantially converge adjacent to the first base portion **184**. Adjacent the second base portion **192** is a resilient ferrule spring **194**. The fiber optic cable **152** is disposed in the ferrule assembly **154** such that a projecting segment **208** of the optical fiber **202** projects from the ferrule **160** end face **164**.

[**0026**] The method of polishing the ferrule **160** end face **164** of the fiber optic cable end connector **200** will now be described in greater detail. First, the fiber optic cable connector **200** is positioned in the ferrule holding recess **105** by pivoting the holding arm **226** away from the ferrule holding recess **105**. The ferrule **160** end face **164** is received in the ferrule holder **100** ferrule holding recess **105**. The end face **164** is inserted into the ferrule holding recess **105** until it is received in the ferrule end face receiving recess **126** and projects from the holding plate second side **127**. The holding arm **226** is then pivoted to its initial position adjacent to the ferrule holder **100** receiving end **104**. The fiber optic cable **152** is received in the cable receiving recess **132** between the first and second legs **230, 232**. The resiliency of the spring **228** biases the legs **230, 232** toward the receiving end **104** and against the ferrule spring **194** projecting from the ferrule receiving recess **105**. The ferrule spring **194** then biases the fiber optic cable connector **150** toward the holding plate second side **127** until the shoulder **168** of the ferrule **160** engages to the holding plate first side **125**.

[**0027**] As shown in **FIG. 1**, the fixture assembly **60** is positioned substantially adjacent to the disk outer periphery **94** such that the end face **164** and the projecting segment **208** of the optical fiber **202** are positioned within the slot **110**. The fixture assembly **60** is then moved toward the polishing surface **52** by the motor **96** and shaft **97** operating on the mounting plate **212** such that the fiber end face and ferrule contact the polishing surface **52**. The positional indicator **99** is used to determine the amount of material which is to be removed from the ferrule and fiber end face. While the disk **16** spins and water is injected through the water injecting recess **102**, the motor **80** drives the threaded shaft **78** causing the mounting structure **76** to move adjacent to the plate top surface **64** and parallel to the polishing surface **52** from the disk outer periphery **94** to the disk center **92**. It should be noted here that water having a pH between 7 and 8 exhibits favorable results in that it acts as a wetting agent without unduly etching the glass of the fiber end being polishing. Additionally, soap and anti-foaming agents may be added to the water to keep the polishing surface **52** clear of material which was removed from the ferrule and fiber end face. As the mounting structure **76** travels from the disk outer periphery **94** to the disk center **92**, the end face **164** and projecting segment **208** contact the rotating polishing surface **52** of the ring **50** positioned at the disk outer periphery **94** having the coarsest abrasive. As the end face **164** continues to move toward the disk center **92**, the end face **164** moves toward the finest ring **50** to achieve a finely polished fiber optic ferrule **160** end face **164** in a single pass polishing.

[**0028**] Further, as the mounting structure **76** travels from the disk outer periphery **94** to the disk center **92**, water or other cleaner or lubricant is injected through water infeed tubing (not shown), through the water injecting recess **102** and is expelled from the water ejecting recess **128** onto the polishing surface **52** of the rings **50** to remove debris and/or lubricate the polishing surface **52** subsequent to the ferrule **160** end face **164** contacting the polishing surface **52**. Excess

water and debris is, thereby, contained in the shroud **222** and drained through the base **12** utilizing well known techniques.

[**0029**] The foregoing illustrates some of the possibilities for practicing the invention. Many other embodiments are possible within the scope and spirit of the invention. It is, therefore, intended that the foregoing description be regarded as illustrative rather than limiting, and that the scope of the invention is given by the appended claims together with their full range of equivalents.

What is claimed is:

1. A fiber optic ferrule polishing devise comprising:

a disk having an outer periphery and a center;

a plurality of rings having a polishing surface coated with varying degrees of abrasive and an attachment surface attached to the disk such that the courseness of abrasive on the rings decreases from the outer periphery to the center;

a ferrule holder having a ferrule holding recess substantially adjacent to the polishing surface and an attachment arm pivotally attached to the ferrule holder such that the arm is positioned substantially adjacent to the ferrule holding recess;

wherein when a fiber optic ferrule is received in the ferrule holding recess the attachment arm biases the fiber optic ferrule toward the disk polishing surface.

2. The device of claim 1, wherein the ferrule holder has a water injecting recess positioned substantially adjacent to the ferrule holding recess.

3. The device of claim 2, wherein the water injecting recess is positioned toward the disk center and the ferrule holding recess is positioned toward the disk outer periphery.

4. The device of claim 1, further comprising a shroud encompassing the disk and the polishing surface.

5. The device of claim 1, wherein the attachment arm has a first arm mount and a second arm mount attached substantially perpendicular to the ferrule holder and having a spring extending therebetween.

6. The device of claim 1, wherein the attachment arm has a cable receiving recess for receipt of a fiber optic cable extending from the fiber optic ferrule positioned in the ferrule holding recess.

7. The device of claim 1, further comprising a mounting plate for mounting the ferrule holder a predetermined distance from the polishing surface.

8. The device of claim 1, further comprising a holding plate having a ferrule end face receiving recess having a smaller diameter than the ferrule holding recess and positioned adjacent to the ferrule holding recess and polishing surface.

9. The device of claim 1, wherein the abrasive is a diamond grit.

10. The device of claim 1, wherein the abrasive is a ceramic material.

11. The device of claim 1 wherein the abrasive is a carborundum material.

12. A fiber optic ferrule polishing devise comprising:

a disk having an outer periphery and a center;

a plurality of rings having a polishing surface coated with varying degrees of abrasive and an attachment surface attached to the disk such that the courseness of abrasive on the rings decreases from the outer periphery to the center;

a ferrule holder having a ferrule holding recess substantially adjacent to the polishing surface, a water injecting recess substantially adjacent to the ferrule holding recess and an attachment arm pivotally attached to the ferrule holder such that the arm is positioned substantially adjacent to the ferrule holding recess; and

wherein when a fiber optic ferrule is received in the ferrule holding recess the attachment arm biases the fiber optic ferrule toward the disk polishing surface.

13. The device of claim 12, wherein the water injecting recess is positioned toward the disk center and the ferrule holding recess is positioned toward the disk outer periphery.

14. The device of claim 12, further comprising a shroud encompassing the disk and the polishing surface.

15. The device of claim 12, wherein the attachment arm has a first arm mount and a second arm mount attached substantially perpendicular to the ferrule holder and having a spring extending therebetween.

16. The device of claim 12, wherein the attachment arm has a cable receiving recess for receipt of a fiber optic cable extending from the fiber optic ferrule positioned in the ferrule holding recess.

17. The device of claim 12, further comprising a mounting plate for mounting the ferrule holder a predetermined distance from the polishing surface.

18. The device of claim 12, further comprising a holding plate having a ferrule end face receiving recess having a smaller diameter than the ferrule holding recess and positioned adjacent to the ferrule holding recess and polishing surface.

19. The device of claim 12, wherein the abrasive is a diamond grit.

20. The device of claim 12, wherein the abrasive is a ceramic material.

21. The device of claim 12 wherein the abrasive is a carborundum material.

22. A fiber optic ferrule polishing devise comprising:

a disk having an outer periphery and a center;

a plurality of rings having a polishing surface coated with varying degrees of abrasive and an attachment surface attached to the disk such that the courseness of abrasive on the rings decreases from the outer periphery to the center;

a ferrule holder having a ferrule holding recess substantially adjacent to the polishing surface, a water injecting recess substantially adjacent to the ferrule holding recess and an attachment arm pivotally attached to the ferrule holder such that the arm is positioned substantially adjacent to the ferrule holding recess;

a holding plate having a ferrule end face receiving recess having a smaller diameter than the ferrule holding recess and positioned adjacent to the ferrule holding recess and polishing surface;

a mounting plate for mounting the ferrule holder a predetermined distance from the polishing surface; and

wherein when a fiber optic ferrule is received in the ferrule holding recess the attachment arm biases the fiber optic ferrule toward the disk polishing surface.

23. The device of claim 22, wherein the water injecting recess is positioned toward the disk center and the ferrule holding recess is positioned toward the disk outer periphery.

24. The device of claim 22, further comprising a shroud encompassing the disk and the polishing surface.

25. The device of claim 22, wherein the attachment arm has a first arm mount and a second arm mount attached substantially perpendicular to the ferrule holder and having a spring extending therebetween.

26. The device of claim 22, where in the attachment arm has a cable receiving recess for receipt of a fiber optic cable extending from the fiber optic ferrule positioned in the ferrule holding recess.

27. The device of claim 22, wherein the abrasive is a diamond grit.

28. The device of claim 22, wherein the abrasive is a ceramic material.

29. The device of claim 22 wherein the abrasive is a carborundum material.

* * * * *