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(54) Polishing fixture and method for fiber optic connectors

(57) A polishing fixture (10) and method suitable for use with springless fiber optic connectors, as well as connectors with integrated springs, is provided. The polishing fixture comprises at least a base plate (14) and a plurality of connector assemblies (12). Each connector assembly (12) includes a spring and the movement of the connector against the force of the spring applies a spring force to the connector during polishing to compensate for the variation of the protrusion of the connector (12) and optical fiber below the base plate (14) of the polishing fixture (10). The polishing fixture (10) of this invention can be used with circular and non-circular shaped connectors and with single and multi-fiber connectors.

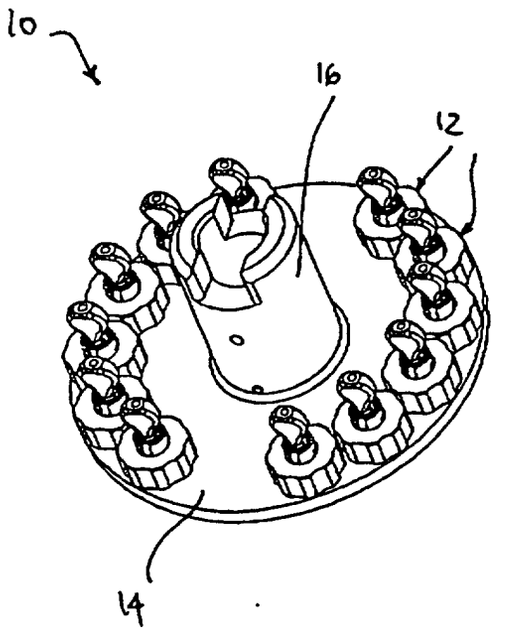

FIG. 1

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Description

FIELD OF THE INVENTION

[0001] This invention relates to a polishing fixture for use with a polishing machine to secure fiber optic connectors to the fixture for high precision polishing operations. More specifically, this invention relates to a novel fixture for securing springless fiber optic connectors thereto for polishing operations.

BACKGROUND OF THE INVENTION

[0002] Fiber optic connectors are an important link in a fiber optic transmission system. Fiber optic connectors provide a mechanical link between two terminal ends of optical fibers thereby permitting transmission through the system. It is important that the connecting terminal ends of the optical fibers are polished to a high precision to minimize the attenuation of signal across the mechanical link.

[0003] Conventional fiber optic connectors typically have an integrated spring contained within the connector body. As used herein, the term "connector" includes numerous fiber optic connectors which may have a variety of ferrule configurations, including, for example, springless fiber optic connectors such as a simplified plug-and-jack SC and ST connector and MTRJ connectors. When such connectors are coupled to a conventional polishing fixture, the terminal ends of the optical fibers, which protrude through the holes formed in the ferrule, extend through the bottom of the polishing fixtures and are polished by a polishing machine. The springless conventional polishing fixture secures the connectors in a fixed position and relies on the connector's integrated spring to compensate for the variation in the protrusion of the ferrules and optical fibers during polishing.

[0004] Springless optical fiber connectors, however, cannot be adequately polished to a high precision using a conventional polishing fixture. Conventional polishing fixtures do not have springs to compensate for the variation in the protrusion of the ferrules and optical fibers. Hence, there remains a need in the art for a polishing fixture that can compensate for the variation in the protrusion of the ferrules and optical fibers in springless fiber optic connectors.

SUMMARY OF THE INVENTION

[0005] Accordingly, it is an object of this invention to provide a polishing fixture that can compensate for the variation in the protrusion of ferrules and optical fibers in fiber optic connectors.

[0006] Another object of the invention is to provide a polishing fixture that can compensate for the variation in the protrusion of optical fibers in springless fiber optic connectors.

[0007] Another object of the invention is to provide a spring load to the fiber optic connector during polishing.

[0008] These and other objects of this invention are realized by a polishing fixture comprising a base plate having at least one puck assembly disposed thereon. The puck assembly comprises a connector receptacle attached to the base plate wherein the connector receptacle is adapted to receive a fiber optic connector for polishing. The puck assembly also includes a spring to bias the fiber optic connector during polishing.

[0009] In an embodiment, the connector receptacle is fixedly attached to the base plate. In another embodiment, the connector receptacle is movably attached to the base plate.

In accordance with one aspect of the invention, the fiber optic connector is substantially fixed to the connector receptacle during polishing, and both the connector and the receptacle are biased toward the base plate of the polishing fixture. The fiber optic connector may be affixed to the connector receptacle during polishing by any known means, including, for example, a bayonet mount or snap fitting spring arms. The connector receptacle may be received in a spring housing, which may be directly affixed to the base plate. Furthermore, the biasing spring may be disposed on the outside or the inside of the connector receptacle.

[0010] In accordance with another aspect of the invention, the fiber optic connector is movable relative to the connector receptacle. The spring preferably exerts a biasing force to bias the connector receptacle towards the base plate.

[0011] Preferably, the connector receptacle is directly affixed to the base plate. The spring may form a component of a spring plate assembly to exert the biasing force. On the other hand, the spring may be a cantilever or leaf spring positioned above the fiber optic connector to exert the biasing force.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The accompanying drawings form a part of the specification and are to be read in conjunction with the specification, in which like reference numerals are used to indicate like parts in the various views:

FIG. 1 is an elevated view of an embodiment of a polishing fixture in accordance to this invention with a plurality of fiber optic connectors coupled thereto;
FIG. 2 is a partially exploded view of the polishing fixture of FIG. 1;
FIG. 3 is an enlarged elevational view of a plug-and-jack puck assembly of the polishing fixture of FIG. 1;
FIG. 4 is a cross-sectional view of the plug-and-jack puck assembly of FIG. 3 along line 4-4;
FIG. 5 is an exploded view of the plug-and-jack puck assembly of FIG. 3;
FIG. 6 is a partially exploded elevational view of another embodiment of the polishing fixture in accord-

ance to this invention;

FIG. 7 is an enlarged view of the plug-and-jack puck assembly shown in FIG. 6;

FIG. 8 is a top view of the polishing fixture of FIG. 6;

FIG. 9 is a cross-sectional view of the polishing fixture of FIGS. 6 and 8 along line 9-9;

FIG. 10 is an elevational view of another embodiment of the polishing fixture in accordance to this invention;

FIG. 11 is an exploded view of the polishing fixture of FIG. 10;

FIG. 12 is another embodiment of a puck assembly in accordance to this invention;

FIG. 13 is an exploded view of the puck assembly of FIG. 12;

FIG. 14 is a cross-sectional view of the puck assembly of FIG. 12; and

FIG. 15 is a polishing fixture adapted to receive a plurality of the puck assembly of FIG. 12.

DETAILED DESCRIPTION OF THE INVENTION

[0013] As shown generally in **FIGS. 1-5,** where like numbers designate like parts, reference number **10** designates an embodiment of the polishing fixture in accordance with this invention. Polishing fixture **10** is adapted to have a number of plug-and-jack puck assemblies **12** fixedly mounted thereon. Although twelve puck assemblies **12** are illustrated in **FIGS. 1** and **2,** any number of puck assemblies **12** can be mounted on the polishing fixture **10.** Polishing fixture **10** comprises a substantially circular base plate **14** and a hollow arm or central boss **16.** As more specifically shown in **FIGS. 3-5,** each plug-and-jack puck assembly **12** is adapted to releasably receive a fiber optic connector **18.** Although springless connectors **18** are shown in the accompanying drawings, the polishing fixtures **10** described herein are also suitable for use with connectors having an integrated spring. Thus, this invention is not limited to any specific connectors described and illustrated herein. Puck assembly **12** comprises a spring housing **20,** which is preferably fixedly attached to base plate **14** of polishing fixture **10,** connector receptacle **22,** compression spring **24,** and retainer housing **26.** Connector receptacle **22** has a tubular body **28** with bayonet slots **30** defined thereon and shoulder **32.** Spring housing **20** is sized and dimensioned to receive connector receptacle **22.** Preferably, spring housing **20** comprises substantially flat, internal surfaces **34,** which are adapted to match with corresponding flat surfaces **36** of shoulder **32** of connector receptacle **22.** Substantially flat surfaces **34** and **36** cooperate to minimize rotational movement of the connectors **18** during polishing.

[0014] Connector **18** preferably has two bayonet lugs **38** disposed thereon. Lugs **38** are sized and dimensioned to be lockably received in bayonet slots **30** of connector receptacle **22,** such that there is no or minimal relative motion between connector **18** and connector receptacle **22.** As particularly shown in **FIG. 4,** after the connector **18** is inserted through connector receptacle **22,** terminal portion **40** of connector **18** is further inserted through well **42** of the spring housing **20** and extends therethrough, such that a portion of terminal portion **40** protrudes through the bottom of spring housing **20** and base **14** and is exposed for polishing. Terminal portion **40** defines a channel **44** that contains the terminal end of the optical fiber **46** for polishing.

[0015] Compression spring **24** is disposed in the annular space between tubular body **28** of connector receptacle **22** and is partially compressed between shoulder **32** of connector receptacle **22** and a top portion of retainer housing **26.** Retainer housing **26** is coupled to the spring housing **20** by matching threads shown most clearly in **FIGS. 4** and **5.** After the plug-and-jack puck assembly **12** is assembled, a portion of the connector receptacle **22** including bayonet slots **30** extends through the hole on top of retainer housing **26** to readily receive connector **18.** After fiber optic connector **18** is inserted in the connector receptacle **22,** terminal portion **40** of connector **18,** with optical fiber **46** disposed therethrough, protrudes through the bottom of the spring housing **20** and extends below the bottom of the base plate **14** of the polishing fixture **10.**

[0016] Although not shown in the figures, the polishing fixture is mounted to a rotary polishing machine. Typically, arm or boss **16** is mounted to an axle or spindle of the polishing machine and is fixedly connected to the machine, for example, by a swing-arm on the machine. Other types of attachments for the polishing machine, such as, for example, the polishing apparatus shown in U.S. Patent No. 5,720,653, are also suitable for use with this invention. In an embodiment, the protruded portion of the connector **18** with the optical fiber **46** rest on an electrically driven platen that extends up from the base of the polishing machine, and a downward force is applied to displace the connector **18** with the optical fiber **46** upward. This upward displacement causes the spring **24** to compress. Preferably, this displacement applies a spring load of about two pounds, simulating a desirable spring force exerted by an integrated spring of a conventional connector. The protruded portions of the connectors **18** and optical fiber **46** are then effectively polished when the platen is driven by the polishing machine. In an embodiment of this invention, the platen is driven by the polishing machine in a circular pattern. In another embodiment of this invention, the platen is driven by the polishing machine in a non-circular pattern.

[0017] Furthermore, if a protruded portion of the terminal end **40** of the fiber optic connector **18** over-extends below the bottom of the polishing fixture **10,** the platen pushes the over-extended portion upward in the direction of arrow **48** in **FIG. 4** against the force of spring **24.** Hence, the protruded portions of all connectors **18** mounted on the polishing fixture are substantially at the same height before polishing begins, and polishing is

carried out uniformly over all the mounted connectors **18.** Additionally, the polishing fixture of this invention is suitable for use with conventional connectors with integrated springs. In this situation, either spring **24** in puck assembly **12** or an integrated spring inside the conventional connector or both may be compressed.

[0018] **FIGS. 6-9** illustrate another embodiment of the polishing assembly in accordance with this invention. Polishing fixture **50** is shown with a number of plug-and-jack puck assemblies **52** coupled thereto. Three puck assemblies **52** are shown wherein exploded views in various stages. A significant feature of this embodiment is that connector **18** is movable relative to the connector receptacle **54.** Furthermore, connector receptacle **54** is fixedly connected directly to the base plate **14.** As more particularly shown in **FIG. 9,** connector receptacle **54** has a tubular body **56** defining a pair of vertical slots **58** adapted to receive bayonet lugs **38** on connector **18.** Slots **58** allow the bayonet lugs **38** and connector **18** to be movable in the vertical direction within the slots. A spring plate assembly **60** is positioned above the connector **18** to exert a spring force on connector **18** during polishing and to compensate for the variation in the protrusion of the connector and optical fiber.

[0019] Spring plate assembly **60** includes plate **62,** a plurality of compression springs **64,** a corresponding number of bolts **66,** and an enclosing cap **68.** As best shown in **FIG. 7,** bolts **66** are inserted through the top of cap **68** through pre-drilled holes and are then inserted through the corresponding springs **64** and are threaded through the threaded holes on plate **62.** Due to the smooth upper portions of bolts **66,** plate **62** is movable in the direction of arrow **70,** shown in **FIG. 9,** against the force of springs **64.**

[0020] Connector **18** is inserted into body **56** of connector receptacle **54** such that lugs **38** are movably received in vertical slots **58** and terminal portion **40** extends through the bottom channel on the connector receptacle **54** and protrudes below base plate **14,** as described above. Spring plate assembly **60** is then coupled with connector receptacle **54** by means of the corresponding threads, as shown. Thereafter, connector **18** abuts plate **62** and spring plate assembly **60** exerts a force on connector **18.** Plate **62** and bolts **66** are movable in the direction of arrow **70** to exert a spring force on connector **18** and to compensate for the variation of the protrusion by connector **18** through base plate **14.**

[0021] **FIGS. 10** and **11** show another embodiment in accordance with this invention. Similar to polishing fixture **50,** polishing fixture **72** has base plate **14** and a plurality of connector receptacles **54** with vertical slots **58.** Connectors **18** are inserted into connector receptacles **54** such that the connectors and the connector receptacles are movable relative to each other. Thereafter, clip ring **74** is placed over central boss **100,** such that each cantilever arm **76** is positioned above each connector **18.** Nut **78** is threaded over boss **100** to press clip ring **74** downward such that each cantilever arm **76** acts like a leaf spring to exert a spring force on each connector **18.** Connectors **18** are also movable upward against the spring force of arms **76** to compensate for the variation in the protrusion of ferrules **18** with optical fibers **46.**

[0022] **FIGS. 12-15** represent another embodiment in accordance to this invention. Puck assembly **80** is sized and dimensioned to accept a non-circular connector **82.** In this embodiment, connector **82** is illustrated as a square-profiled connector. Non-circular connector **82,** however, many have any polygonal, elliptical, or other profile. Similar to the puck assembly **12** described above and shown in **FIGS. 1-5**, connector **82** and the connector receptacle are fixedly attached to each other, *i.e.*, they are not movable relative to each other, during polishing. As most clearly shown in **FIGS. 13** and **14,** puck assembly **80** comprises base **84,** connector receptacle **86,** compression spring **88,** and nut **90.**

[0023] Base **84,** which performs the same function as the spring housing **20** of polishing fixture **10,** is fixedly attached to base plate **92,** shown in **FIG. 15.** Connector receptacle **86** defines a hole through its bottom surface and is adapted to fit over boss **94** of base **84.** Spring **88** is positioned over boss **94** and nut **90** is fixedly fitted, for example by press fitting, to the top of boss **94** to contain spring **88** between nut **90** and connector receptacle **86** as best shown in **FIG. 14.** Connector receptacle **86** is sized and configured to be movable in the direction of arrow **96** relative to base **84,** against the force of spring **88.**

[0024] Adapter has cavity **96** adapted to receive connector **82,** such that the connector is fixed to the adapter and both of these components are movable relative to base **84.** Connector **82** has two spring prongs **98,** which snap into cavity **96** to secure connector **82** to connector receptacle **86.** In this embodiment, the movement of connector **82** and connector receptacle **86** against the force of spring **88** and relative to base **84** exerts a spring force on the connector during polishing and compensates for the variation of the protrusion of the connectors **82** below the base plate **92.**

[0025] While various embodiments have been described in fulfillment of the features, aspects, and advantages of this invention, it is understood that these embodiments can be used singly or in combination thereof. For example, although single fiber connectors are illustrated herein, MT or other multi-fiber ferrules or connectors can be used with this invention. Additionally, the invented polishing fixture can be adapted to accept any number of ferrules or connectors. Furthermore, the puck assemblies described above can be adapted to be used with linear, oval, or rectangular polishing fixtures in addition to circular fixtures. It should be recognized that these embodiments are merely illustrative of this invention. Numerous modifications and adaptations thereof will be readily apparent to those skilled in the art without departing from the spirit and scope of this invention.

Claims

1. A polishing fixture comprising:

   a base plate for securing a puck assembly thereto;
   the puck assembly configured to engage a fiber optic connector, the puck assembly comprises:

   a connector receptacle for receiving the fiber optic connector for polishing, wherein the connector receptacle is attached to the base plate; and
   a spring for providing a biasing force to the fiber optic connector during polishing.

2. The polishing fixture of claim 1, wherein the puck assembly further comprises:

   means for substantially eliminating the relative motion between the connector receptacle and the fiber optic connector.

3. The polishing fixture of claim 2, wherein the means for substantially eliminating the relative motion between the connector receptacle and the fiber optic connector comprises:

   at least one bayonet lug, wherein the bayonet lug is sized and dimensioned to be lockably received in a bayonet slot on the connector receptacle.

4. The polishing fixture of claim 1, wherein the fiber optic connector engages the connector receptacle using a bayonet connection.

5. The polishing fixture of claim 1, wherein the fiber optic connector engages the connector receptacle using one or more snap fitting spring arms.

6. The polishing fixture of claim 1, wherein the spring biases the connector receptacle towards the base plate.

7. The polishing fixture of claim 1, wherein the puck assembly further comprises:

   a spring housing to secure the spring, wherein the spring housing is fixedly attached to the base plate.

8. The polishing fixture of claim 1, wherein the spring is disposed around the connector receptacle.

9. The polishing fixture of claim 1, wherein the spring is disposed inside the connector receptacle.

10. The polishing fixture of claim 7, wherein the connector receptacle and the spring housing each comprise substantially corresponding straight edges to substantially eliminate relative rotational movement of the fiber optic connector during polishing.

11. The polishing fixture of claim 1, wherein the connector receptacle is movable relative to the fiber optic connector.

12. The polishing fixture of claim 11, wherein the polishing fixture further comprises:

    a spring plate assembly for use with the spring to exert the biasing force on the fiber optic connector during polishing and to compensate for the variation in the protrusion of the fiber optic connector and an optical fiber.

13. The polishing fixture of claim 12, wherein the spring plate assembly comprises a plate, a plurality of compression springs, a plurality of bolts corresponding to an equal number of the compression springs, and an enclosing cap.

14. The polishing fixture of claim 13, wherein the plate is biased by the spring to exert the biasing force.

15. The polishing fixture of claim 12, wherein the polishing fixture further comprises:

    a clip ring having at least one cantilever arm for use with the spring plate assembly, wherein the cantilever arm exerts a spring force on the fiber optic connector.

16. The polishing fixture of claim 15, wherein the fiber optic connector is positioned between the cantilever arm and the connector receptacle.

17. A polishing fixture comprising:

    a base plate for securing a puck assembly thereto;
    the puck assembly configured to engage a fiber optic connector, the puck assembly comprises:

    a connector receptacle for receiving the fiber optic connector for polishing; and
    a spring for providing a biasing force to the fiber optic connector during polishing.

18. A puck assembly attachable to a polishing fixture, the puck assembly comprises:

    a connector receptacle adapted to receive a fiber optic connector to polish; and
    a spring to bias the fiber optic connector during

polishing..

19. The puck assembly of claim 18, wherein the puck assembly further comprises:

means for substantially eliminating the relative motion between the connector receptacle and the fiber optic connector.

20. The puck assembly of claim 19, wherein the means for substantially eliminating the relative motion between the connector receptacle and the fiber optic connector comprises:

at least one bayonet lug, wherein the bayonet lug is sized and dimensioned to be lockably received in a bayonet slot on the connector receptacle.

21. The puck assembly of claim 20, wherein the connector receptacle is movable relative to the fiber optic connector.

22. A method of using a polishing fixture to compensate for the variation in the protrusion of one or more springless fiber optic connectors, comprising:

providing a puck assembly puck configured to engage the fiber optic connector;
securing the puck assembly to a base plate;
engaging the springless fiber optic connector in the puck assembly, wherein the puck assembly comprises:

a connector receptacle for receiving the fiber optic connector for polishing, wherein the connector receptacle is attached to the base plate; and
a spring for providing a biasing force to the fiber optic connector during polishing.

applying a downward force to the polishing fixture to displace the springless fiber optic connector; and
polishing the terminal end of the fiber optic connector.

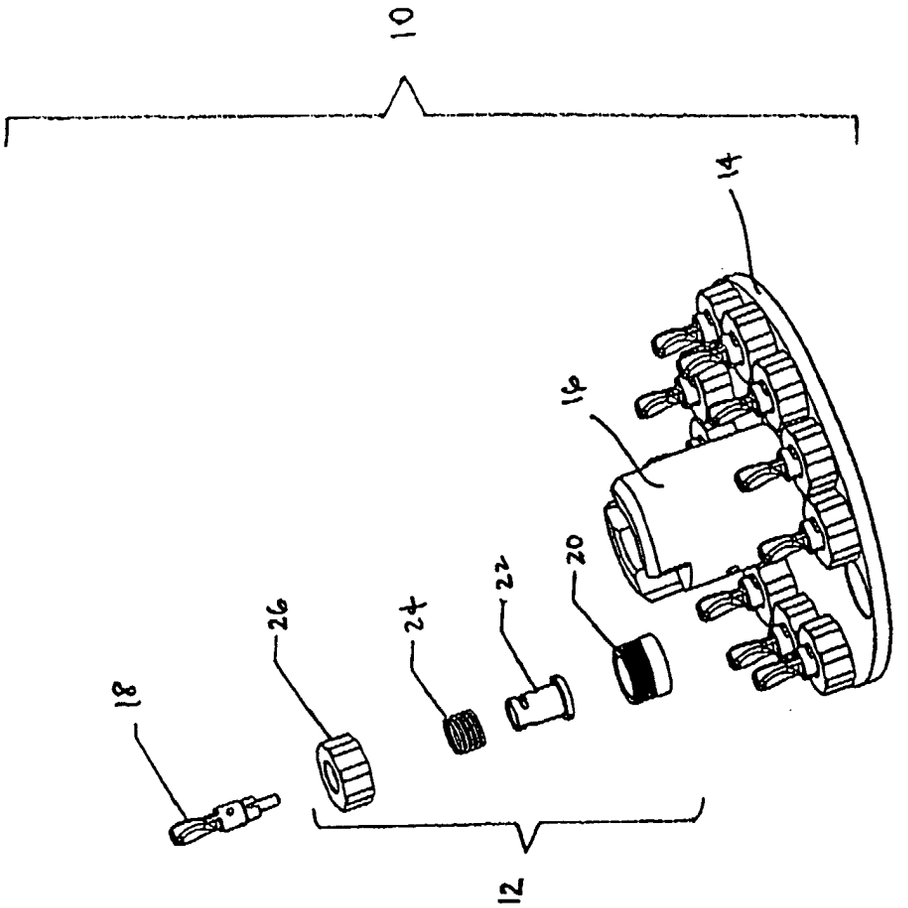

FIG. 2

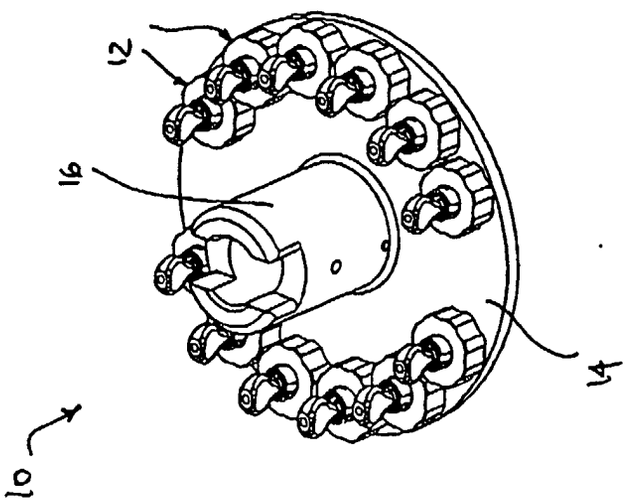

FIG. 1

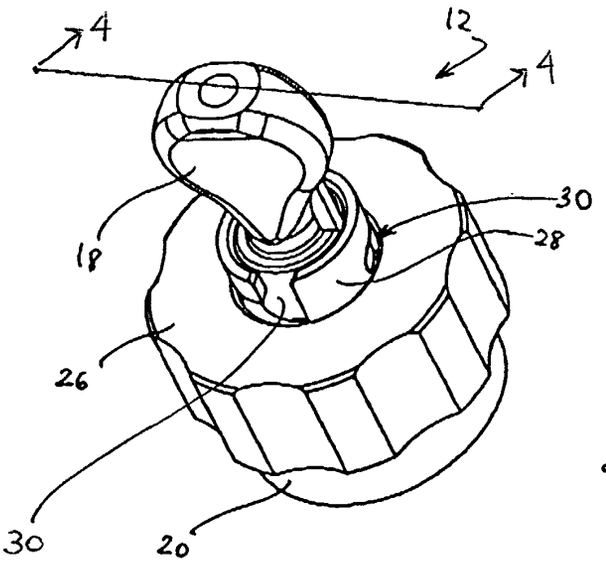

FIG. 3

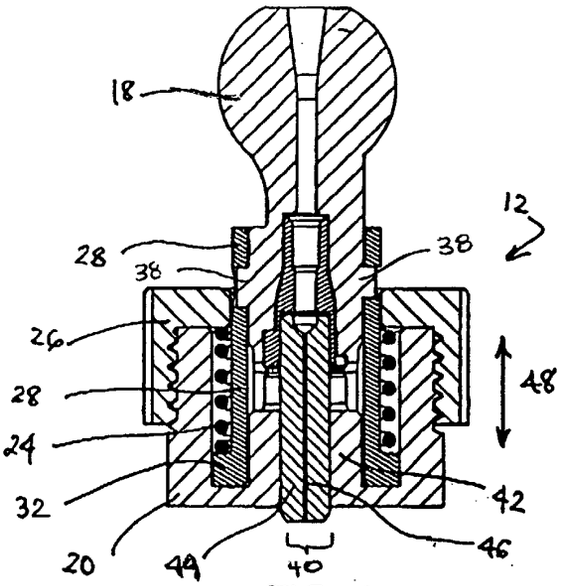

FIG. 4

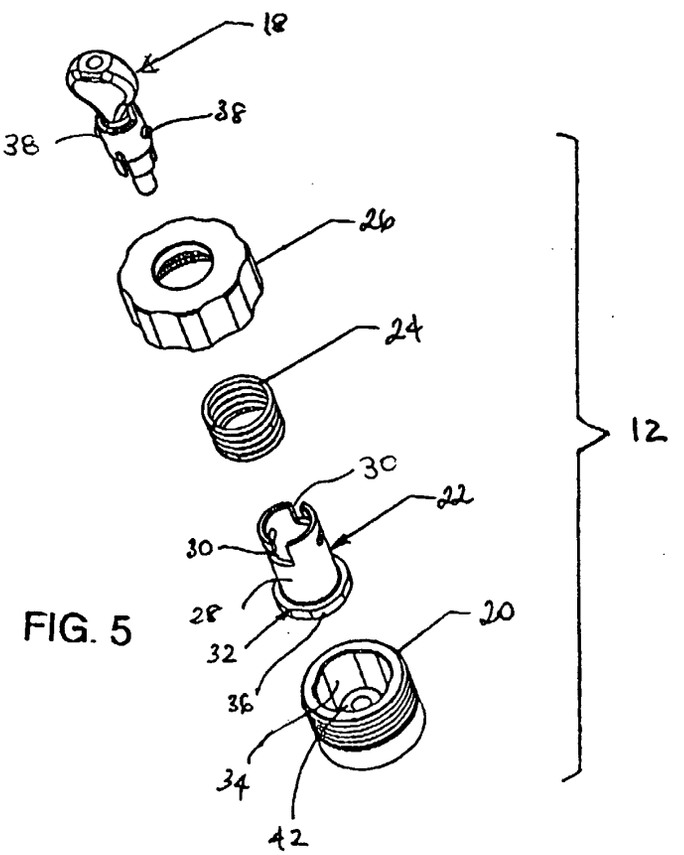

FIG. 5

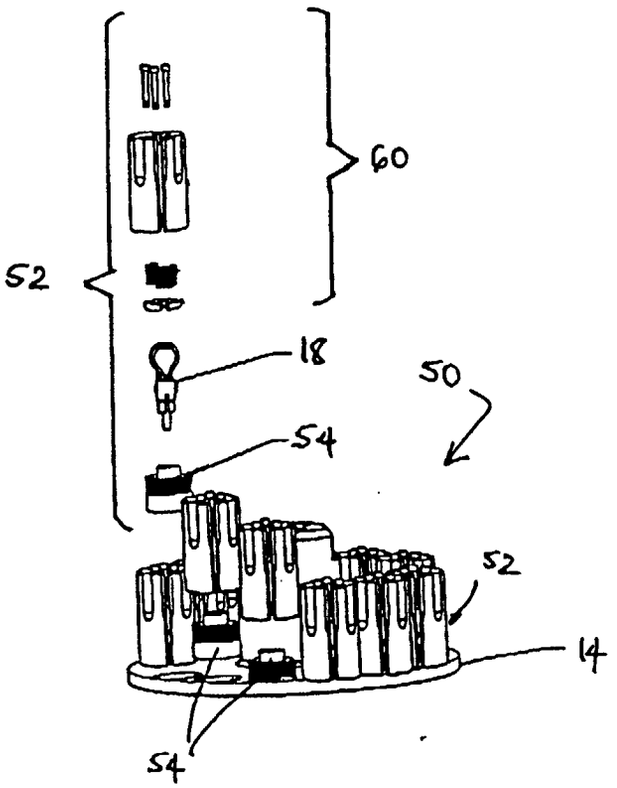

FIG. 6

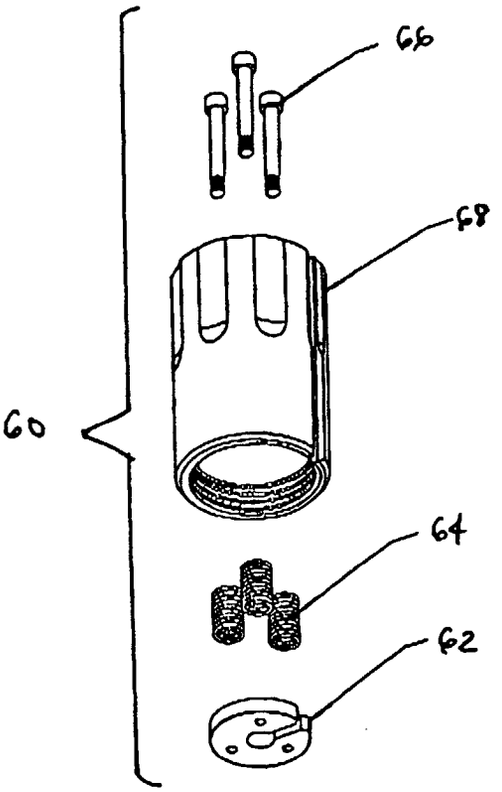

FIG. 7

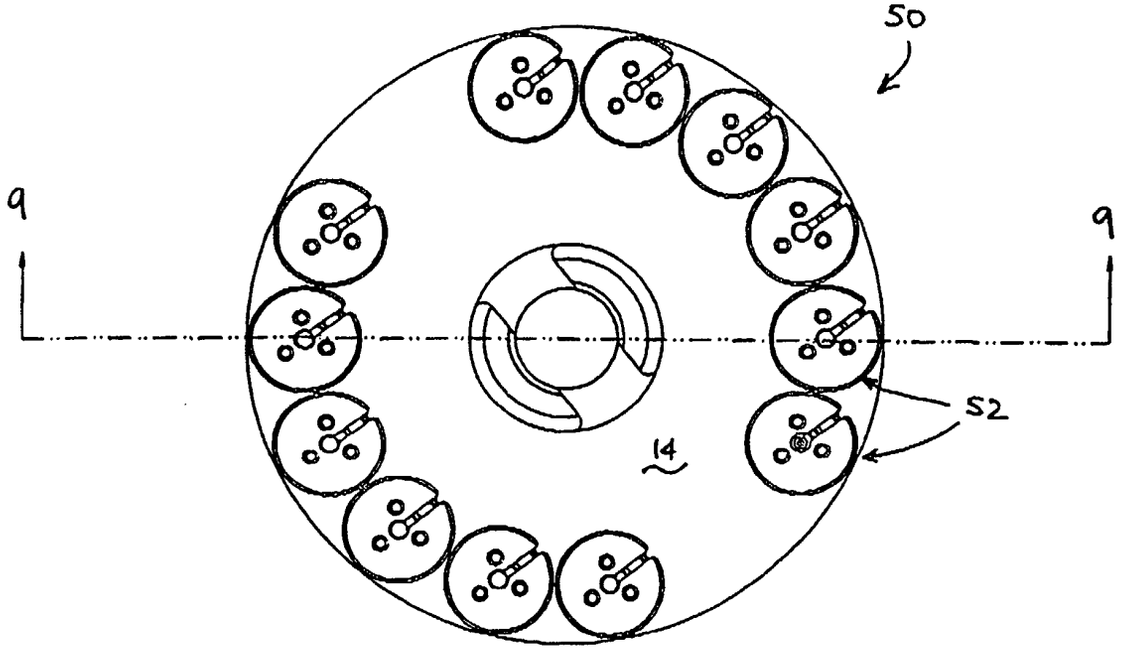

FIG. 8

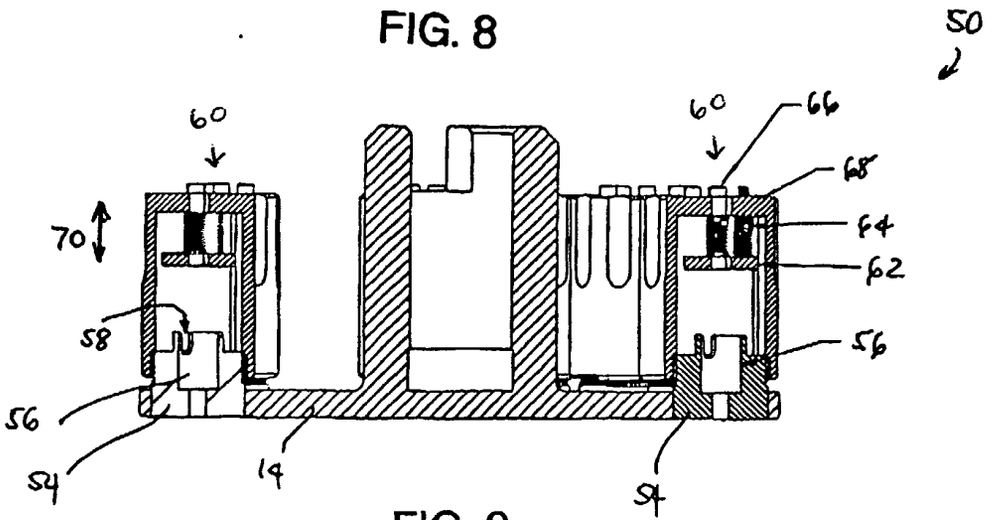

FIG. 9

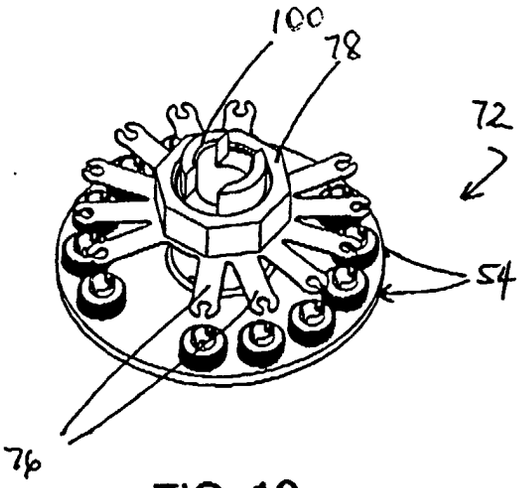

FIG. 10

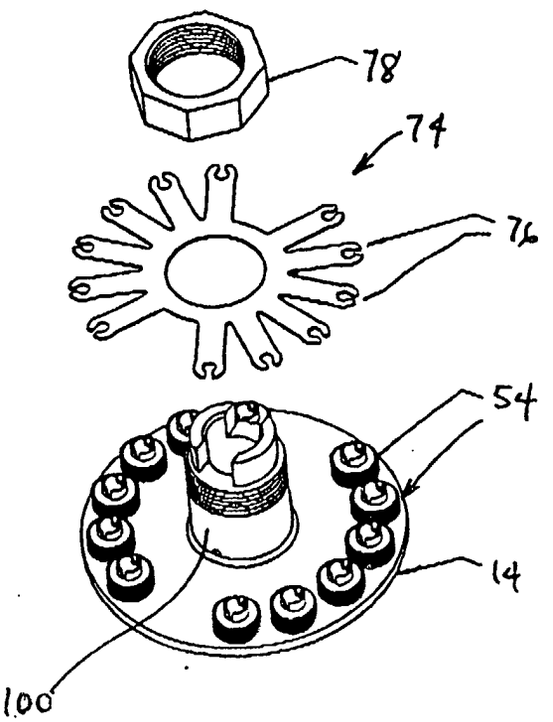

FIG. 11

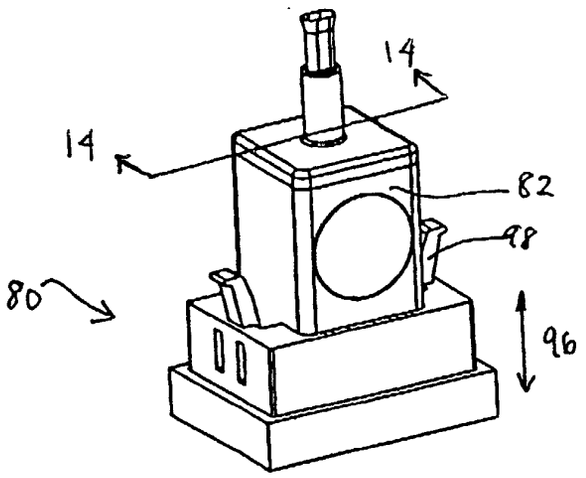

FIG. 12

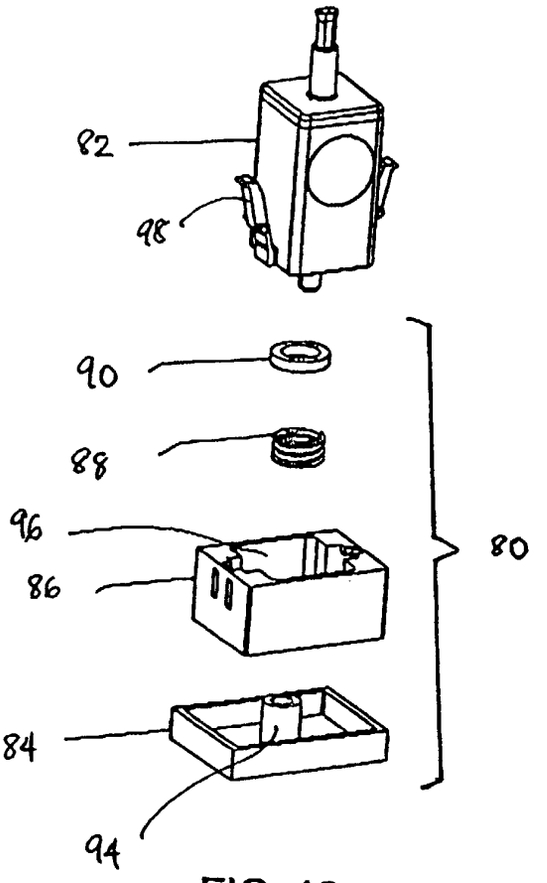

FIG. 13

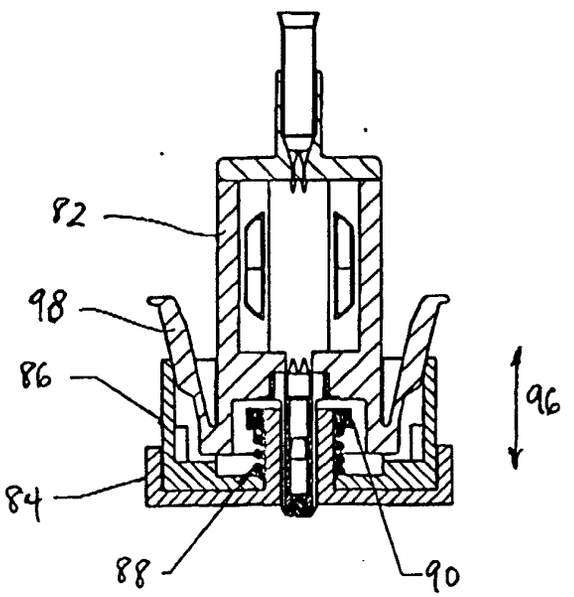

FIG. 14

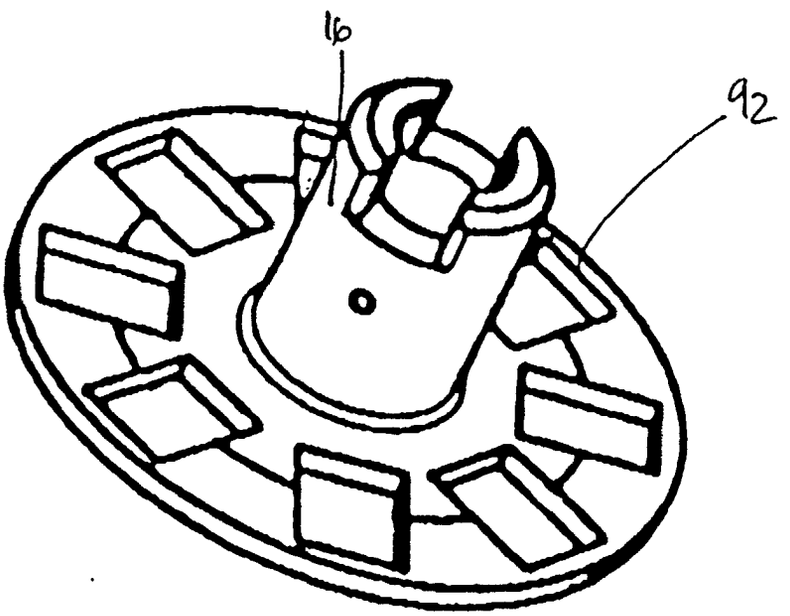

FIG. 15