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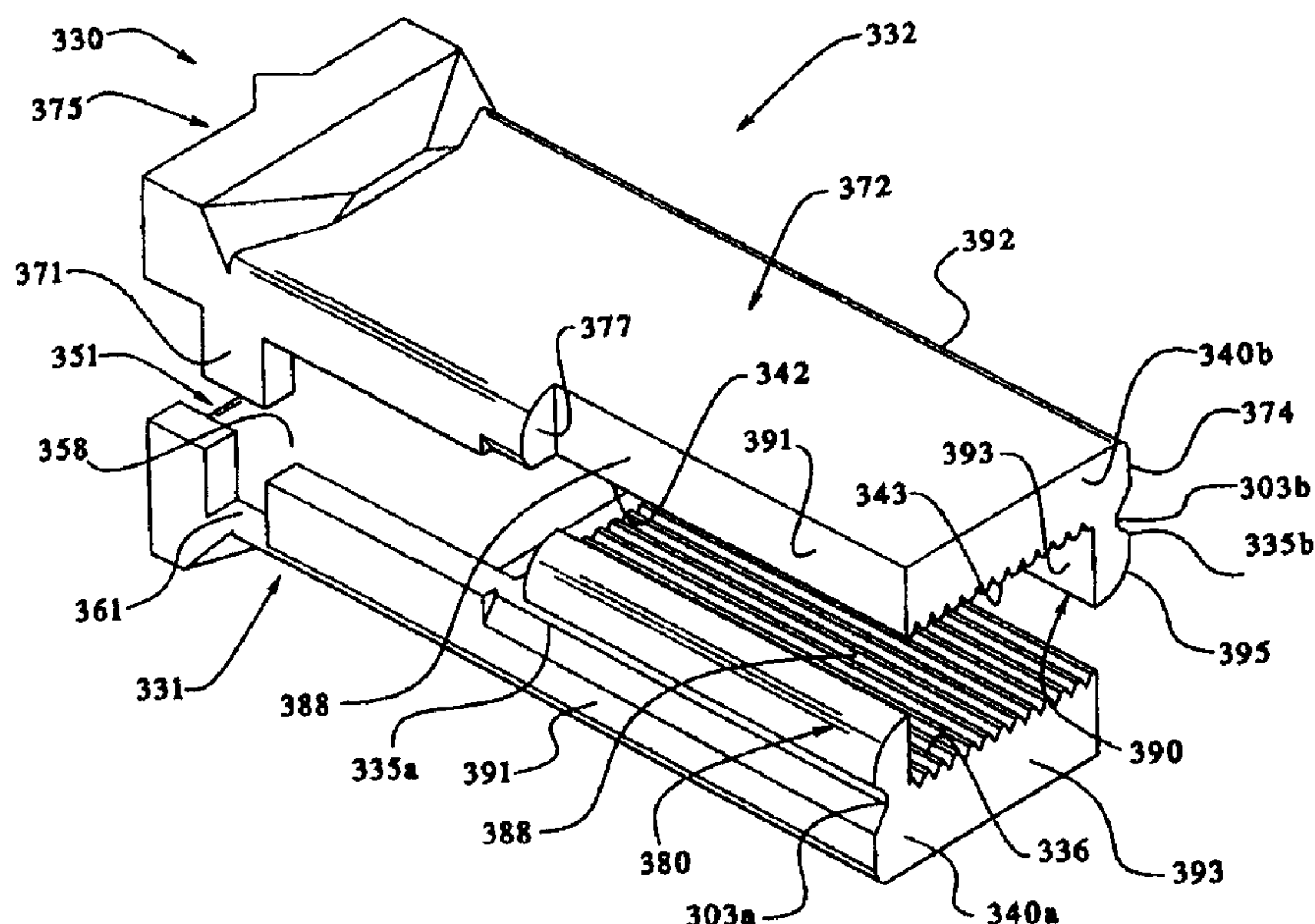
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(54) **SYSTEME MASSIF D'INTERCONNEXION OPTIQUE
PARALLELE**

(54) **MASSIVE PARALLEL OPTICAL INTERCONNECT SYSTEM**



(57) L'invention concerne un connecteur consistant en un connecteur de fibres optiques possédant une ferrule polymère (331, 332) présentant des rainures en V (336) dans lesquelles sont montées des fibres multiples, ainsi que des bords biseautés (335a, 335b) servant à aligner la ferrule (331, 332) quand le connecteur de fibres optiques est introduit dans une prise (500) possédant un ensemble d'alignement et un élément d'alignement monté à l'intérieur de cet ensemble afin d'exécuter un alignement de précision. Elle concerne un ensemble prise présentant une première moitié de prise (400) servant à recevoir un connecteur de fibres optiques possédant un premier

(57) A connector is provided which includes a fiber optic connector having a polymer ferrule (331, 332) having multiple fibers mounted in V-grooves (336) of the ferrule (331, 332) and beveled edges (335a, 335b) of the ferrule providing for alignment of the ferrule (331, 332) when the fiber optic connector is mated to a receptacle (500) having an alignment assembly and an alignment member mounted within the alignment assembly to provide for precision alignment. A receptacle assembly is provided having a first receptacle half (400) for receiving a fiber optic connector having a first form factor and a second receptacle half (300) for receiving a fiber optic connector

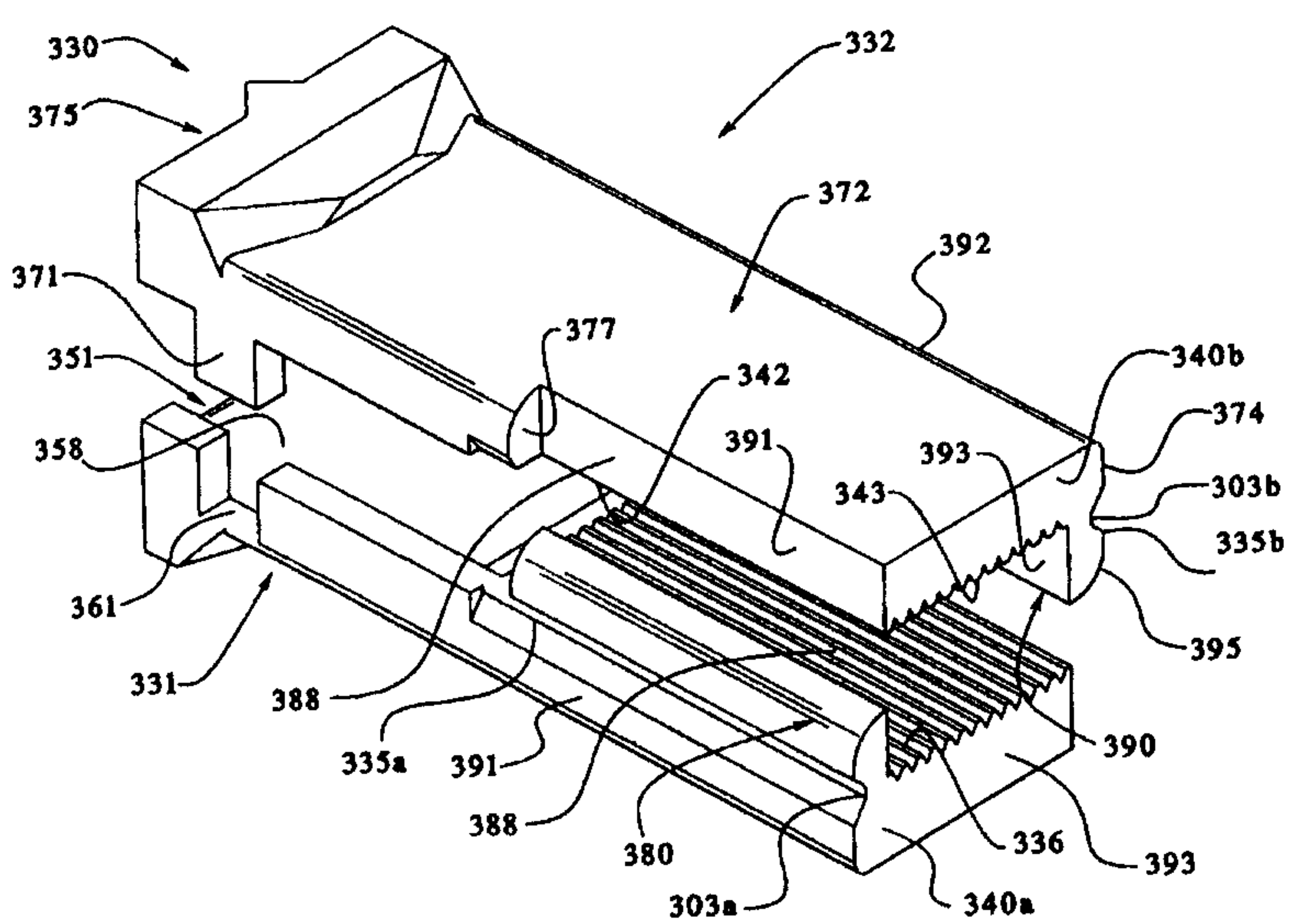


facteur de forme et une deuxième moitié de prise (300) servant à recevoir un connecteur de fibres optiques possédant un deuxième facteur de forme. Elle concerne également une ferrule de fibres optiques comportant une paire de moitiés de ferrule (331, 332) opposées l'une à l'autre et se réunissant, de manière à définir une zone de support de fibres optiques recevant des fibres optiques, dans laquelle au moins une des moitiés de ferrule (331, 332) comprend une paroi alignée verticalement (380, 390) formant une saillie en direction de la moitié de ferrule opposée.

having a second form factor. A fiber optical ferrule is also provided having a pair of mutually opposing ferrule halves (331, 332) that join to define a fiber optical support region that receives optical fibers, where at least one of the ferrule halves (331, 332) includes a vertically aligned wall (380, 390) that protrudes toward the opposing ferrule half.

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(21) International Application Number: PCT/US99/05576 (22) International Filing Date: 16 March 1999 (16.03.99) (30) Priority Data: 09/044,597 19 March 1998 (19.03.98) US (71) Applicant: METHODE ELECTRONICS, INC. [US/US]; 7444 West Wilson Avenue, Chicago, IL 60656-4549 (US). (72) Inventors: WEISS, Roger, E.; 10 Mary Way, Foxborough, MA 02035 (US). VLADIC, Daniel, P.; 42643 Linden Lane, Antioch, IL 60002 (US). SCHOFIELD, Philip, W.; 1218 North Euclid, Oak Park, IL 60302 (US). (74) Agent: BARRETT, Robert, M.; Hill & Simpson, Sears Tower, 85th floor, 233 South Wacker Drive, Chicago, IL 60606 (US).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i>
(54) Title: MASSIVE PARALLEL OPTICAL INTERCONNECT SYSTEM  (57) Abstract A connector is provided which includes a fiber optic connector having a polymer ferrule (331, 332) having multiple fibers mounted in V-grooves (336) of the ferrule (331, 332) and beveled edges (335a, 335b) of the ferrule providing for alignment of the ferrule (331, 332) when the fiber optic connector is mated to a receptacle (500) having an alignment assembly and an alignment member mounted within the alignment assembly to provide for precision alignment. A receptacle assembly is provided having a first receptacle half (400) for receiving a fiber optic connector having a first form factor and a second receptacle half (300) for receiving a fiber optic connector having a second form factor. A fiber optical ferrule is also provided having a pair of mutually opposing ferrule halves (331, 332) that join to define a fiber optical support region that receives optical fibers, where at least one of the ferrule halves (331, 332) includes a vertically aligned wall (380, 390) that protrudes toward the opposing ferrule half.		

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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

5 Be it known that we, **Roger E. Weiss, Daniel P. Vladic, and Philip W. Schofield**, each citizens of the United States of America and residents of 10 Mary Way, Foxborough, Massachusetts, 42643 Linden Lane, Antioch, Illinois, and 1218 North Euclid, Oak Park, Illinois, respectively, have invented a

MASSIVE PARALLEL OPTICAL INTERCONNECT SYSTEM

of which the following is the specification.

MASSIVE PARALLEL OPTICAL INTERCONNECT SYSTEM

This is a continuation-in-part of U.S. Serial No. 08/668,922, filed on June 24, 1996, which is a continuation-in-part of U.S. Serial No. 08/577,508, filed on December 22, 1995.

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BACKGROUND OF THE INVENTION

This invention pertains to a fiber optic interconnect system and, in particular, a massive parallel optical interconnect system.

Optical fiber connectors having multiple fibers are known in the art. Such multi-fiber connectors are increasingly necessary as greater bandwidth applications are needed. Generally, the array of fibers are mounted in V-grooves which are etched in a silicon material in order to provide for precision positioning of the fibers. Precision positioning of the fibers in the silicon block is imperative so that when two connectors are mated, the fibers align as closely as possible in order to limit any signal loss. The use of silicon blocks is useful in that the V-grooves may be etched precisely. Etching of silicon blocks is well known in the art and generally is accomplished using standard anisotropic etchants, such as ethylene diamine pyrocatechol (EDP) or KOH in combination with a standard etch mask material such as thermally grown SiO₂. However, the mounting of silicon blocks within a housing and ensuring the proper alignment of two silicon blocks when they are mated is difficult where automated assembly is desired. Also, silicon is a hard, brittle material which is difficult to polish and is easily broken. Other multiple fiber connectors using silicon blocks have the blocks mounted within a housing and splines mounted next to the blocks which protrude beyond the end face of the block and the connector. This arrangement of assembling the connector having the silicon blocks, splines, fibers and a housing is time consuming. In other designs, splines are inserted within the silicon block. In such an arrangement, the connector having the splines protruding therefrom mates with a connector without splines; so that the first connector splines are inserted into the vacant grooves of the silicon block of the second connector. Such an arrangement is disadvantageous because the splines may stub on the silicon resulting in breakage. Moreover, silicon blocks as presently configured are not easily terminated in the field. Due to the arrangement of the connector housing, the fibers must be placed in the grooves of the silicon blocks prior to

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placing the major surfaces of the silicon blocks next to each other in order to capture the optical fibers within the grooves. Such assembly and alignment is not easily accomplished by technicians in the field.

Therefore, it is an object of the present invention to provide a massive parallel
5 optical interconnect system which is easily and inexpensively manufactured and assembled and provides for simple field termination.

It is another object of the present invention to provide a fiber optic connector which has a common form factor presently used in the fiber optic connector industry.

It is a further object of the present invention to provide a multi-fiber connector
10 in a miniaturized package.

It is also an object of the present invention to provide a ferrule which is easily and inexpensively manufactured and provides for precision alignment of massive or multiple optical fibers.

It is another object of the present invention to provide a miniaturized fiber optic
15 connector having a multiplicity of optical fibers terminated therein.

It is also an object of the present invention to provide an interconnection system which allows both ends of the cable to be identically terminated to ease installation.

It is a further object of the present invention to provide methods of assembling a fiber optic connector which provides for a simple termination process.

It is another object of the present invention to provide a massive parallel optical
20 receptacle which allows for the mating of a massive parallel optical connector from a first side and an optical connector having a differing form factor from a second side.

It is yet another object of the present invention to provide for a fiber optic ferrule that may be formed from ferrule halves, where each ferrule half contains an entire
25 beveled edge.

It is another object of the present invention to provide each ferrule half with a vertically aligned wall that prevents seepage of adhesive fluid onto the beveled edge when the ferrule halves are combined to form a ferrule.

It is another object of the present invention to provide for a ferrule made of a resin
30 composition having an anisotropy of 1.5 or less.

SUMMARY OF THE INVENTION

A principal object of this invention is to provide a massive parallel interconnect system comprising a plug body including an aperture therethrough including a ferrule having beveled edges and a receptacle including an opening having an alignment sleeve having two alignment members for providing alignment with the beveled edges of the ferrule. The ferrule accommodates multiple fibers. The ferrule is injection molded plastic having grooves therein for receiving optical fibers. The grooves are rectilinear to the beveled edges of the ferrule. The plug body includes a mating end that dimensionally conforms to an SC style fiber optic connector form factor having an end face dimension of approximately 8.99 mm x 7.39 mm. The ferrule includes at least two optical fibers. A pair of plug bodies is inserted into either end of the receptacle and provides for a precision alignment of the ferrules. The alignment sleeve includes a pair of alignment members mounted within the receptacle providing a spring-form system wherein a force is applied to the alignment members and towards the beveled edges of a ferrule parallel to major surfaces of the ferrule halves. The alignment sleeve includes a spring clip for retaining alignment members within the alignment sleeve. The spring clip includes arms having a hook portion for engaging the alignment member. The spring clip applies a spring force to the alignment members toward the beveled edges of the ferrule parallel to major surfaces of the ferrule halves. The plug body includes a rear holder mounted at the cable entry end of the plug body and the rear holder includes an aperture for receiving a fiber optic cable. The rear holder includes a strain relief which receives a bend relief boot. The fiber optic cable is secured to the rear holder via retention means to capture strength members of the fiber optic cable and transfer forces applied to the cable to the plug body. The plug body includes a marking to designate the position of the first optical fiber. The plug body includes a resilient member to provide for axial resiliency of the ferrule. The aperture of the plug body is greater in size than the size of the ferrule wherein the ferrule is pivotally movable within the plug body. The plug body includes a sliding tab release sleeve. The receptacle includes latch arms. The receptacle includes an opening which dimensionally conforms to an SC style fiber optic receptacle form factor including an opening of approximately 9.0 mm x 7.4 mm. The ferrule includes a window for receiving adhesive therethrough. The ferrule is terminated by inserting

multiple optical fibers within grooves of the ferrule and securing the optical fibers within the grooves via chemical bonding and polishing the end face of the ferrule. In one particular embodiment, the ferrule is formed of two halves each having a major surface having V-grooves therein and the halves each having a pair of beveled edges. The ferrule halves include a mating end and a rear end having a collar half molded integrally with the ferrule half. The ferrule includes a mating end and a rear end having a collar mounted thereon. The ferrules halves are bonded together and the fibers are secured therein via adhesive.

In an embodiment, a massive parallel optical connector is provided comprising a plug body having an aperture therethrough and a molded plastic ferrule having multiple optical fibers and the ferrule mounted in the aperture. The ferrule includes beveled edges. The ferrule is a molded plastic ferrule having grooves therein for receiving the optical fibers. The grooves are rectilinear to the beveled edges of the ferrule. The plug body includes a mating end which dimensionally conforms to an SC style fiber optic connector form factor having an end face dimension of approximately 8.9 mm x 7.39 mm. The ferrule includes at least two optical fibers. The plug body includes a rear holder mounted at the cable entry end of the plug body and the rear holder includes an aperture for receiving a fiber optic cable. The rear holder includes a strain relief which receives a bend relief boot. The fiber optic cable is secured to the rear holder via a retention means such as a crimp sleeve, to capture strength members of the fiber optic cable and transfer forces applied to the cable to the plug body. The plug body includes a marking to designate the position of the first optical fiber. The plug body includes a resilient member to provide for the axial resiliency of the ferrule. The aperture of the plug body includes a size greater than the size of the ferrule so that the ferrule is pivotally movable within the plug body. The plug body includes a sliding tab release sleeve. The ferrule includes a window for receiving adhesive therethrough. The ferrule is terminated by inserting multiple optical fibers within grooves of the ferrule and securing the optical fibers within the grooves via chemical bonding and polishing the end face of the ferrule. The ferrule is formed of two halves each having a major surface having V-grooves therein and the halves each having a pair of beveled edges. The ferrule halves including a mating end and a rear end having a collar half molded integrally with

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the ferrule half. The ferrule includes a mating end and a rear end having a collar mounted thereon. The ferrule halves are bonded together and the fibers are secured therein via adhesive.

In an embodiment, a massive parallel connector is provided comprising a plug
5 body including a mating end which dimensionally conforms to an SC style fiber optic connector form factor having an end face dimension of 8.9 mm x 7.39 mm and an aperture through the plug body and a ferrule having multiple fibers and ferrule mounted within the aperture. The ferrule includes beveled edges. The ferrule is a molded plastic ferrule having grooves therein for receiving the optical fibers. The grooves are rectilinear
10 to the beveled edges of the ferrule. The ferrule is formed of two halves each having a major surface having V-grooves therein and the halves each having a pair of beveled edges.

In an embodiment, a massive parallel optical connector is provided comprising a first block of polymer material having a groove formed in a first major surface for
15 receiving an optical fiber, a second block having a second major surface abutting against the first major surface of the first block and a housing having an end face and an aperture for receiving the first and second blocks wherein a portion of the first and second blocks extend beyond the end face of the housing. The second block is formed of a polymer material. The second block includes a groove formed in the second major surface. The
20 first and second blocks form a ferrule having multiple fibers. The first block includes beveled edges being rectilinear to the grooves. The housing end face dimensionally conforms to an SC style fiber optic fiber optic connector form factor having an end face diameter of approximately 8.99 mm x 7.39 mm. The housing includes a rear holder mounted at a cable entry end of the housing and the rear holder including an aperture for
25 receiving a fiber optic cable. The first and second blocks include a mating end and an opposed rear end having a collar half mounted integrally with the blocks. The first and second blocks include a mating end and a rear end having a collar mounted thereon.

In an embodiment, a massive parallel optical receptacle is provided comprising a receptacle housing including an opening having an alignment assembly having an
30 alignment member for providing alignment with a connector received therein. The alignment assembly includes a pair of alignment members mounted within the receptacle

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providing a spring-form system wherein a force is applied to the alignment members. The alignment assembly includes a means for retaining alignment members within the alignment assembly. The retention means includes arms having a hook portion for engaging the alignment member. The spring clip applies a spring force to the alignment members toward beveled edges of a ferrule parallel to major surfaces of the ferrule halves. The receptacle includes latch arms. The receptacle includes an opening which dimensionally conforms to an SC style fiber optic receptacle form factor including an opening of approximately 9.0 mm x 7.4 mm.

In an embodiment, a method of forming an optical connector is provided including the steps of forming a silicon block master template, forming a mold insert from the master template, injection molding plastic block halves from the mold insert and assembling a ferrule from the plastic block halves. The method further including the steps of injection molding plastic block halves from the mold insert having grooves, inserting fibers in the grooves and securing the fibers in the grooves. The method further including the steps of inserting a core pin in the grooves of a first half, securing a second half to a first half, removing the core pins, inserting fibers in the grooves and securing the fibers in the grooves. The method wherein the fibers are secured via an adhesive. The method wherein the silicon block master template is formed by anisotropically etching grooves and beveled edges simultaneously along crystallographic planes, wherein the center axes of the grooves are in line with the center axes of the beveled edges. The method wherein the mold insert is formed by nickel plating the silicon block master template. The method wherein the plastic block is injection molded of a dimensionally stable polymer material.

In an embodiment, a receptacle housing is provided including a first end having an alignment assembly having a pair of alignment members and a pretensioning means and for providing alignment with a first connector having a ferrule having grooves for mating with the alignment members of the first end and a second end of the receptacle having the alignment members protruding therethrough and providing for alignment with a second connector having a different alignment means than the first connector. The second connector may include a ferrule having a pair of holes for receiving the alignment members.

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In accordance with the descriptions herein, one embodiment of the invention may provide for an optical receptacle assembly which includes an optical receptacle for receiving a first and second connector. More specifically, the first connector is received within a first receptacle half, and the second connector is received within a second
5 receptacle half. The first connector may have a ferrule that includes beveled edges that mate with alignment means within the first receptacle half. Still further, the second connector may include guide pins that protrude from a front end face that is inserted into the second receptacle half. The beveled edges of the ferrule may then be precisely spaced to accommodate the guide pins, thereby eliminating the need for separate alignment
10 members disclosed herein.

In further accordance with the descriptions herein, the aforementioned embodiment may provide for a complete fiber optical ferrule that includes a pair of mutually opposing ferrule halves that have joined together to define in part a fiber optical support region. In this embodiment, one of the ferrule halves may include a vertically
15 aligned wall integrally protruding therefrom towards the opposing ferrule half at a first side. The first beveled edge may then be contained within one of the ferrule halves at the first side. In similar fashion, a second vertically aligned wall may be included within one of the ferrule halves and protrude therefrom towards the other ferrule half at a second side. A second beveled edge may then be contained within one ferrule half at the second
20 side.

In this embodiment, the fiber optical support region receives one or more optical fibers, including twelve optical fibers for use with MT or MACII optical style ferrules. The beveled edges may be spaced along the ferrule half to engage an alignment member extending within a receptacle for mating with another optical ferrule. The alignment
25 member may align the ferrule to optically connect with another ferrule within the receptacle, as described herein. The alignment member may include guide pins that extend within the receptacle from the opposing fiber optical ferrule and engage the beveled edges incorporated in this embodiment.

Still further, the fiber optical ferrule or other components similar therein may
30 comprise a resin composition having a anisotropy of 1.5 or less. The resin composition may comprise at least one resin selected from the group consisting of polyethermides,

polyethersulfones, and epoxy resins. Additives such as monocrystalline inorganic needles and silica powder may also be employed within the resin composition, preferably to increase or decrease selected physical characteristics.

These and other features of the invention are set forth below in the following
5 detailed description of the presently preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the fiber optic connector of the present invention;

FIG. 2 is an exploded view of FIG. 1;

FIG. 3 is a perspective view of a block half of the present invention;

10 FIG. 4 is a perspective view of the fiber optic interconnect system of the present invention wherein the fiber optic connector of FIG. 1 is shown being inserted into a receptacle of the present invention;

FIG. 5 is an enlarged view of FIG. 4 showing a cut-away view of the receptacle of the present invention;

15 FIG. 6 is a cut-away top view of the receptacle of the present invention taken at line 6-6 and FIG. 9;

FIG. 7 is an alignment member of the present invention;

FIG. 8 is a top cut-away view of the optical interconnect system of the present invention having a pair of fiber optic connectors mated within a receptacle;

20 FIG. 9 is an end cut-away view of FIG. 8, taken at line 9-9;

FIG. 10 is a side view of the alignment means of the present invention as shown in FIG. 6;

FIG. 11 is perspective partially cut-away view of an alternate embodiment of the receptacle of the present invention;

25 FIG. 12 is a top cut-away plan view of the receptacle of FIG. 11 taken at line 12-12;

FIG. 13 is a top cut-away plan view of the receptacle of FIG. 11 having a corresponding receptacle for receiving a connector of a different form factor attached to the first receptacle;

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FIG. 14 is a top view of an MTP connector engaged with the optical receptacle and connector of this invention;

FIG. 15a is a sectional front view of the optical receptacle in FIG. 14;

FIG. 15b is a sectional rear view of the optical receptacle in FIG. 14;

5 FIG. 16 is an enlarged isometric side view displaying the proximate side of a bottom ferrule half of this invention;

FIG. 17 is an enlarged isometric side view displaying the distal side of the bottom ferrule half of this invention; and

FIG. 18 is an enlarged isometric view of the bottom ferrule half joining with a top
10 ferrule half to form a ferrule encompassed by this invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

The present invention relates to a massive parallel (MP) optical interconnect system. A preferred embodiment of the present invention is best understood with
15 reference to FIGS. 1-10. FIGS. 1, 2 and 3 disclose the MP optical connector of the present invention; FIGS. 6, 7 and 10 disclose the MP optical receptacle of the present invention; and FIGS. 4, 5, 8 and 9 disclose both the MP optical connector and MP optical receptacle interconnect system of the present invention.

FIG. 1 discloses a preferred embodiment of an assembled MP optical connector
20 having plug body 10. The plug body 10 includes a mating end 11 and a cable entry end 12. The mating end 11 includes a connector end face 15. In a preferred embodiment, the dimensions of the mating end 11 of the plug body 10 dimensionally conform to the form factor for an SC style fiber optic connector as covered under Japanese Industrial Standard C 5973. Therefore, the end face 15 has dimensions of approximately
25 7.39 mm x 8.99 mm. While this is a preferred embodiment, the end face dimensions of alternate embodiments of the present invention may be of any size. Running through the plug body 10 is an aperture 16 (see FIG. 2). The aperture 16 communicates between the end face 15 and the cable entry end 12 of the plug body 10. Extending beyond the end face 15 is a ferrule 30. The MP optical connector 5 of FIG. 1 is shown in its fully
30 assembled form, including the ferrule 30 having optical fibers 50 terminated therein. The

ferrule includes a first half 31 and a second half 32 being molded of a polymer material. The first ferrule half 31 and second ferrule half 32 abut each other at first major surface 41 of the first half 31 and second major surface 42 of the second half 32. In a preferred embodiment, each ferrule half 31,32 includes V-grooves along its major surface 41,42. Mounted within the V-grooves are optical fibers 50. In a preferred embodiment, twelve optical fibers are shown mounted in the ferrule 30. Alternate embodiments may have 2, 4, 6, 8 or 10 or more fibers according to standard multi-fiber cable arrangements. Each ferrule half 31,32 includes beveled edges 35 oriented so that the major surface 41,42 has a width less than the width of the side of the ferrule half opposite the major surface.

In a preferred method of forming the present invention as shown in FIG. 3, the V-grooves and the beveled edges 35 of the plastic ferrule halves 31,32 are formed from a silicon block master template which is used to form a mold insert in which the ferrule halves 31,32 are injection molded. The halves are molded of a dimensionally stable polymer material such as a liquid crystal polymer (LCP) according to the following process. A master template is formed of silicon by anisotropically etching the desired number of V-grooves along the crystallographic planes of the silicon block and on the desired spacing. The beveled edges are formed simultaneously in the silicon by etching a deep groove. A cut is made in the bottom of the groove in order to form the sides of the silicon block. Since the beveled edges are etched at the same time along the same crystallographic planes as the fiber grooves, the center axes of the fibers mounted in the grooves will be in line with the center axes of the alignment members to be mounted in the beveled edges of the plastic ferrule formed from the silicon template. The V-grooves of the silicon block are formed by masking part of the silicon block and anisotropically etching the grooves in the desired locations. Masking inhibits the etching of material from areas of the block where grooves are not desired.

The master template silicon block is then nickel plated in order to make a mold insert having the negative proportions of the silicon block. The silicon block is then removed from the resultant mold insert and the mold insert is then used in conjunction with other mold inserts and incorporated into injection mold tooling to injection mold a plastic block half 33 including ferrule half 31 and a ferrule rear body half 51. As the first

half 31 and second half 32 of the ferrule 30 are hermaphroditic, a single mold may be used to injection mold both halves. Thus, the block half 33 is molded in a preferred embodiment having ferrule half 31 including grooves 36 along major surface 41 and beveled edges 35 and ferrule rear body 51 including collar 55, recess 58 and window 57.

5 The above process provides for the etching of all the grooves of the silicon block completely and simultaneously without masking or cutting the outside beveled edges. According to the above description, it may be understood that a multi-fiber ferrule having precision aligned grooves and edges may be manufactured quickly, easily and inexpensively.

10 A further preferred method of assembling and terminating the ferrule is as follows. Assembly of the ferrule 30 after it is injection molded is accomplished by placing core pins (not shown) in the grooves 36 of the first half 31 (see FIG. 3). The major surfaces 41,42 are then placed together to enclose the core pins between the two halves 31,32. The core pins extend beyond the end of the ferrule halves so they may be
15 easily removed. The two halves are then secured together, for example, by chemical bonding or sonic welding. A collar 55 (see FIG. 2) which is injection molded simultaneously with the ferrule half 31 includes a recess 58 from which the core pins may protrude. In an alternate embodiment, a separate collar is secured around the rear body of the ferrule halves 31,32. The core pins have a diameter just slightly larger than the
20 diameter of the optical fibers to be replaced in the grooves. For example, the core pins may have a diameter of approximately .1255 microns. The core pins are removed, leaving the ferrule 30 having V-groove passages which are precisely aligned between the top half 31 and bottom half 32 and are free from any disturbance along their passage walls such as misalignment of the V-grooves of the ferrule halves 31,32. The ferrule
25 being assembled in this manner may then be quickly and easily terminated according to the description below.

Turning to FIG. 2, the assembled ferrule 30 is shown prior to termination. While FIG. 1 shows the optical connector of the present invention in the fully assembled orientation, FIG. 2 shows an exploded view of the fiber optic connector in an
30 unassembled state and prior to the termination of the ferrule 30 and attachment of cable 60 and optical fibers 50. The unique arrangement of the present invention allows

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for the entire connector to be assembled in a factory so that it arrives to the field in the fully terminated state as shown in FIG. 1 or the connector may be delivered to the field in a disassembled state such as shown in FIG. 2, to be assembled by a field technician.

Termination of the ferrule 30, according to a preferred method includes the steps
5 of stripping a multi-fiber cable 6 so that the bare fibers protrude a predetermined distance beyond the insulation of the cable 60 and exposing the strength members. The stripped cable is then inserted through the rear holder assembly 70. The fibers are first inserted through the strain relief portion 71 and exit from a bore 72 of a spring support 74. The cable 60 and bare fibers 50 are pulled through the bore 72 so that there is an excess length
10 of the cable 60 and fibers 50 to work with. The rear holder assembly 70 may include a slot along its length allowing it to be placed on the cable after assembly. The parallel array of fibers 50 are then inserted through the collar 55 so that the cable is received by recess 58 (see FIG. 3) and the fibers 50 are received by the multiple grooves 36 of the ferrule 30. The recess 58 of the ferrule rear body may act as a strain relief or bend relief
15 member for the cable 60. The multiple fibers are pushed through the ferrule 30 so that the ends of the fibers protrude beyond the ferrule end face 40. The fibers are then secured within the ferrule 30 via chemical bonding such as injection of an anaerobic adhesive within the ferrule. For example, a primer such as Locquic® Primer N 7649 (Loctite Corp., Rocky Hill, Conn.) is used with a hardener such as RC™ 680 Retaining
20 Compound High Strength (Loctite Corp., Rocky Hill, Conn.). Anaerobic adhesives are preferred because they cure upon exposure to air and adhere well to plastics. Alternate chemical bonding methods may also be used such as epoxies used with curing ovens. The adhesive may be injected from either end of the ferrule 30 or through window 57. The adhesive secures the fibers within the V-grooves of the ferrule 30 and also secures
25 the ferrule halves 31,32 together.

After the adhesive has cured the optical fibers 50 are then cleaved and polished. In an alternate embodiment of the present invention, the ferrule end face 40 may also have molded around the V-grooves a polishing pedestal such as that disclosed in U.S. Patent Nos. 5,333,223, and 5,193,133 which are incorporated herein by reference. The
30 end face of the ferrule 40 is polished using standard polishing procedures so that the optical fibers 50 are in an optimal condition for transmission. The aforementioned

termination procedure may be easily accomplished in the field by technicians. This termination process is similar to termination methods for single fiber ferrules such as SC connectors and is repeatable with a high rate of success. Due to the novel construction of the multi-fiber ferrule of the present invention, and the preassembly of the ferrule halves 31,32 into a single ferrule unit 30, the termination process is accomplished quickly and easily. After polishing, the rear holder 70 is installed onto cable 60, for example, by pulling the cable 60 back through the rear holder 70 or inserting the cable through a slot 73 in the side of the rear holder 70. The slot 73 is dimensioned so that the cable may be inserted into the rear holder 70, but not able to escape therefrom. The cable 60 is anchored to the rear holder 70 by capturing the Kevlar® strength members of the cable 60 around the rear holder 70 using a retention means such as a crimp sleeve (not shown). The rear holder 70 and ferrule 30 are then inserted within the aperture 16 of the plug body 10 so that the terminated ferrule 30 protrudes beyond the end face 15 of the plug body 10 in its fully assembled position as shown in FIG. 1. A bend relief boot may be slid over strain relief portion 71.

In an alternate method of assembling the MP optical connector of the present invention, the fibers are placed in the grooves of a first ferrule half 31, adhesive material is added and the second ferrule half 32 is then placed over the first half so that the major surfaces 41,42 abut and enclose the fibers 50 within the ferrule 30. The rear holder 70 is installed onto the cable and the ferrule is inserted into the plug body 10. Due to the unique assembly of the multiple fiber ferrule 30, the field assembly and termination of the optical fibers to the ferrule 30 and final assembly of the MP optical connector may be easily and quickly accomplished, providing for a high precision data transfer means.

Returning to FIG. 1, the plug body 10 also includes T-shaped slots 14 on opposite sides of the plug body. The T-shaped slots 14 accommodate a sliding tab release sleeve 81 (see FIG. 8) which is attached over the plug body 10 and provides for the easy disconnection of the plug 5 from a receptacle as described in U.S. Patent No. 5,233,674, which is incorporated herein by reference. The plug body 10 also includes detentes 19 which protrude adjacent the T-shaped slots 14 and prohibit the sliding tab release sleeve 81 (see FIG. 8) from sliding off of the cable entry end 12 of the plug body 10. The sliding tab release sleeve 81 is mounted onto the plug body 10 by sliding over the cable

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entry end 12 of the plug body 10 and past the detente 19. The sliding tab release sleeve 81 includes tab release members 82 which ride in T-shaped slots 14 and upon sliding of the tab release sleeve 81 forward, the tab release members 82 will unlatch the plug body 10 from a receptacle (see FIGS. 4, 5 and 8). The plug body 10 also includes
5 at the cable entry end 12 ribbed surface 18 to aid in gripping the plug body 10. The plug body also includes a polarizing member 19. The polarizing member 19 assures that the plug body 10 is inserted into a receptacle in the proper orientation. In addition, because there are multiple fibers 50 mounted within the ferrule 30, the proper orientation of the fibers must also be designated. It is common for multiple fiber cables to be marked to
10 designate fiber "1" as shown by marking 61 on cable 60. The rear holder 70, as well as the collar 55 of the ferrule assembly 30, may also be correspondingly marked to indicate the position of fiber "1". This marking 75 is visible when the fiber optic connector is assembled, so that the first fiber position of the fiber optic connector may be inserted in a receptacle in such a way that when a second fiber optic connector is inserted on the
15 other side, the first fibers will align and data can be transferred according to a preestablished sequence. Any other means of designating the position of fiber "1" may also be used.

Turning to FIGS. 4 and 5, the optical interconnect system of the present invention is shown. MP optical connector 5 is shown in its unmated condition from MP optical
20 receptacle 100. Referring to FIG. 4, the MP optical connector 5 is intermatable with the receptacle 100. The receptacle 100 includes latch members 110,111 and housing 120. As well, a receptacle outer housing 160,162 (see FIG. 8) encloses the receptacle 100 and includes a polarizing slot thereon for receiving polarizing member 19. The latch members 110,111 and the housing 120 of the receptacle 100 are formed to dimensionally
25 conform to a fiber optic SC style receptacle form factor as covered in Japanese Industrial Standard C 5973, discussed previously. As the MP optical connector 5 of a preferred embodiment of the present invention has been formed so that it dimensionally conforms to an SC style connector form factor, it is intermatable with a receptacle having latches 110,111 a housing 120 and an outer housing 160,162 of standard SC style
30 receptacle size having an interior chamber dimension of approximately 9.0 mm x 7.4 mm. However, the multiple fiber ferrule of the present invention includes an

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improved alignment means within the interior of the housing 120 of the receptacle 100.

FIG. 5 is an enlarged view of FIG. 4 having the receptacle housing 120 broken away to expose the alignment means therein. Mounted within the rectangular chamber 121 of the housing 120 is an alignment sleeve assembly 130. In a preferred embodiment, the alignment sleeve 130 is formed of a metallic material. The alignment sleeve 130 is generally oval in shape, having its elongated edges bowed outward. The alignment sleeve includes sidewalls 131. The alignment sleeve 130 is split at joint 135 which abuts a boss 126, of the housing 120. The alignment sleeve 130 is shown in its most contracted state having joint 135 tightly gripping the boss 126. Upon insertion of the connector 5 and ferrule 30 within the alignment sleeve 130, the sleeve 130 will expand (see FIG. 9). The fully expanded alignment sleeve is positioned within the housing so that it may freely float therein. For example, approximately a .005 inch buffer area is provided between the interior wall of the receptacle chamber 121 and the fully expanded external surface of the sidewalls 131 of the alignment sleeve 130. Mounted adjacent the sidewalls 131 is an alignment member 140. In a preferred embodiment, the alignment member 140 is mounted within the alignment sleeve 130 via a spring clip 150. The spring clip 150 includes arms 152 which attach the spring clip 150 to the alignment sleeve 130. The arm 152 includes a hook portion 154. The hook portion 154 protrudes through a window 190 (see FIGS. 9 and 10) in the sidewall 131 of the alignment sleeve 130. The alignment member 140 is inserted through the hook portion 154 and supported therein. In an alternate embodiment, the alignment sleeve 130 may have hook portions 154 attached directly to the alignment sleeve to receive the alignment member 140 therein.

Upon mating of the MP optical connector with the MP optical receptacle 100, the latches 110,111 latch with the plug body 10 and simultaneously, the ferrule 30 is inserted within the alignment sleeve 130. The alignment members 140 of the alignment sleeve 130 engage the beveled edges 35 of the ferrule 30. The alignment members 140 have tapered ends so that the beveled edges 35 of the ferrule 30 may abut against the tapered edges of the alignment members 140 and be guided to the major longitudinal surface (center body portion 149; see FIG. 7) of the alignment member 140. The alignment means of the present invention provides for a spring-form system so that only

the alignment members 140,141 come into contact with the ferrules 30,30' (see FIGS. 8,9) at the beveled edges 35. In this way, the ferrules 30,30', upon insertion within the alignment sleeve 130 will find their own centers and the alignment members 140 under pressure from the spring clip 150 will apply approximately one to three pounds of force against the beveled edges 35 of the ferrule 30. The MP optical connector 5, once inserted within the receptacle 100, is in a condition to mate with a second MP optical connector 6 being inserted from the other side of the receptacle 100 (see FIG. 8). The receptacle 100 is attached to a second receptacle 102 which receives a second MP optical connector 6 in an opposing direction to that of MP optical connector 5. The second receptacle 102 includes a chamber which communicates with the chamber 121 of the housing 120 of the first MP optical receptacle 100. The alignment sleeve 130 is mounted within the pair of chambers 121 of the first and second receptacles 100,102. Thus, it can be understood that the alignment members 140 run from a first opening 125 of the chamber 121 in the first receptacle 100 to the second opening 126 (see FIG. 6) of the chamber 121 of the second receptacle 102. In this way, the second MP optical connector 6 which is inserted in the second receptacle 102 is guided along the alignment members 140 so that the end faces of the ferrules 30,30' of the mating MP optical connectors 5,6 are precisely aligned so that the multiple optical fibers mounted within the ferrules are in alignment and provide for optimal transmission. Hence, the alignment of the ferrules is totally under the influence of the two alignment members.

The latch arms 110, 111 include locking projections 117, 118. The locking projections 117, 118, include tapered front portions to engage with the shoulder 17 of the plug body 10. Upon full insertion, the locking projections 117,118 spring behind the shoulder 17 in order to lock the MP optical connector 5 to the MP optical receptacle 100. In order to release the connector 5 from the receptacle 100, any means may be incorporated. However, in a preferred embodiment, a sliding tab release sleeve 81 is used, as discussed above, in order to engage the locking projections 117,118 and spread them outwardly so that the MP optical connector 5 may be released from the receptacle 100.

FIG. 6 discloses the MP optical receptacle assembly of the present invention and is a top cut-away view taken at line 6-6 of FIG. 9. Receptacle halves 100,102 are shown

connected together to form a coupling, having a common chamber 121 communicating therebetween. The receptacles 100,102 include housing 120 and latch arms 110,111,112,113. The housing 120 includes openings 125,126 at each end of the chamber 121. Mounted within the chamber is the alignment sleeve 130. Attached to the
5 alignment sleeve 130 is spring clip 150 and alignment members 140,141 which run from the first opening 125 to the second opening 126.

Turning to FIG. 7, the alignment member 140 is shown having a first end 142 and a second end 143. It can be seen that the alignment member 140 includes a first reduced diameter portion 144 adjacent the first end 142 and a second reduced diameter
10 portion 145 adjacent the second end 143. The first reduced diameter portion 144 is narrower than the second reduced diameter portion 145. In addition, the first end 142 includes a broader head portion 146 than head portion 147 of the second end 143. This arrangement provides for the easy assembly of the alignment means of the present invention. The alignment means as assembled by attaching the spring clip 150 to the
15 alignment sleeve so that the hook portions 153,154 of the arms 152 protrude within windows 190 of the alignment sleeve 130 (see FIGS. 6, 9, and 10). The alignment members 140 are then slid within the alignment sleeve 130 with the first end 142 of the alignment member 140 being inserted at the first opening 125 through the hook portion 154 of the spring clip 150. The first end 142 includes a narrow first reduced
20 diameter portion 144 which enables the alignment member 140 to slide from the first opening 125 past the hook portion 154 and the hook portion 154 runs along the center body portion 149 of the alignment member 140 toward the second opening 126. The first end 142 of the alignment member 140 then abuts the hook portion 153 at the second opening 126 until the hook portion 154 is seated within the second reduced diameter
25 portion 145. Simultaneously, the hook portion 153 will seat within the first reduced diameter portion 144. In this orientation, the alignment member 140 will then not be able to be removed from the alignment sleeve 130. As well, the hook portions 153,154 form a recessed surface with the center body portion 149 of the member 140 assuring that only the precision surface of the member 140 contacts the beveled edges of the ferrule 30.

30 Turning to FIG. 8, a top cut-away view of the MP optical interconnect system of the present invention having a pair of MP optical connectors 5,6 mated within a coupler

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or MP optical receptacles 100,102 is shown. Receptacle outer housings 160,162 are shown attached together having receptacles 100,102 mounted therein. It is noted that in FIGS. 4-6, only the receptacle 100,102 is shown. However, in a preferred embodiment, an outer housing 160,162 is present having mounting flanges 166,167. The receptacles
5 100,102 include housing 120 and inner chamber 121. Mounted in the chamber 121, within each receptacle half 100,102, is an alignment means including an alignment assembly having a single alignment sleeve 130. Mounted within the alignment sleeve 130 are alignment members 140,141. The alignment assembly prevents the transmission of misaligning forces between the two interconnected ferrules. Inserted
10 within the alignment means are a pair of MP optical connectors 5,6 from each side joining within the receptacles 100,102. A first connector 5 includes ferrule 30 which abuts with ferrule 30' of a second connector 6 at end face 40.

While only specific elements of the first connector 5 will be discussed, like elements are also found in the identical second connector 6. The ferrule 30 is mounted
15 within the aperture 16 of the plug body 10. The ferrule 30 includes at its rear end, collar 55. The collar 55 as discussed previously may be a separate member placed onto the ferrule halves in order to maintain them together. The aperture 16 includes step 13. The collar 55 abuts the step 13 so that the ferrule 30 may not escape through the front end of the aperture 16. Mounted in the aperture 16 behind the collar 55 is a resilient
20 member 80, such as a spring. In a preferred embodiment, the spring 80 has a rectangular shape to correspond to the rectangular aperture 16. The spring 80 provides for resiliency in the ferrule 30 so that upon mating with a ferrule 36 of a second connector 6, the ferrules 30,30' may have axial flexibility in order to cushion the abutment of the ferrule end faces and avoid degradation of the end face surfaces 40. In addition to the axial
25 flexibility which the spring 80 provides, the aperture 16 also includes a larger diameter than the collar 55 so that a slight pivotal movement of the ferrule also is provided. This arrangement allows for the ferrule to be aligned most precisely within the alignment sleeve 130. The spring 80 abuts against spring support 74 which is attached to the rear holder 70 which is mounted at the cable entry end 12 of the plug body 10. Inserted
30 through bore 72 of the rear holder 70, is a multiple fiber optical cable 60. The cable 60 exits from the strain relief portion 71. A bend relief boot (not shown) is attached to the

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strain relief portion 71 in order to limit the strain of the cable as it enters into the connector 5. The cable 60 is attached to the rear holder 70 by securement of the strength members of the cable 60 to the holder 70 so that the forces applied to the cable 60 are transferred to the rear holder 70 and to the plug body 10. The plug body 10 also includes a sliding tab sleeve 81 which includes tab release members 82 which slide forward in T-shaped slot 14 to abut against locking projections 117 of the latch arms 111. Upon insertion of the release member 82 adjacent the locking projection 117, the latch arm 111 will be pushed outwardly so that the locking projection unlocks from the shoulder 17 of the plug body 10. The MP optical connector 5 may then be removed from the MP optical receptacle 100.

Turning to FIG. 9, a cut-away view of the interconnect system of FIG. 8, taken at line 9-9 is shown. The receptacle 100 includes the chamber 121. Mounted within the chamber 121 is the alignment sleeve 130. The alignment sleeve 130 is split at joint 135 adjacent the boss 126 of the receptacle housing 120. The alignment sleeve 130 has mounted thereon the spring clip 150 which includes the arm 152 having the hook portion 154. The hook portion 154 protrudes through the window 190 of the alignment sleeve 130. Mounted within the hook portion 154 of the spring clip 150 are the alignment members 140,141. Supported and aligned by the alignment members 140,141 is the ferrule 30. The alignment means provides a spring force of approximately one to three pounds against the beveled edges 35 parallel to the major surfaces 41,42 of the ferrule halves 31,32. Upon insertion of the ferrule 30 within the receptacle 100, the alignment members 140,141 abut the beveled edges 35 of the ferrule 30 and cause the sleeve 130 to expand causing the joint 135 to separate and move away from the boss 126 of the housing 120. When the ferrule is removed, the joint 135 contracts and abuts the boss 126 and the boss maintains the alignment assembly 130 in a pretensioned state in order to provide for a low insertion force receptacle. In a preferred embodiment, the boss 126 is integrally molded with the housing 120 and protrudes transversely within the chamber 121. The ferrule 30 includes first ferrule half 31 and second half 32. First major surface 41 of first ferrule half 31 abuts second major surface 42 of the second ferrule half 32. Each half 31,32 of the ferrule includes grooves, such as V-grooves 36 and mounted within the V-grooves 36 are optical fibers 50. Such a ferrule 30 may then be

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aligned according to the miniaturized MP optical interconnect system of the present invention so that the fibers mounted in the mated ferrules 30,30' are rectilinear with the alignment members 140,141 of the alignment sleeve.

FIG. 10 discloses a side view of the alignment means of the present invention as shown in FIG. 6. The alignment sleeve 130 includes spring clip 150 having arms 152, including hook portion 153 which supports alignment member 140. The hook portion 153 protrudes through window 190 of the alignment sleeve 130. The alignment sleeve assembly 130 includes spring clips 150a and 150b and integral hook arms 153 for retaining the alignment members 140. The hook arms 153 form resilient members to hold the alignment members 140 in an abutting position to the sleeve section. The hook arms 153 also hold the two alignment members 140 and the split alignment sleeve in relative position.

FIG. 11 is a perspective, partially cut-away view of an alternate embodiment of a receptacle of the present invention. The first receptacle half 200 includes an outer housing 260 having inner receptacle 202 mounted therein. The outer housing 260 includes mounting flanges 266 for attaching the receptacle 200 to a corresponding receptacle as shown in FIG. 13. Mounted in the inner receptacle 200 is an alignment means including an alignment assembly having a single alignment sleeve 230. Mounted within the alignment sleeve 230 are alignment members 240,241. The alignment assembly prevents the transmission of misaligning forces between two interconnected ferrules. The alignment means and alignment sleeve 230 receive an MP optical connector 5 (FIG. 5) which is inserted through the first opening 225 of the first receptacle half 200. It is noted that FIG. 5 is a view taken from the first opening of an alternate receptacle embodiment. The alignment assembly of FIG. 11 includes an alignment sleeve 230 that is split at joint 235 which abuts a boss 226 which is integrally molded with the housing 220 of the inner receptacle 202. The alignment sleeve 230 operates with the alignment members 240,241 as discussed above, for FIG. 5, in order to align a ferrule of an MP connector received therein from the first opening 225. The alignment sleeve 230 of FIG. 11 has the alignment members 240,241 mounted therein via formed cut-outs 254 which are formed integrally with the alignment sleeve 230 and hold the alignment members 240,241 within the alignment sleeve 230. Upon insertion of an MP

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connector through the first opening 225 of the first receptacle half 200, the plug body of the MP connector is engaged by latches 210,211 and simultaneously, the ferrule of the MP connector will be inserted within the alignment sleeve 230. In the alternate embodiment of FIG. 11, only a single alignment sleeve 230 is mounted in a receptacle assembly of the first receptacle half 200 and another receptacle half. However, the alignment members 240,241 protrude from the alignment sleeve 230 beyond the end of the mounting flange 266 face, or second end 272, in order to align the alignment sleeve 230 with a corresponding receptacle half to be attached thereto. The receptacle assembly shown in FIG. 8 is configured to receive two MP optical connectors having the form factor described in the present invention from each end of the receptacle and mated therein. The alternate embodiment of the first receptacle half 200 shown in FIG. 11 allows for the coupling of multiple fiber optical connectors having differing form factors. The MP optical connector of the present invention has a ferrule having a different orientation and plug body than previous multi-fiber connectors known in the art. However, the MP optical connector of the present invention may include twelve optical fibers which are on standard spacings of 250 microns which correspond to the spacings of the optical fibers of other previously known multiple fiber optical connectors. Therefore, the first receptacle half 200 may receive an MP optical connector as disclosed in the present invention and a corresponding second receptacle half 300 (FIG. 13) may be mounted to the first receptacle half 200 for receiving an alternate connector having a differing form factor. The alignment members 240,241 of the first receptacle half 200 will aid in the alignment of a second fiber optic connector to the end face of the ferrule of the MP fiber optic connector mounted in the first receptacle half 200 and allow for the efficient transmission of light waves therebetween.

Turning to FIG. 12, a top plan cut-away view of FIG. 11 is shown taken at line 12-12. The first receptacle half 200 includes the outer housing 260 and mounted therein the inner receptacle 202 having mounted therein the alignment sleeve 230 having alignment members 240,241. Latches 210,211 are integrally molded with the inner receptacle 202 and formed to receive and latch an MP optical connector inserted through the first opening 225 of the first receptacle half 200. The first receptacle half 200 shown in FIG. 12 is shown in its orientation prior to assembly to a corresponding receptacle half.

Turning to FIG. 13, a receptacle assembly is shown having the first receptacle half 200 mounted to a second receptacle half 300. The first receptacle half 200 is the same receptacle shown in FIGS. 11 and 12 and receives an MP optical connector of the present invention through the first opening 225. The second receptacle half 300 may have any orientation which allows for the reception of an optical connector for mating with an MP optical connector mounted in the first receptacle half 200. In the embodiment shown in FIG. 13, the second receptacle half 300 is oriented for receiving an MTP optical connector or MT ferrule such as that manufactured by U.S. Conec™. However, other second receptacles halves 300 may provide for reception of such optical connectors, including a MACII™ connector manufactured by Berg Electronics, Inc. or any other fiber optic connectors. The alignment members 240,241 protrude from the first receptacle half 200 into the cavity 328 of the second receptacle half 300 and provide for the alignment of a corresponding second connector to the MP optical connector mounted within the first receptacle half 200. For example, an MTP optical connector may be inserted through the second opening 326 of the second receptacle half 300 and the ferrule of the MTP connector will be guided by the alignment members 240,241 in order to mate the end faces of the MTP ferrule to the end face of the MP connector ferrule mounted within the first receptacle half 200. For example, the alignment members 240,241 may be inserted in bores at the sides of the MTP ferrule which is fiducially oriented to the grooves in which the optical fibers are mounted. In an alternate embodiment, the alignment members 140,141 may be received by grooves formed in the edges of the ferrule inserted within the second receptacle half 300 in order to provide alignment of the second ferrule to the first ferrule of the first receptacle half 200. Such a receptacle assembly 200,300 allows for the coupling of optical connectors having differing form factors. Therefore, it may be understood that the present invention provides for the alignment means of the pair of receptacle halves 200,300 having alignment members 240,241 mounted in the alignment sleeve 230 that provide for the precise alignment of the optical fibers of a first connector mounted in the first receptacle half 200 and a second connector mounted in the second receptacle half 300 in order to provide the transmission of light waves with a low transmission loss.

With further reference to FIG. 11, the alignment means encompassed by this

invention may be provided for by engaging two connectors within the aforementioned receptacle, where one connector includes guide members 240 and 241 that protrude from its end face and optically align the opposing connector. The guide members 240, 241 may be in the form of uniform pins that extend into the first receptacle half 200 with the
5 insertion of the second connector. More generally, the invention encompasses alignment means that provide for the opposing connectors within the receptacle to align one another, such that the optical fibers of the first connector mounted in the first receptacle half 200 are precisely aligned with the optical fibers of the second connector mounted in the second receptacle half 300.

10 In accordance with the aforementioned description, FIG. 14 shows in more detail a preferred assembly where an MP and MTP connector 470 and 370 align one another within a receptacle 500. The receptacle 500 contains a first receptacle half 400 for engaging the MP connector 470, and a second receptacle half 300 for engaging the MTP connector 370. The MP connector 470, or similar styled connector therein, inserts within
15 the first receptacle half 400 via an opening 425. Upon insertion of an MP connector 470 through the first opening 425, the plug body of the MP connector 470 is engaged by a plurality of latches 410, 411. The latches 410, 411 are integrally molded to receive and latch the MP connector 470 as it is inserted through the first opening 425. A polarized member 419 engages an accompanying receptacle slot 421 to ensure proper alignment
20 of the MP connector within the first receptacle half 400. The ferrule 430 may then be positioned within a cavity 428 of the first receptacle half 400 to oppose the second receptacle half 300 for engagement with a second connector.

As with previous embodiments, the MTP connector 370, or similar connector therein, inserts into the second receptacle half 300 via opening 326. The MTP connector
25 370 has an MT ferrule end face 381 that includes a pair of guide pins 440a, 440b that oppose each other along its longer axis. The guide pins 440a, 440b extend from the MT ferrule end face 381 to engage a MP ferrule 430. In accordance with all embodiments encompassed in this invention, the MP ferrule 430 may be precisely dimensioned to engage the receptacle 500 and alignment means thereof. Accordingly, in this preferred
30 embodiment, the MP ferrule 430 may provide for a pair of beveled edges 435 that are precisely located to engage the guide pins 440a, 440b which extend into the first

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receptacle half 400 upon insertion of the MTP connector 370 in the second receptacle half 300. Thus, in this configuration, the guide pins 440a, 440b that extend from the MT ferrule end face 381 are used to align the respective MP and MTP connector 470 and 370 within the receptacle 500. Consequently, the use of guide pins 440a, 440b in conjunction with corresponding beveled edges 435 substitutes for the alignment sleeve mentioned in previous embodiments, as the two connectors engage to adequately align one another.

With reference to FIGS. 15a and 15b, the first and second receptacle half 400 and 300 have differing cross-sections and form factors to accommodate the respective connectors. FIGS. 15a and 15b show the respective cross-sections of the second receptacle half 300 and first receptacle half 400 used to interconnect the MTP and MP connector 370 and 480 respectively. For the first receptacle half 400, a pair of opposing rectangular buffers 489 and 491 position longitudinally within the rectangular opening 425 to engage corresponding contours of the MP connector 470. Similarly, opening 326 of the second receptacle half 300 is oval to accommodate MTP connector 370, with walls 389 and 391 engaging corresponding contours on the MTP connector 370.

It should be apparent to one skilled in the art that the embodiments described herein are not limited to the specific connector design mentioned above or elsewhere in this application. As previously mentioned, the connectors employed with the previous embodiments, and elsewhere as described in this application, may include Mechanically Transferable (hereinafter "MT") ferrule connector designs. Under the known art, MT connector design may include MTP, mini-MT, MT-RJ, MTO-MTP, MPO, and all other embodiments descending therefrom. Additionally, the connectors employed with this application may include MACII connectors. Thus, the ferrules and receptacles described with this invention may just as easily be employed with connectors and receptacles of variable styles and designs, including MT and MACII style connectors.

With reference to FIG. 16, still another alternative embodiment is shown in a proximal perspective comprising a bottom ferrule half 331 that combines with a top ferrule half 332 (FIG. 18) to form a complete ferrule 330 (FIG. 18). For purposes of this disclosure, the ferrule 330 will be referenced in conjunction with the MP connector 470 mentioned above, although other connectors known in the art may be equally employed. The ferrule 330 may be discussed relative to proximal and distal sides 391 and 392 of the

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juxtaposed bottom and top ferrule halves 331 and 332 (shown in FIG. 18) respectively. In this embodiment, as shown in FIG. 16, the bottom ferrule half 331 has a bottom front portion 353 with a first major surface 341 that includes a set of bottom V-grooves 336. The bottom V-grooves 336 extend axially along the first major surface 341 in a direction
5 normal to a front end face 340a, where the axial direction is defined herein to be the direction of insertion for the ferrule 330 into the receptacle (represented by numeral 500 in FIG. 14). An upward wall 380 protrudes from the first major surface 341 and spans at or near the proximal side 391. The upward wall 380 includes a proximal side surface 364 that runs along the proximal side 391, herein defined to include surfaces that extend
10 orthogonal or in a bisecting direction to the first major surface 341. The upward wall 380 has a first outer surface 385, that includes the proximal side surface 364, and a first interior surface 383 (shown in FIG. 17). The first outer surface 385 and the proximal side surface 364 form a first continuous beveled edge 335a that runs axially along the first major surface 341. The first beveled edge 335a may be defined-in-part by a maximum
15 deflection line 303a. Thus, the entire first beveled edge 335a of this embodiment is contained within the bottom ferrule half 331 as a unitary feature.

With further reference to FIG. 16, a lower rear body 351 integrally adjoins the bottom front portion 353. An incline 381 accesses the first major surface 341 to a recess 358 for receiving a flat ribbon cable therein and contained within the lower rear body
20 351. A base 357 surrounds the recess 358 and includes a bottom mating wall 359 and bottom mating slot 361 that oppose each other.

FIG. 17 shows a reverse side perspective of the bottom ferrule half 331 included in this invention. A bottom cut-out 378 mirroring the contours of the upward wall 380 adjoins the distal side 392. The bottom V-grooves 336 span axially along the first major
25 surface 341 on the bottom front portion 353. The upward wall 380 extends across the proximal side 391 (FIG. 16) of the ferrule 330. The first outer surface 385 integrally joins a continuous beveled edge 335a, such that the entire beveled edge 335a is contained within the bottom ferrule half 331. The incline 381 accesses the first major surface 341 and recess 358 contained within the lower rear body 351. The base 357 is included
30 within the lower rear body 351, with the mating wall 359 and the bottom mating slot 361 extending upwards at opposite ends of the base 357.

With reference to FIG. 18, a top ferrule half 332 is illustrated joining with bottom ferrule half 331 to form the ferrule 330. The top ferrule half 332 has a top front portion 372 containing a second major surface 342 with a set of top V-grooves 343 that precisely aligns across the first major surface 341 (FIG. 16) and the corresponding bottom V-grooves 336 to orthogonally abut the front end face 340b. The top ferrule half 332 includes a downward wall 390 that spans the second major surface 342 axially along the distal side 392 in similar fashion to the upward wall 380 along the proximal side 391. Likewise, the downward wall 390 includes a distal side surface 374 that runs or otherwise extends adjacent to the distal surface 391 in an orthogonal or bisecting direction to the second major surface 342. The downward wall 390 extends from the second major surface 342 and distal side surface 374 in alignment towards the bottom cut-out 378 (FIG. 17). As with the bottom half 331, the downward wall 390 has a second outer surface 395 that includes the distal side surface 374. A second beveled edge 335b is formed by the second outer surface 395 and the distal side surface 374, and is further defined in-part by a maximum deflected line 303b. As with the first beveled edge 335a, and in accordance with other beveled edges not explicitly mentioned, the second beveled edge 335b is contained entirely within the corresponding top ferrule half 332. The downward wall 390 further includes second interior surface 393 that extends towards the first major surface 341. In similar fashion, the top ferrule half 332 contains a top cut-out 377 that accommodates the contours of the upward wall 380 at the proximal side 391. As shown in FIG. 18, the two ferrule halves 331 and 332 are hermaphroditic and may be made from the same mold. The hermaphroditic feature allows the optical fibers to be inserted in V-grooves 336 and 343 on opposing ferrule halves 331 and 332 in a manner that allows the ferrule halves to precisely align over one another. In this way, the ferrule design provides for precise alignment of the ferrule halves at a very low cost to the assembly process.

FIG. 18 further illustrates an upper rear body 375 that integrally adjoins the top front portion 372, and includes an upper base (not shown) and upper recess (not shown) corresponding to features of the lower rear body 351. The upper peripheral base has a top mating wall 371 and top mating slot (not shown) which oppose each other.

With further reference to FIG. 18, the termination of the ferrule 330 may as a final step require the parallel arrays of fibers 50 (shown in FIG. 1) contained within cable 60 (shown in FIG. 1) to be inserted through the lower rear body 351 and received by recess 358. The bottom and/or top V-grooves 336 and 343 initially accommodate individual
5 optical fibers as they are inserted via cable 60 through the lower rear body 351. While similar embodiments may have 2, 4, 6, 8 or 10 or more fibers according to standard multi-fiber cable arrangements, the ferrules of this embodiment incorporates 12 fibers spaced either 250 μ m apart in the individual bottom V-grooves 336.

Once the optical fibers are inserted and received by V-grooves of either ferrule
10 half, adhesive or bonding agents may be applied between the first and second major surfaces 341 or 342 to secure the optic fibers. The ferrule 330 may then be formed by joining the bottom ferrule half 331 with the top ferrule half 332. When the two ferrule halves 331 and 332 are joined, the upward wall 380 of the bottom ferrule half 331 engages the top cut-out 377 of the top ferrule half 332. Likewise, the downward wall 390
15 engages the bottom cut-out 378 (shown in FIG. 17) of the bottom ferrule half 331. When the top and bottom ferrule halves 331 and 332 are joined, the first and second vertical walls 380 and 390 form longitudinally aligned borders at the proximal and distal side 391 and 392 of the ferrule 330. Similarly, the top mating wall 371 and top mating slot (not shown) align to engage the bottom mating slot 359 and bottom mating wall 361
20 respectively. In this way, the optic fibers exposed within the ferrule 330 are protected from peripheral exposure upon application of the adhesives.

One limitation of the prior art is that the joining of the bottom and top ferrule halves 331 and 332 causes adhesive fluids to seep through the sides and periphery of the ferrule 330 and into the beveled edges 335a and 335b. The presence of adhesives along
25 the beveled edge 335a and 335b can cause the engaging alignment members disclosed herein to misalign the MP connector 470 when interfaced with another connector or optical receptacle. In this embodiment, when the bottom and top ferrule halves 331 and 332 are juxtaposed into ferrule 330, the upward and downward vertical walls 380 and 390 prevent seepage of adhesive liquids onto the proximal and/or distal side surface 364 and
30 374 and corresponding beveled edge 335a and 335b. As such, the embodiment achieves a critical advantage over the known prior art, in that the top and bottom ferrule half 331

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and 332 may be joined by liquid adhesives without the adhesive dripping or interfering with the beveled edges 335a and/or 335b. Therefore, the beveled edges 335 are continuous, without imperfections or misalignments that may result from the application of adhesives or joining of the bottom and top ferrule halves. Moreover, the beveled edges 335a and 335b are not prone to severing or cracking, which may occur with individual beveled edges that are formed by joining two ferrule halves. Rather, the beveled edges 335a and 335b of this embodiment share the strength and rigidity of the respective ferrule halves 331 and 332, as they are integrated features therein.

The advantages of this invention ensure that the ferrule 330 within the MP connector 470, or other connector not mentioned herein, may be assembled in the field to engage an optical receptacle and precisely align with an opposing connector of a same or differing form factor. The exact dimensions and design of the ferrules 330 containing the beveled edges 335a and 335b may be dictated by various factors, including the alignment members being employed. However, the dimensions and design of the ferrule 330 and corresponding beveled edges 335a and 335b may be efficiently implemented during the manufacturing process. Thus, the MP connector 470 or other connector incorporating the ferrule of this invention, may employ beveled edges 335 that are spaced to accommodate guide pins protruding from the MTP connector when the two connectors are mated within a receptacle, as disclosed herein with receptacle 500. In accordance with other disclosures herein, the MTP connector may have a pair of guide members 440a and 440b (as shown in FIG. 14) that protrude from the ferrule end face 381 (FIG. 14) or other surface inserted within the second half of the optical receptacle 300 (FIG. 14). The guide members 440a and 440b precisely engage the beveled edges 335a and 335b of the ferrule 330 upon its insertion in the first receptacle half 400. The precise engagement between the beveled edges 335a and 335b and the guide members 440a and 440b provide the necessary alignment forces that allow the two connectors to optically connect and transmit light waves with little transmission loss. Thus, in this particular arrangement, the need for alignment sleeves (as shown in FIG. 11) or equivalents is removed, as the engagement of the opposing ferrules effectuates adequate alignment forces.

In accordance with previous disclosures in this application, it should be apparent

to one skilled in the art that the ferrule of this embodiment may be incorporated within other styled connectors not explicitly described herein, including MT or MAC II style connectors. Likewise, the ferrule encompassed by this embodiment may be designed to engage other MT or MACII connectors within a suitable receptacle. As such, the ferrule
5 of this embodiment may also be specifically designed to mate with opposing ferrules and/or receptacles which include alignment members, guide pins, or other alignment means described herein that incorporate elements of variable dimensions.

With further reference to FIG. 18, another readily apparent advantage of this invention is that the ferrule 330 is conducive to precision manufacturing. The ferrule 330
10 is preferably formed from precision molding techniques known in the art. In accordance with previous descriptions herein of the preferred precision molding technique, the master template may be formed of silicon by etching the desired number of V-grooves along the crystallographic planes of the silicon block and with the desired spacing. Similarly, the entire beveled edge 335 is formed simultaneously in the silicon by etching
15 a deep groove in the respective ferrule half 331 or 332. The novel features of the ferrule 330 may be efficiently manufactured with the ferrule half by providing for the upward wall 380 in the mold insert. The formation of one vertically aligned wall 380, 390 may be used to serve as a precise mold for the cut-out 377, 378, just as the cut-out may be used as a mold for the vertically aligned walls. Moreover, the formation of the bottom
20 ferrule half 331 is also preferably an exact replica of the top ferrule half 332. Thus, the invention may provide for a symmetrical ferrule 330, where the formation of each ferrule half is simplified and hermaphroditic as either bottom or top half 331 or 332 of the ferrule 330. As such, the ferrule of this embodiment may be more efficiently and precisely molded than other ferrules known in the art. The master template may then
25 comprise one ferrule half which may be plated with materials such as nickel to form a mold insert in which the ferrule halves 331 and/or 332 may be injection molded. Other molding techniques such as compression molding or transfer molding are comparatively inefficient and produce less favorable results.

It should be readily apparent to one skilled in the art that other manufacturing
30 techniques may be employed to produce the ferrule of this invention. Alternative manufacturing techniques may include etching all or selected features of the invention

directly on individual ferrules. Still further, the ferrule 330 may be manufactured from precision machining techniques known in the art, such as chemical or diamond machining.

5 The ferrules and other components of the present invention should be molded from materials that allow for small dimensional tolerances. Suitable materials should have low shrinkage factors such that the dimensions provided from the mold are maintained throughout the molded article upon cooling. Dimensional inaccuracies may occur during cooling of the selected polymer, where rate of cooling is unevenly distributed throughout the material. Non-uniform cooling rates result in microfine
10 changes in the density of the material, which generates inner stress that affects the dimensionality of the material. Moreover, excessive internal dimensional stress has been found to result in warpage. Furthermore, warpage may cause axial misalignment of the optic fibers in the ferrules and cables, thereby resulting in transmission loss. In accordance with these principals, one preferred embodiment of this invention
15 incorporates liquid crystalline polymers that may be employed to form resin compositions with low mold shrinkage factors. Accordingly, such materials have dimensional tolerances that negligibly affect molded article in fiber optic applications, including multi-mode optic transmissions. Examples of suitable liquid crystalline polymers for this application include Vectra, manufactured by Ticoma .

20 However, certain fiber optic applications require extremely low dimensional tolerances for molding ferrules and optical receptacles. Specifically, extremely low dimensional tolerances are required for molded components employed with single-mode fiber optic transmission, which require precision alignment and connection between ferrules. Accordingly, in another embodiment of the invention, the ferrule comprise resin
25 material that is enhanced by providing shrinkage factors that result in extremely precise dimensional molding. The desired shrinkage factor may be produced by employment of materials exhibiting low anisotropy or isotropic properties. The anisotropy may be expressed in terms of any physical property, including physical relationships derived from stress-strain relationships such as rigidity or bulk, mold shrinkage factor, coefficient
30 of linear expansion or preferably the flexural modulus. The anisotropic properties may quantitatively be expressed in terms of a ratio where the physical property is measured

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relative to a first direction corresponding to the direction resin flow upon injection molding versus a second direction perpendicular to the first. For this preferred embodiment, the anisotropy of the material should preferably not exceed 1.5. Resin material exhibiting the aforementioned characteristics include thermoplastic
5 compositions with low anisotropic properties. Suitable compositions of thermoplastic resins with low anisotropy include resins such as ULTEM, manufactured by GE.

It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications may be made without departing from the spirit and scope of
10 the present invention and without diminishing its attendant advantages. It is, therefore, intended that such changes and modifications be covered by the appended claims.

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What is claimed is:

1. An optical receptacle assembly comprising:
an optical receptacle including a first and second half;
a first connector including a first ferrule, the first ferrule including at least one
5 beveled edge, said first connector received in said first half of said optical receptacle;
a second connector including a second ferrule, the second ferrule including at
least one hole, said second connector received in said second half of said optical
receptacle; and
an alignment member received by said hole of said second ferrule and mated with
10 said beveled edge of said first ferrule in order to align the first ferrule to the second
ferrule.
2. The optical receptacle assembly of claim 1 wherein the alignment member is a
pin mounted within the optical receptacle assembly.
3. The optical receptacle assembly of claim 2, wherein the first and second ferrules
15 receive a plurality of optical fibers.
4. The optical receptacle assembly of claim 2, wherein the first half of the optical
receptacle has a first form factor.
5. The optical receptacle assembly of claim 4, wherein the second half of the optical
receptacle has a second form factor.
- 20 6. The optical receptacle assembly of claim 5, wherein the first form factor provides
for a MP style optical connector.
7. The optical receptacle assembly of claim 5, wherein the second form factor
provides for a MT style optical connector.

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8. The optical receptacle assembly of claim 7, wherein the first form factor provides for the MP style connector, and the second form factor provides for the MTP style connector.
9. The optical receptacle assembly of claim 5, wherein the first form factor provides for a MACII style connector and the second form factor provides for a MT style connector.
10. The optical receptacle assembly of claim 9, wherein the first form factor provides for the MACII style connector and the second form factor provides for a MTP style connector.
11. The optical receptacle assembly of claim 6, wherein the first form factor provides for the MP style connector and the second form factor provides for a MTP style connector.
12. The optical receptacle assembly of claim 4, wherein the optical receptacle includes a plurality of latches integrated within said first half for latching said first connector.
13. The optical receptacle assembly of claim 6, wherein the optical receptacle further comprises a receptacle slot for engaging a polarizing member of said first connector.
14. The optical receptacle assembly of claim 13, wherein the optical receptacle includes a plurality of latches integrated within said second half for latching said second connector.
15. An optical receptacle assembly comprising:
an optical receptacle including a first and second receptacle half;
a first connector including a first ferrule, the first ferrule including a beveled edge, said first ferrule being inserted into said first receptacle half;

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a second connector including a second ferrule, the second ferrule having an end face inserted into said second receptacle half; and

a pair of guide members that engage the end face of said second ferrule and engage said beveled edge of said first ferrule in order to align the first ferrule to the
5 second ferrule.

16. The optical receptacle assembly of claim 15, wherein the pair of guide members are mounted within the optical receptacle assembly.

17. The optical receptacle assembly of claim 16, wherein the first and second connectors receives a plurality of optic fibers.

10 18. The optical receptacle assembly of claim 17, wherein said first receptacle half has a first form factor.

19. The optical receptacle assembly of claim 18, wherein said second receptacle half has a second form factor.

15 20. The optical receptacle assembly of claim 19, wherein said first form factor conforms to a MP style connector.

21. The optical receptacle assembly of claim 20, wherein said second form factor conforms to a MT style connector.

22. The optical receptacle assembly of claim 21, wherein the first form factor conforms to the MP style connector and the second connector conforms to the MTP style
20 connector.

23. The optical receptacle assembly of claim 19, wherein the first form factor conforms to a MACII style connector.

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24. The optical receptacle assembly of claim 23, wherein the first form factor provides for a MACII style connector and the second form factor provides for a MT style connector.
25. The optical receptacle assembly of claim 19, wherein the second form factor
5 conforms to a MACII style connector.
26. The optical receptacle assembly of claim 15, wherein said guide member is an alignment pin extending from the end face of said second ferrule.
27. A fiber optical ferrule having a proximal and distal side, the ferrule comprising:
a ferrule first half containing a first front portion having a first major surface for
10 receiving a plurality individual optical fibers; and
a first vertically aligned wall protruding beyond the first major surface and along the proximal side.
28. The fiber optical ferrule of claim 27, further comprising a first beveled edge at the proximal side.
- 15 29. The fiber optical ferrule of claim 28, further comprising a first cut-out running along said distal side.
30. The fiber optical ferrule of claim 29, wherein said first cut-out includes dimensions approximately equal to dimensions of the first vertically aligned wall.
- 20 31. The fiber optical ferrule of claim 30, further comprising:
a ferrule second half aligning over said ferrule first half, said ferrule second half containing a second front portion having a second major surface for receiving a plurality individual optical fibers;
a second vertically aligned wall protruding beyond the second major surface
25 along said distal side; and

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a second beveled edge at the distal side.

32. The fiber optical ferrule of claim 31, wherein said first ferrule half contains the first cut-out along said distal side for receiving said second vertically aligned wall.

5 33. The fiber optical ferrule of claim 32, wherein the second ferrule half contains the second cut-out along the proximal side for receiving said first vertically aligned wall.

34. The fiber optical ferrule of claim 33, wherein said first ferrule half contains a plurality of first V-grooves for receiving individual optical fibers.

10 35. The fiber optical ferrule of claim 34, wherein said second ferrule half contains a plurality of second V-grooves for receiving individual optical fibers, where said second V-grooves oppose said first V-grooves.

36. The fiber optical ferrule of claim 35, wherein said first and second beveled edges are spaced to engage at least one guide pin from a MT style connector.

15 37. The fiber optical ferrule of claim 35 wherein said fiber optical ferrule has a form factor that conforms to a MT style connector.

38. The fiber optical ferrule of claim 35 wherein the first ferrule half and the second ferrule half are hermaphroditic.

39. The fiber optical ferrule of claim 35, wherein said first and second beveled edges are spaced to engage at least one guide pin from a MACII style connector.

20 40. The fiber optical ferrule of claim 35, wherein said fiber optical ferrule has a form factor that conforms to a MACII style connector.

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41. A fiber optical ferrule comprising:
a pair of mutually opposing ferrule halves joined to define in part a fiber optical support region for receiving at least one optical fiber;
one of said ferrule halves including a vertically aligned wall protruding therefrom
5 towards the other of said ferrule halves at a first side; and
a first beveled edge contained within one of said ferrule halves at the first side.
42. The fiber optical ferrule of claim 41, further comprising:
a second vertically aligned wall included within one of said ferrule halves and protruding therefrom towards the other of said ferrule halves at a second side; and
10 a second beveled edge contained within one of said ferrule halves at the second side.
43. The fiber optical ferrule of claim 42, wherein said first and second beveled edges are spaced to receive a pair of guide pins.
44. The fiber optical ferrule of claim 43, wherein the fiber support region contains a
15 plurality of opposing V-grooves for receiving individually a plurality of optical fibers.
45. The fiber optical ferrules of claim 44, wherein the fiber support region contains twelve opposing V-grooves.
46. The fiber optical ferrule of claim 44, wherein the first and second beveled edges are spaced to engage at least one guide pin from a MT style connector.
- 20 47. The fiber optical ferrule of claim 44, wherein the first and second beveled edges are spaced to engage at least one guide pin from a MACII style connector.
48. The fiber optical ferrule of claim 44, wherein said fiber optical ferrule has a form factor that conforms to a MT style connector.

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49. The fiber optical ferrule of claim 44, wherein said fiber optical ferrule has a form factor that conforms to a MACII style connector.

50. The fiber optical ferrule of claim 41 wherein:

the fiber optical ferrule is formed of a resin composition with an anisotropy of less than 1.5, where said resin composition consists of at least one resin selected from the group consisting of polyetherimides, polyethersulfones, and epoxy resins.

51. A fiber optical ferrule comprising:

- a top ferrule half including a front portion having an upper major surface;
- a bottom ferrule half including a front portion having a lower major surface;
- a plurality of V-grooves formed the upper and lower major surfaces;
- an upward wall integrally formed with the front portion of the bottom ferrule half, the upward wall axially bordering the front portion of the bottom ferrule half at a proximal side, and the upward wall protruding vertically beyond the lower major surface;
- a downward wall integrally formed with the front portion of the top ferrule half, the downward wall axially bordering the front portion of the top ferrule half at a distal side, and the downward wall protruding vertically beyond the upper major surface;
- a first cut-out formed in the bottom ferrule half which axially borders the front portion of the bottom ferrule half at the distal side, wherein the first cut-out receives the downward wall;
- a second cut-out formed in the top ferrule half which axially borders the front portion of the top ferrule half at the proximal side, wherein the second cut-out receives the upward wall;
- a first beveled edge formed in the upward wall and axially extending along the front portion of the bottom ferrule half; and
- a second beveled edge formed in the downward wall and axially extending along the front portion of the top ferrule half.

52. The fiber optical ferrule of claim 51, wherein said front portion receives twelve optical fibers.

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53. The fiber optical ferrule of claim 52, wherein said fiber optical ferrule has a form factor that conforms to a MT style connector.
54. The fiber optical ferrule of claim 51, wherein said fiber optical ferrule conforms to a MACII style connector.
- 5 55. The fiber optical ferrule of claim 54, wherein the first and second beveled edges are spaced to receive a pair of guide pins.
56. The fiber optical ferrule of claim 55, wherein the first and second beveled edges are spaced apart to receive the pair of guide pins protruding from a MT style connector.
- 10 57. The fiber optical ferrule of claim 55, wherein the first and second beveled edges are spaced apart to receive the pair of guide pins protruding from a MACII style connector.
58. The fiber optical ferrule of claim 51, wherein the fiber optical ferrule is formed of a resin composition with an anisotropy of less than 1.5, where said resin composition consists of at least one resin selected from the group consisting of polyetherimides, polyethersulfones, and epoxy resins.
- 15 59. A method for assembling a fiber optical ferrule comprising the steps of:
providing a first ferrule half including a first front portion having a first major surface and at least one V-groove formed therein, the first front portion also having a first vertically aligned wall at a proximal side, wherein the first vertically aligned wall protrudes beyond the first major surface and extends axially along the first front portion, and wherein the first vertically aligned wall includes a first beveled edge at the proximal side;
placing at least one optical fiber within the V-groove;
providing a second ferrule half including a second front portion having a second major surface, the second front portion also having a second vertically aligned wall at a
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distal side, wherein the second vertically aligned wall protrudes beyond the second major surface and extends axially along the second front portion, and wherein the second vertically aligned wall including a second beveled edge at the distal side;

applying a bonding material to the optical fiber; and

5 mating the first major surface to the second major surface wherein the first and second vertically aligned walls prevent the bonding material from seeping into the respective first and second beveled edges.

60. The method of claim 59, including the steps of:

10 providing the first ferrule half with the first front portion, wherein the front portion also includes a first cut-out at the distal side for receiving the second vertically aligned wall; and

providing the second ferrule half with the second front portion, wherein the second front portion also includes a second cut-out at the proximal side for receiving the first vertically aligned wall.

15 61. The method of claim 60, wherein the step of providing the second ferrule half includes providing the second front portion with a second major surface that has at least one V-groove formed therein for placement of at least one optical fiber.

62. The method of claim 59, wherein the step of applying the bonding material to the optical fiber includes applying bonding material comprising anaerobic adhesives.

20 63. The method of claim 59, including the additional step of curing the bonding material.

64. The method of claim 63, including the additional step of cleaving and polishing the optical fibers within the cured fiber optical ferrule.

25 65. The method of claim 59, wherein the V-groove is molded into the first major surface of the first ferrule half.

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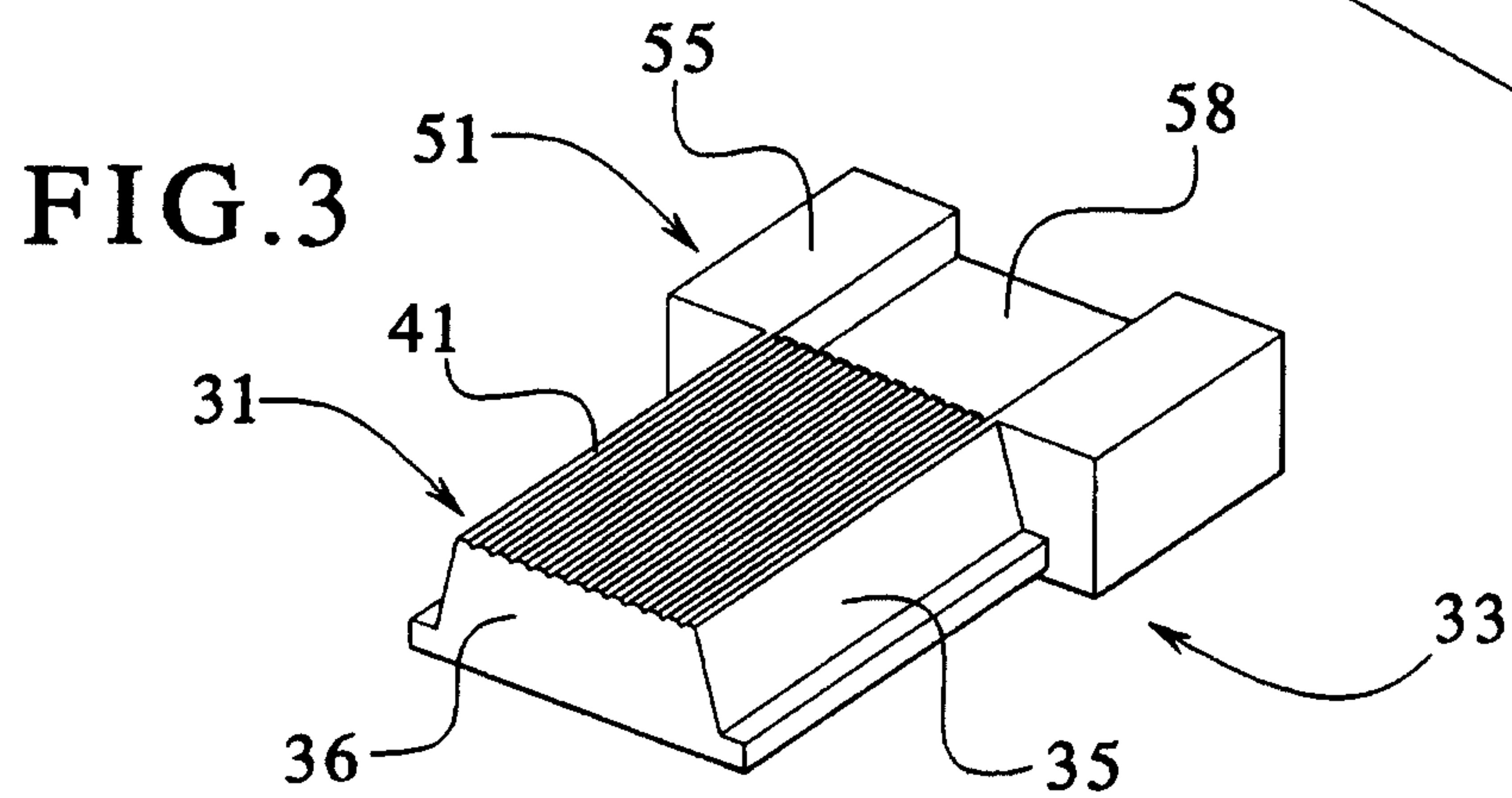
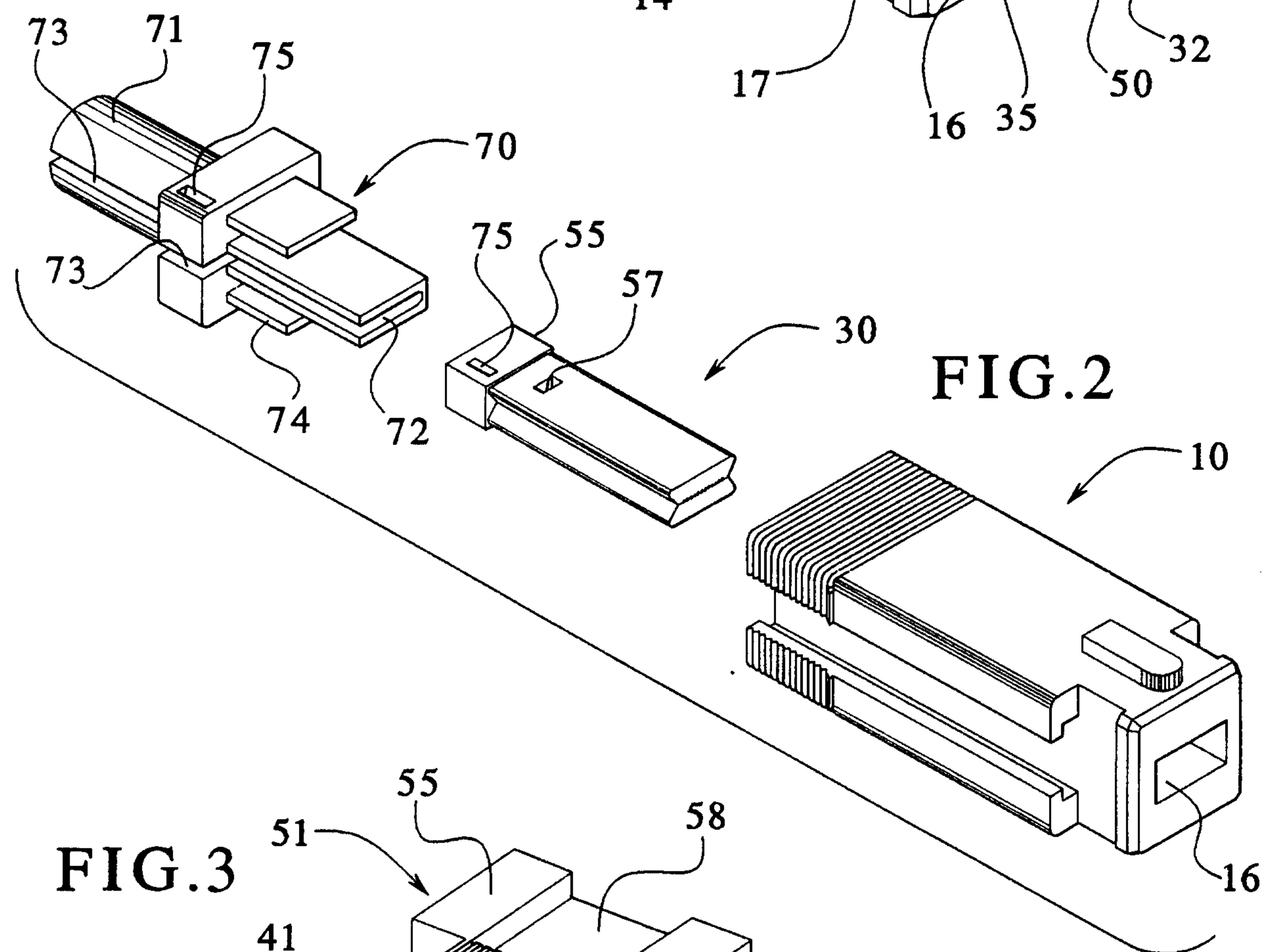
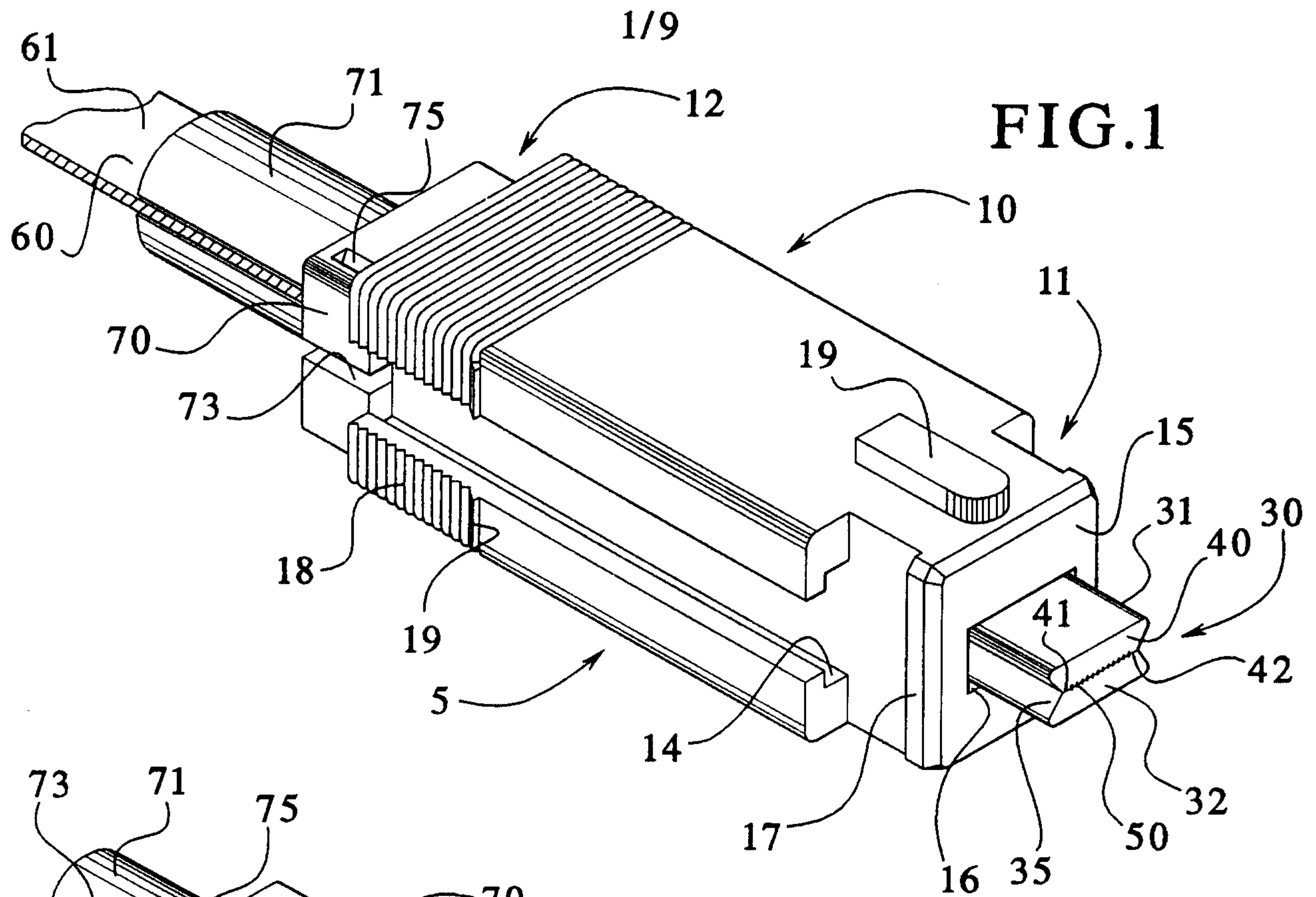
66. The method of claim 59, wherein the V-groove is machined into the first major surface of the first ferrule half.

67. The method of claim 59, wherein the V-groove is etched into the first major surface of the first ferrule half.

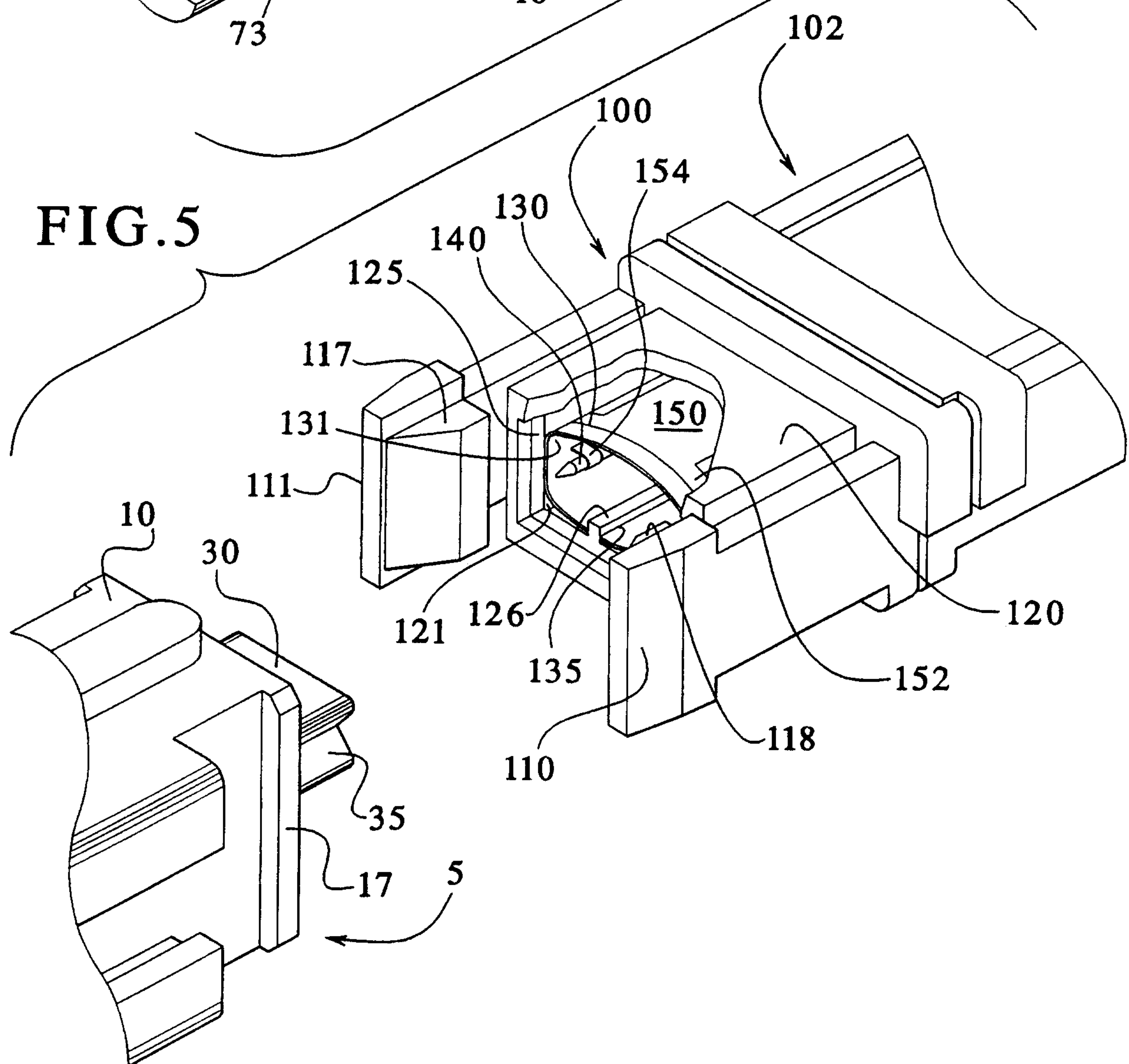
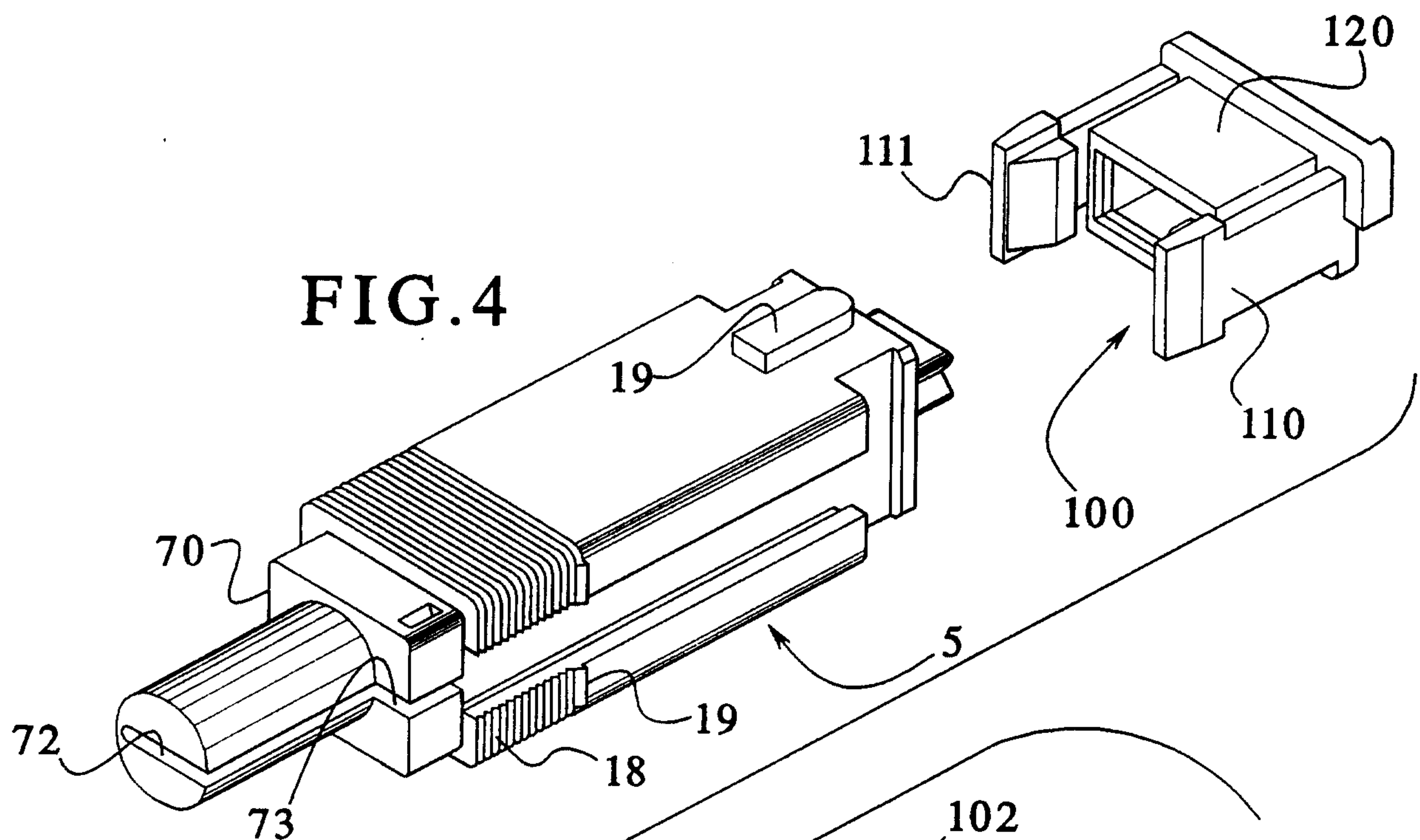
5 68. The method of claim 59, wherein the first beveled edge is molded into the proximal side.

69. The method of claim 59, wherein the first beveled edge is machined into the proximal side.

10 70. The method of claim 59, wherein the first beveled edge is etched into the proximal side.



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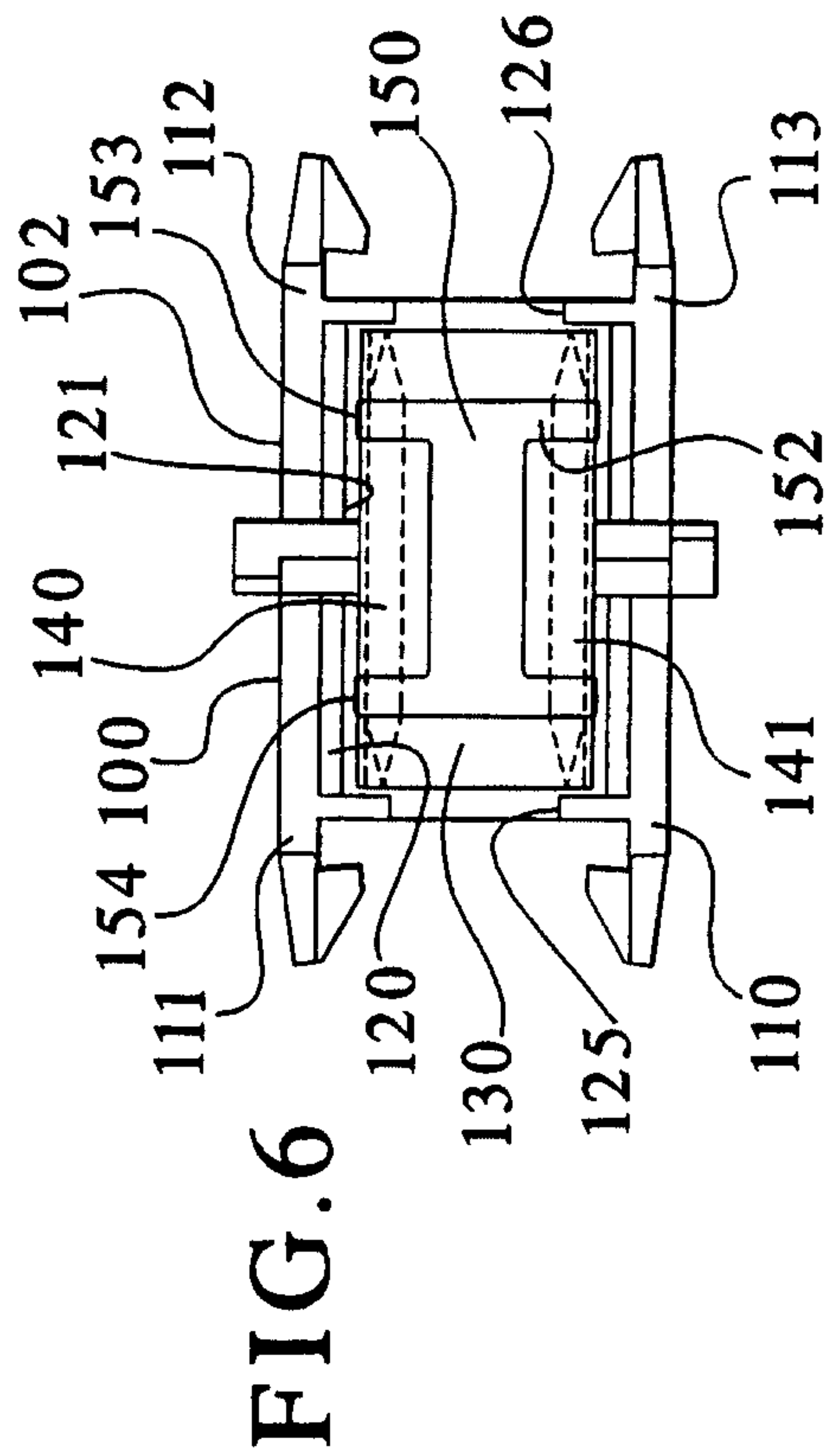


FIG. 7

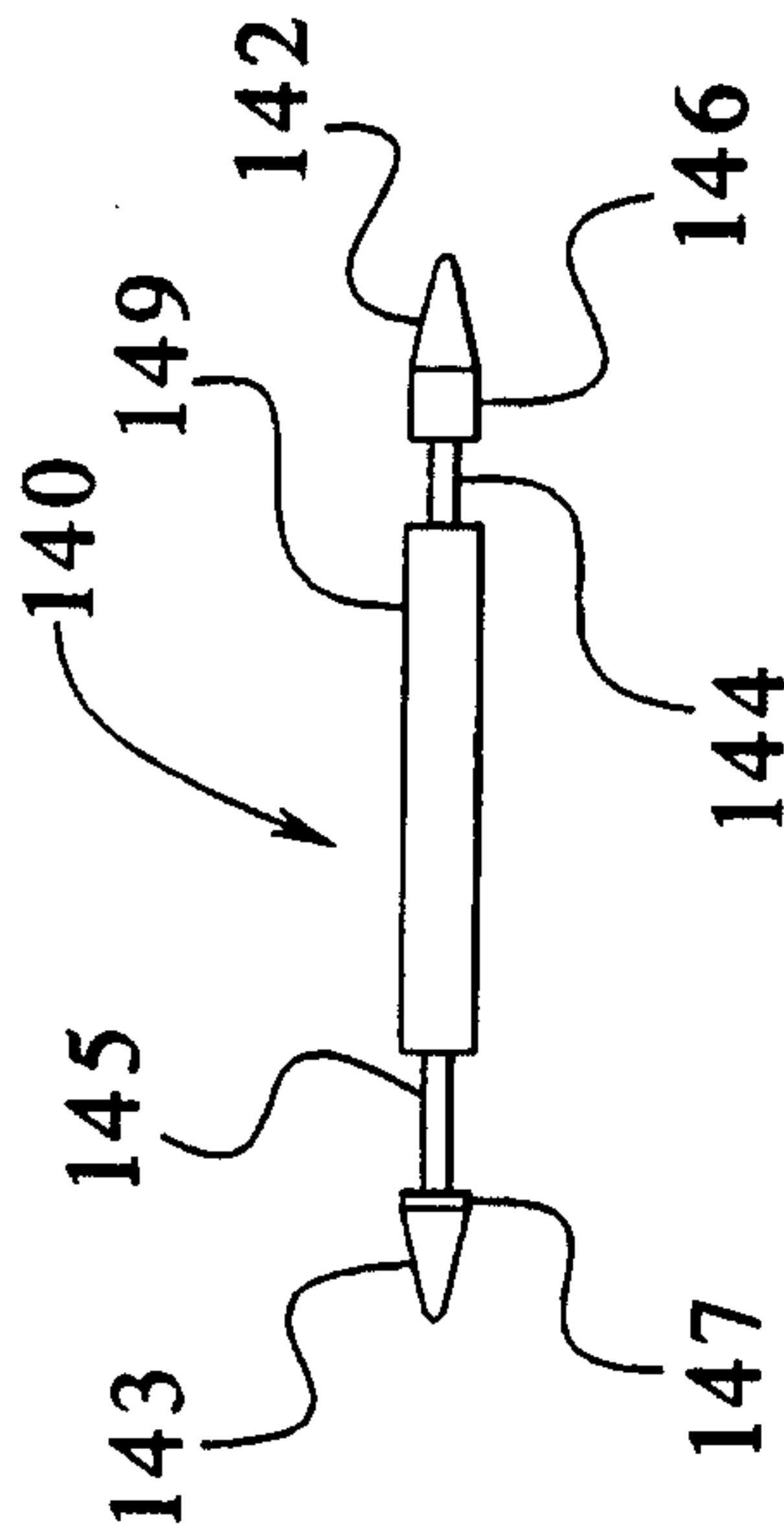
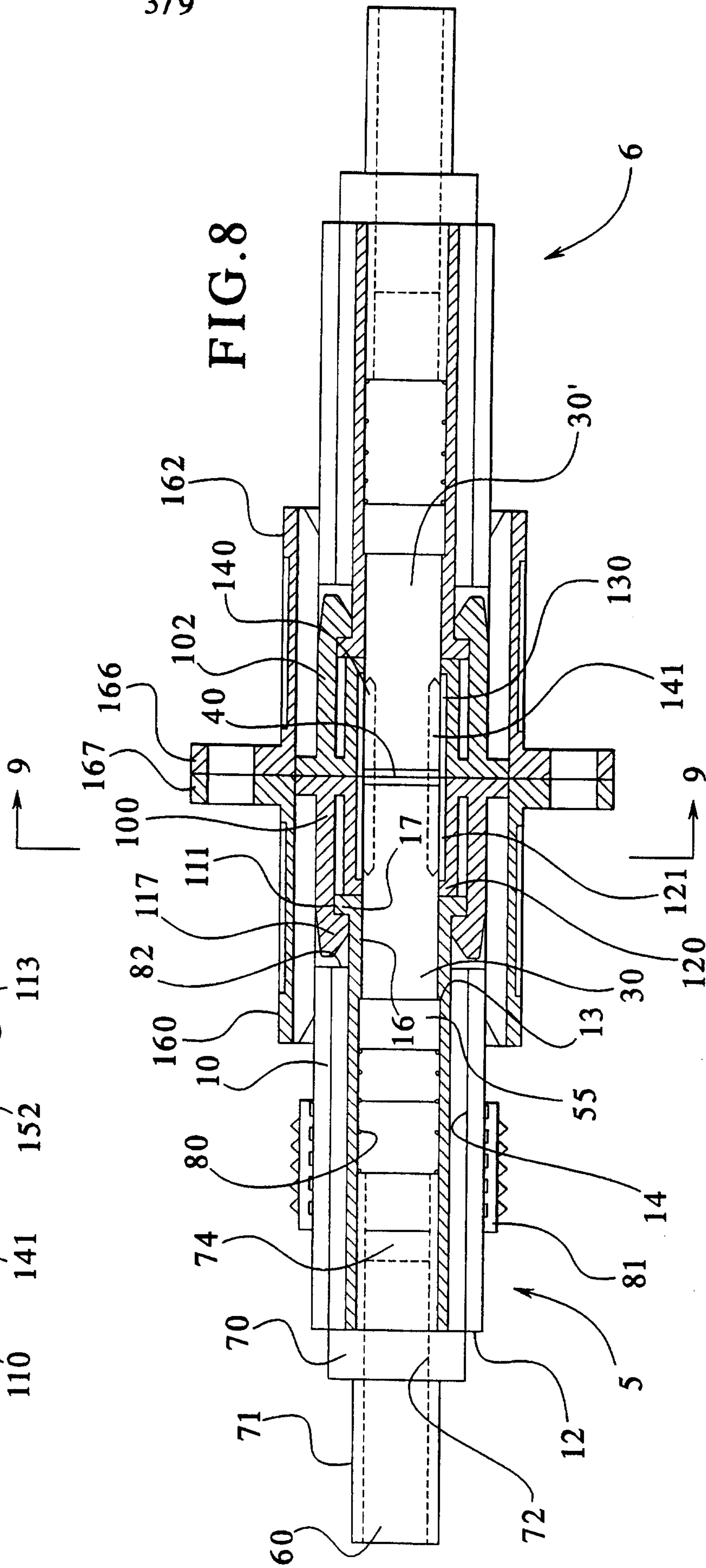


FIG. 8



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FIG. 9

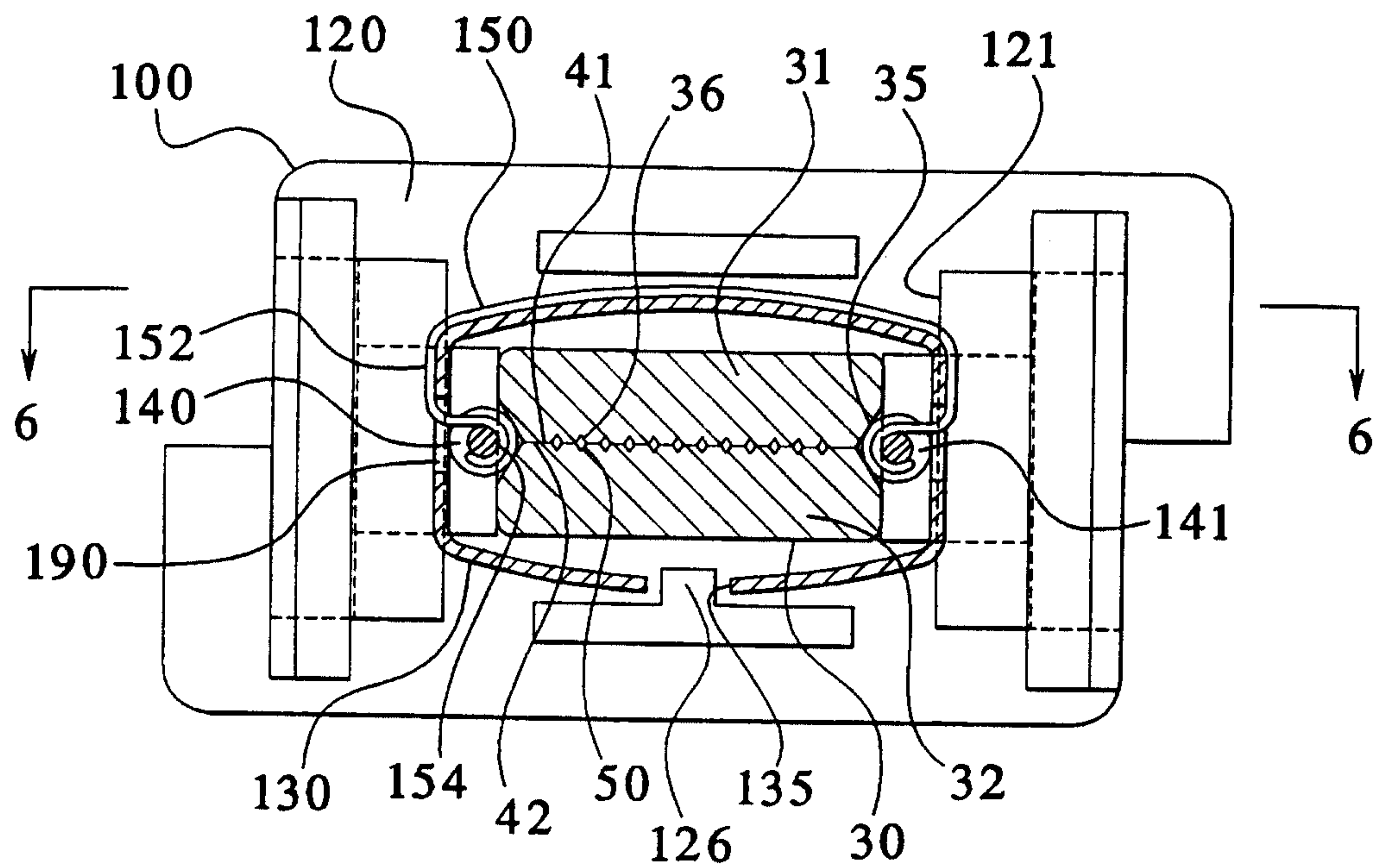


FIG. 10

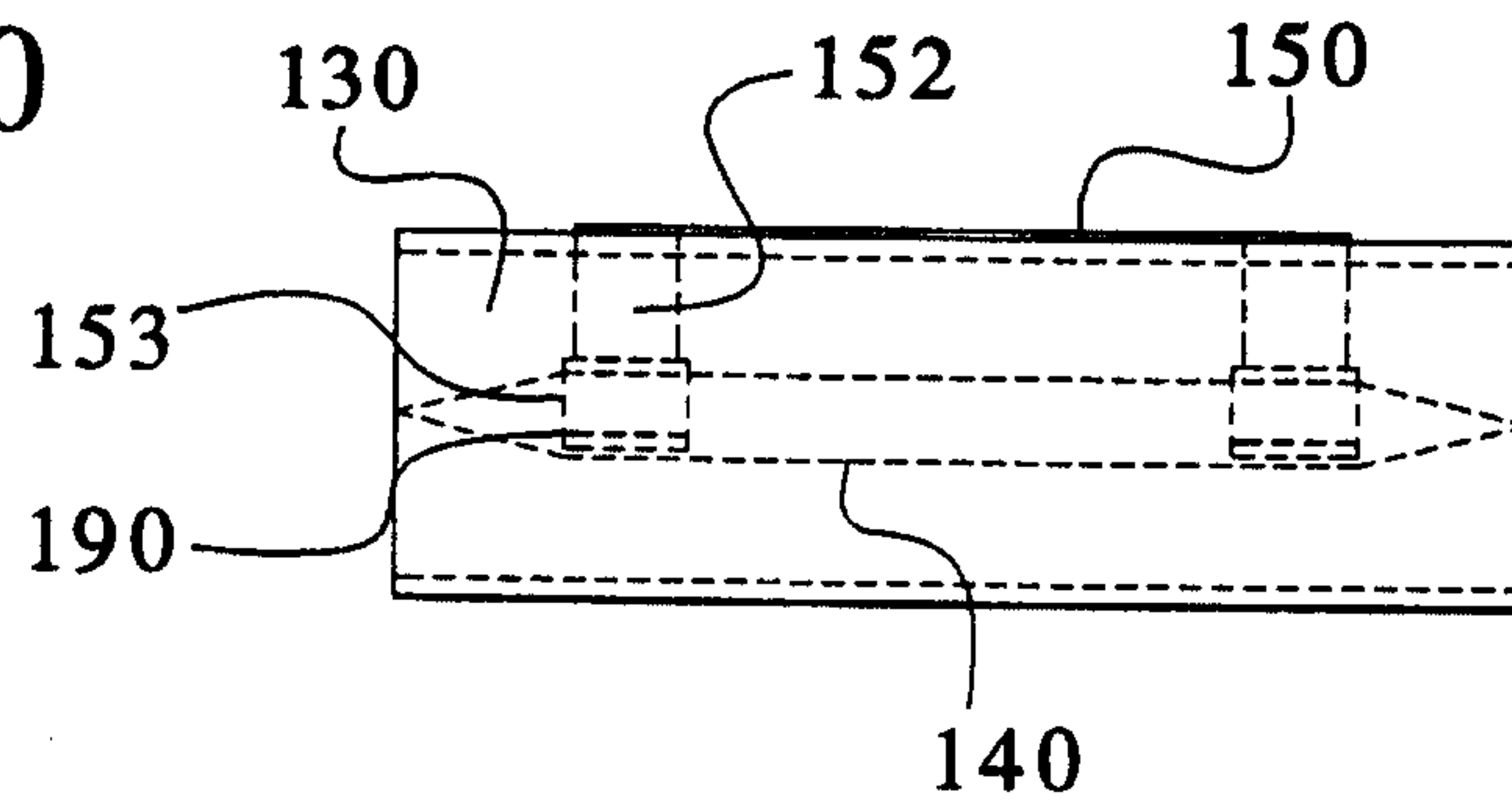


FIG. 13

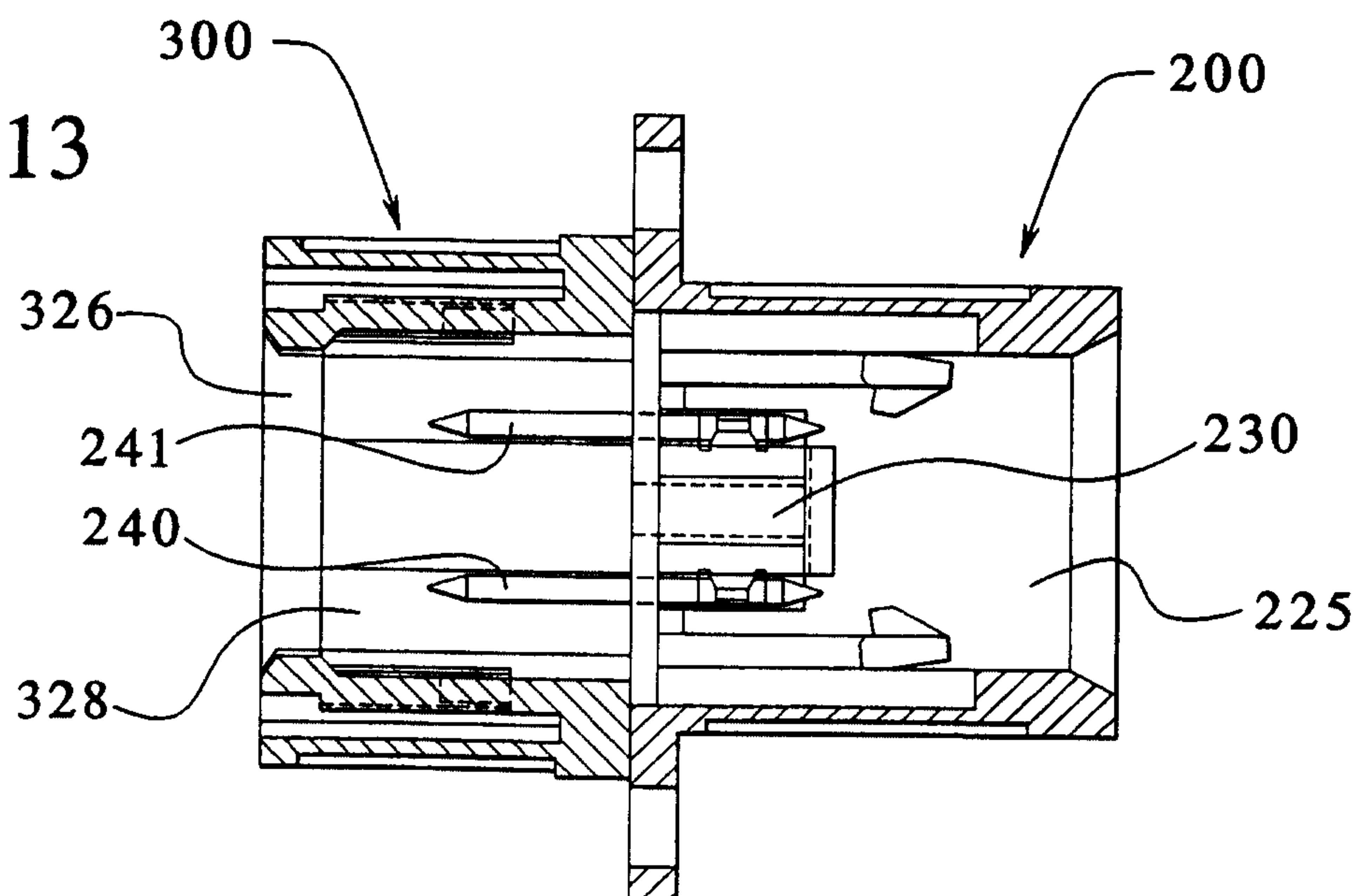


FIG.14

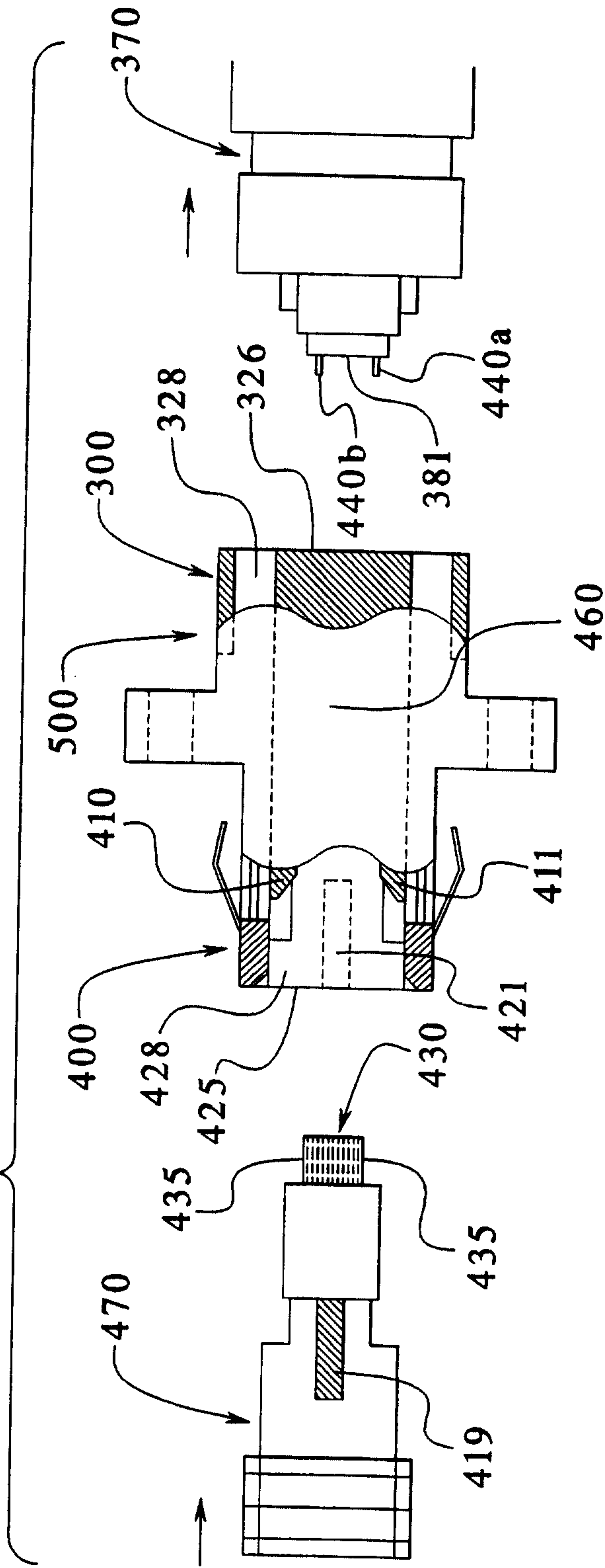


FIG.15a

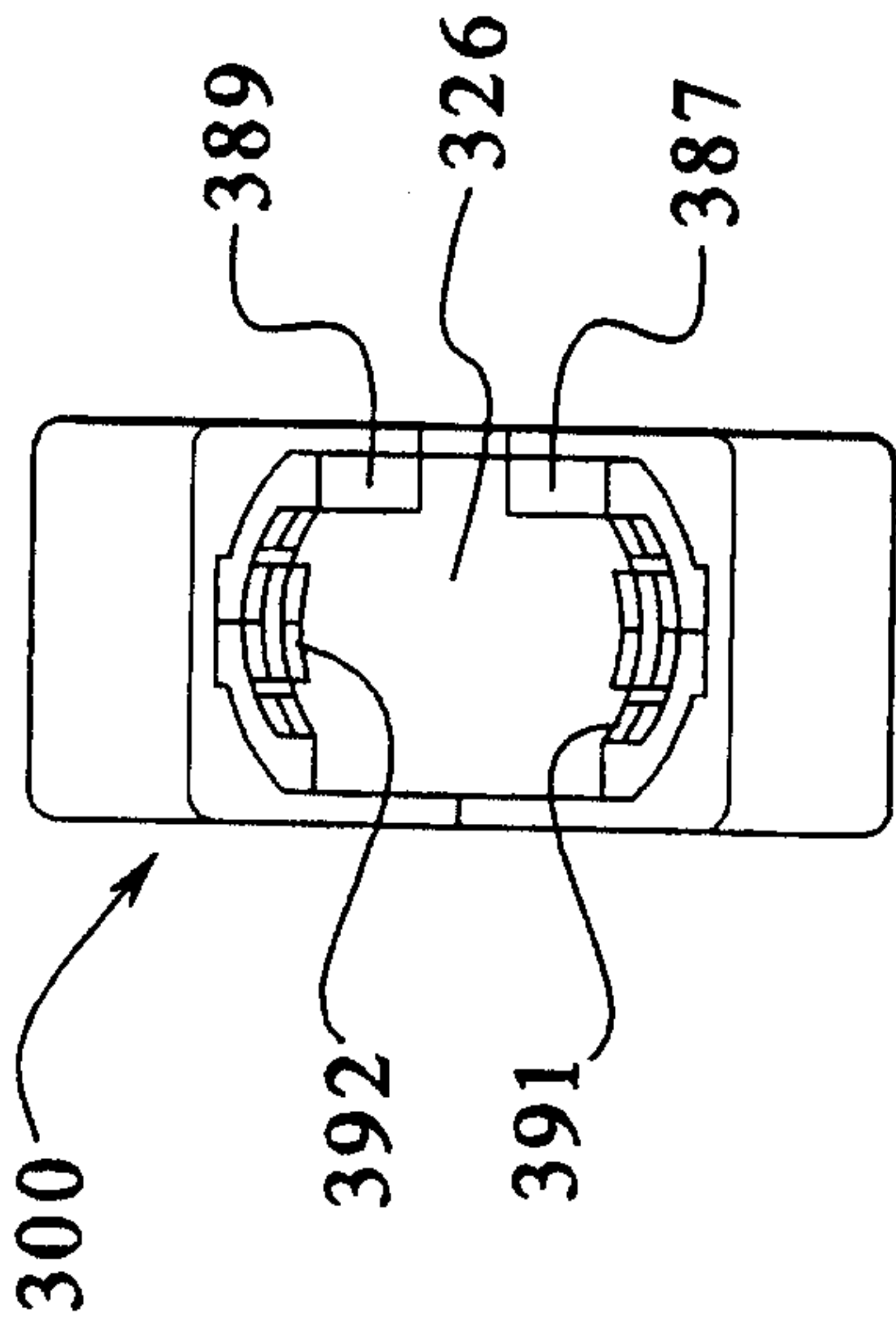
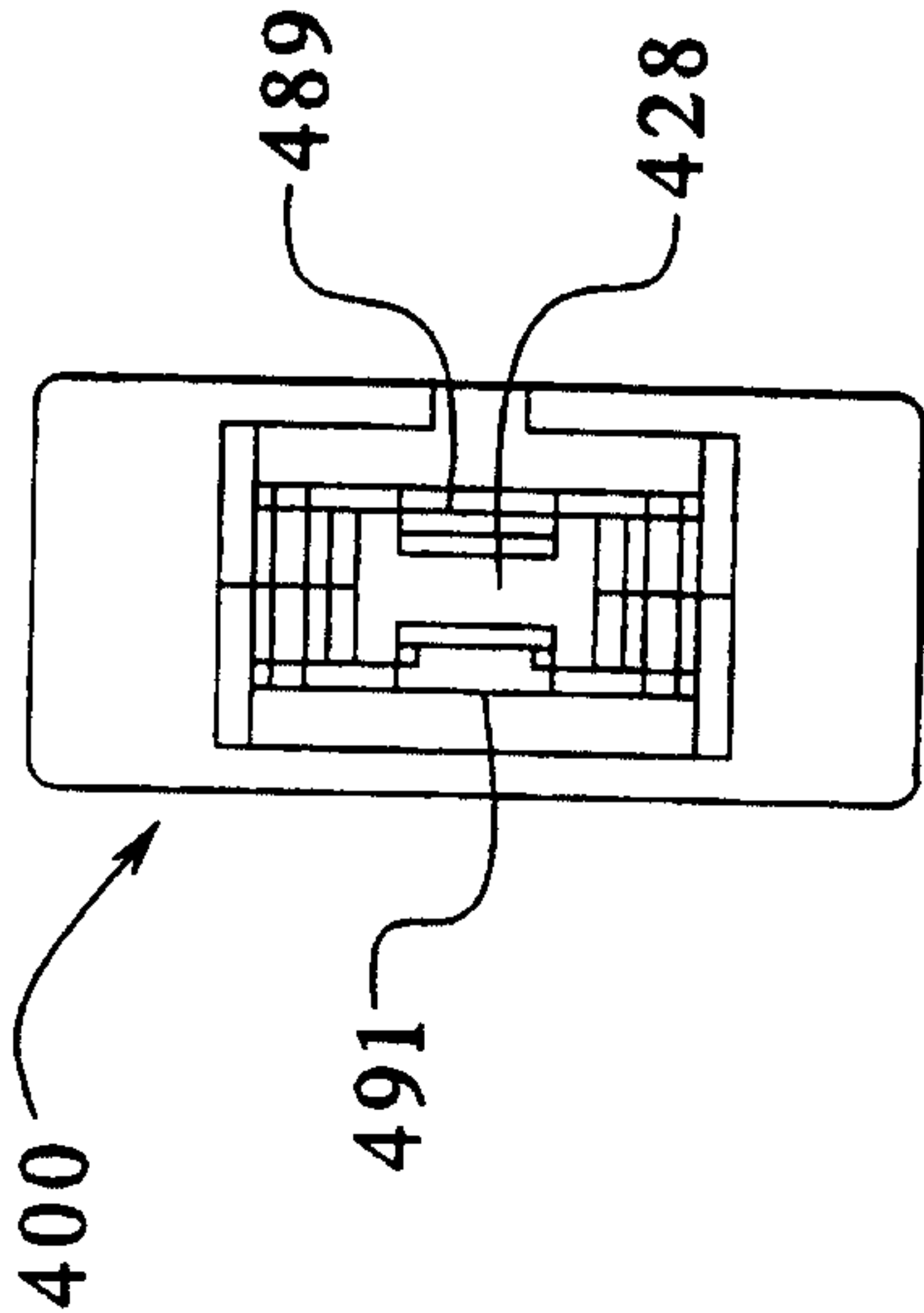
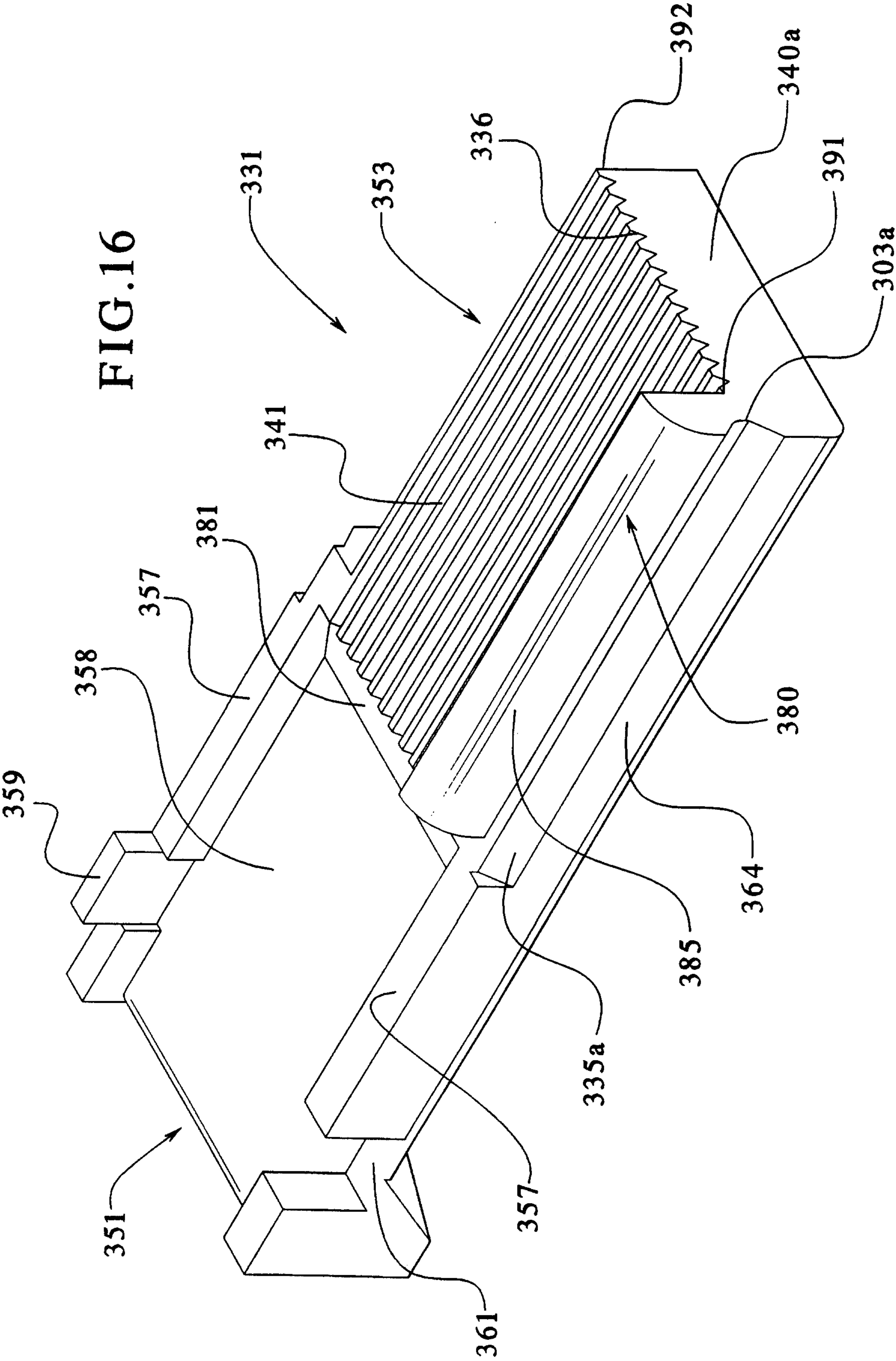
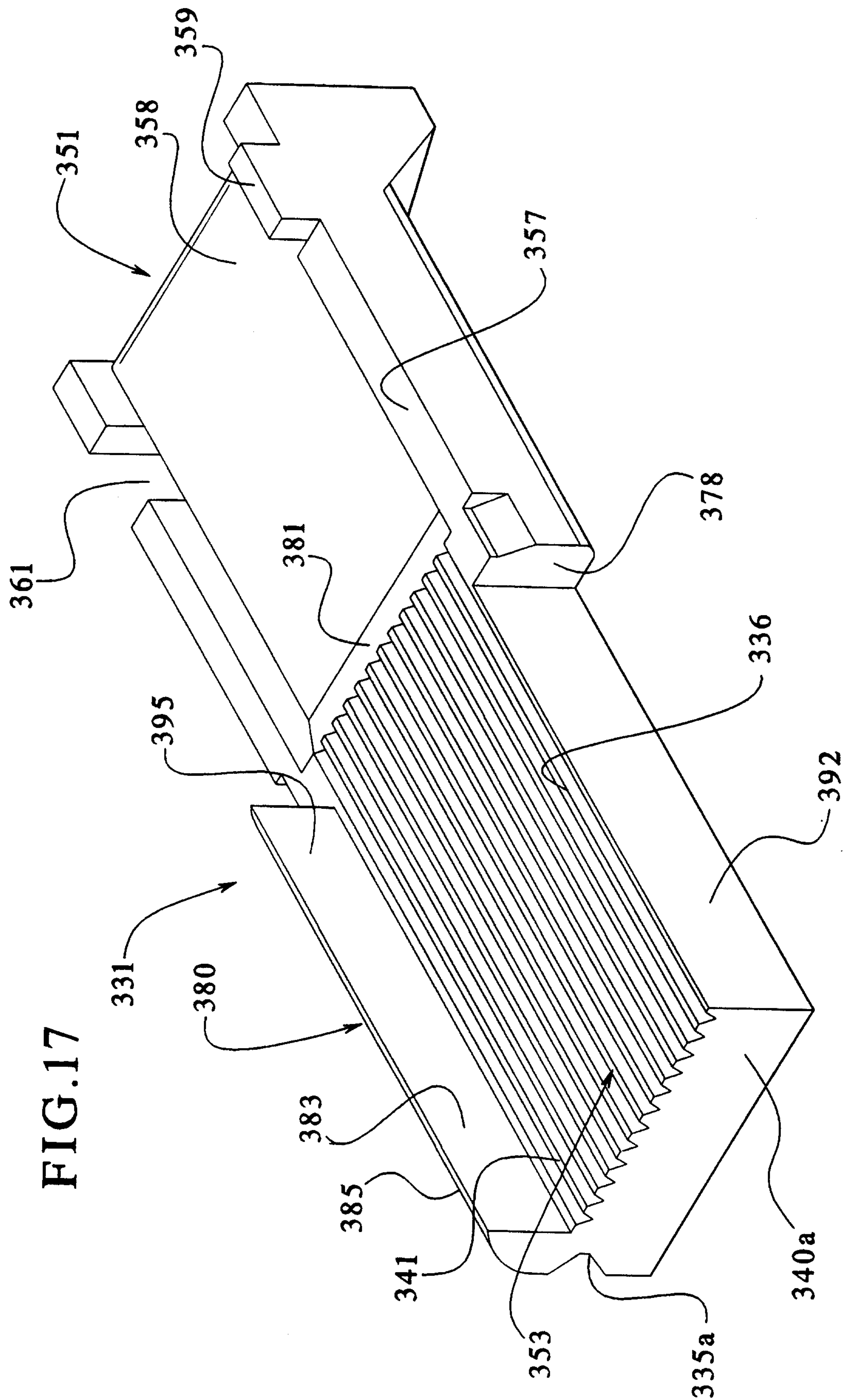


FIG.15b



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