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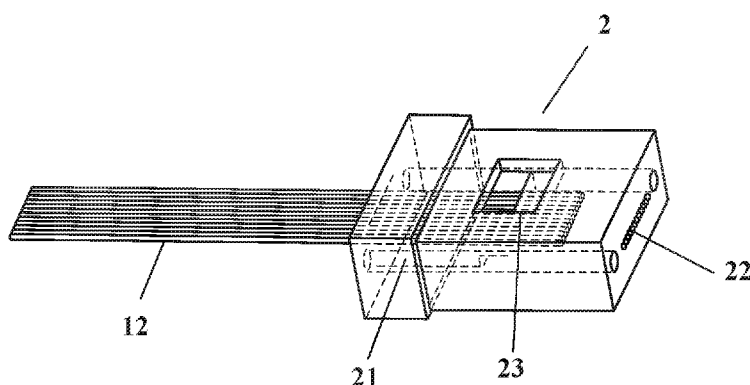


Fig. 3

(57) **Abstract:** The present disclosure has disclosed a system for manufacturing a multi-fiber connector comprising a plurality of optical fibers and a multi-fiber ferrule, wherein the system comprises: a cutting means configured to cut the plurality of optical fibers such that respective end faces thereof are flush with each other; a fiber inserting means configured to insert the plurality of optical fibers into the multi-fiber ferrule along an insertion direction; a visual sensor means configured to detect a protrusion amount of the end faces of the plurality of optical fibers; a controller configured to control a movement of the plurality of optical fibers according to the detected protrusion amount so that the protrusion amount becomes a predetermined value; and a fiber fixing means configured to fix the plurality of optical fibers when the protrusion amount becomes the predetermined value. It is also possible to manufacture a multi-fiber connector that meets the requirements even without the need of a polishing step.



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SYSTEM FOR MANUFACTURING MULTI-FIBER CONNECTOR

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CROSS-REFERENCE TO RELATED APPLICATIONS

This application is being filed on April 9, 2019 as a PCT International Patent Application and claims the benefit of Chinese Patent Application No. 201810321242.9, filed on April 11, 2018, and claims the benefit of Chinese Patent Application No. 201820508011.4, filed on April 11, 2018, the disclosures of which are incorporated herein by reference in their entireties.

TECHNICAL FIELD

The present disclosure generally relates to the field of a multi-fiber connector. More specifically, the present disclosure relates to a system for manufacturing a multi-fiber connector.

20

BACKGROUND

In optical communication, a multi-fiber connector has been widely used. The multi-fiber connector typically comprises a plurality of optical fibers and a multi-fiber ferrule. The multi-fiber ferrule has separate insert holes each receiving one of the plurality of optical fibers. The plurality of optical fibers are typically bounded together by a strippable coating to form an optical fiber ribbon.

A conventional system for manufacturing a multi-fiber

connector typically comprises: means for stripping the coating from the optical fiber ribbon, means for cleaning the plurality of optical fibers, means for applying an adhesive to the multi-fiber ferrule through a window in the multi-fiber ferrule, means for inserting and passing the plurality of optical fibers through the multi-fiber ferrule, means for curing the adhesive, means for polishing the front end faces of the plurality of optical fibers and means for testing the manufactured multi-fiber connector.

In the conventional system for manufacturing the multi-fiber connector, after the plurality of optical fibers pass through the multi-fiber ferrule and is fixed, the front end faces of the plurality of optical fibers exposed from the multi-fiber ferrule has to be polished so that the front end faces of the plurality of optical fibers satisfies the requirements. However, polishing is a very complicated process that typically requires up to six steps, and the polishing is typically affected by such factors as the pressure, time, cleanness, and precision of polishing and the experience of an operator. For a plurality of optical fibers, which typically include 6, 12, 24, 48 or more optical fibers, it has to be ensured that each optical fiber meets the requirements after polishing, which is very difficult. Therefore, the conventional method for manufacturing a multi-fiber connector is complicated and inefficient, and the manufactured multi-fiber connector has a poor yield.

SUMMARY OF THE INVENTION

One object of the present disclosure is to provide a

system for manufacturing a multi-fiber connector capable of overcoming at least one drawback in the prior art.

According to one aspect of the present disclosure, there is provided a system for manufacturing a multi-fiber connector comprising a plurality of optical fibers and a multi-fiber ferrule, wherein the system comprises: a cutting means, which is configured to cut the plurality of optical fibers exposed such that respective end faces of the plurality of optical fibers are flush with each other; a fiber inserting means, which is configured to insert the plurality of optical fibers into the multi-fiber ferrule along an insertion direction; a visual sensor means, which is configured to detect a protrusion amount of the end faces of the plurality of optical fibers protruding from the multi-fiber ferrule; a controller, which is configured to control a movement of the plurality of optical fibers in the multi-fiber ferrule according to the detected protrusion amount so that the protrusion amount becomes a predetermined value; and a fiber fixing means, which is configured to fix the plurality of optical fibers with respect to the multi-fiber ferrule when the protrusion amount becomes the predetermined value.

Preferably, the plurality of optical fibers are bounded together by a coating to form an optical fiber ribbon, wherein the system further comprises: a fiber stripping means, which is configured to strip a certain length of the coating from the optical fiber ribbon.

Preferably, the fiber fixing means includes an

adhesive applicator that is configured to apply an adhesive into the multi-fiber ferrule after the end faces of the plurality of optical fibers completely pass through the multi-fiber ferrule.

5 Preferably, the fiber inserting means includes an actuator, and the controller is configured to control the action of the actuator such that the plurality of optical fibers are moved along a retraction direction opposite to the insertion direction when it is judged that the
10 detected protrusion amount is larger than the predetermined value after the end faces of the plurality of optical fibers completely pass through the multi-fiber ferrule.

 Preferably, the controller is configured to control
15 the action of the actuator such that the plurality of optical fibers are moved along the insertion direction when it is judged that the detected protrusion amount is smaller than the predetermined value or the end surfaces of the optical fibers are not protruded.

20 Preferably, the fiber fixing means further includes a rapid curer, which is configured to rapidly cure the adhesive when the protrusion amount becomes the predetermined value.

 Preferably, the rapid curer is at least one of a UV
25 curer and a thermal curer.

 Preferably, the visual sensor means includes an image sensor, a processor and a memory, wherein the image sensor is configured to sense a sensed image containing the end faces of the plurality of optical

fibers, the memory stores a reference image, and the processor is configured to compare the sensed image with the reference image and obtain the protrusion amount according to a comparison result.

5 Preferably, the visual sensor means includes at least one of a CCD image sensor and a CMOS image sensor.

Preferably, the visual sensor means has a resolution on the order of micrometers or higher.

10 Preferably, the cutting means includes a laser.

Preferably, the cutting means includes a cutting blade, and the system further comprises a thermal annealing means which is configured to thermally anneal the plurality of optical fibers upon cutting and/or
15 after cutting.

Preferably, the predetermined value of the protrusion amount is 5 μm or less.

Preferably, the cutting length is controllable by the cutting means.

20 By using the system for manufacturing a multi-fiber connector of the present disclosure, it is also possible to manufacture a multi-fiber connector that meets the requirements even without the need of a polishing step.

25

BRIEF DESCRIPTION OF THE DRAWINGS

After reading the embodiments below in combination with the drawings, a plurality of aspects of the present disclosure will be better understood. In the drawings:

Figure 1 is a schematic view of an optical fiber ribbon with a segment of coating stripped according to one embodiment of the present disclosure;

5 Figure 2 is a schematic view of the optical fiber ribbon with the end faces of the optical fibers cut to be flush with each other according to one embodiment of the present disclosure;

10 Figure 3 is a schematic view of a multi-fiber ferrule having a plurality of optical fibers being inserted according to one embodiment of the present disclosure;

Figure 4 is a schematic view of controlling a protrusion amount of a plurality of optical fibers according to one embodiment of the present disclosure.

15 EMBODIMENTS

The present disclosure will be described below with reference to the drawings, in which several embodiments of the present disclosure are shown. It should be understood, however, that the present disclosure may be
20 presented in various different ways, not limited to the embodiments described below. In fact, the embodiments described below are intended to make the disclosure of the present disclosure more complete and to adequately explain the protection scope of the present disclosure to a
25 person skilled in the art. It should also be understood that, the embodiments disclosed herein can be combined in various ways to provide more additional embodiments.

It should be understood that, in all the drawings, the same reference signs present the same elements. In the

drawings, the size of certain features may be modified for the purpose of clarity.

It should be understood that, the wording in the specification is only used for describing particular
5 embodiments and is not intended to define the present disclosure. All the terms used in the specification (including technical terms and scientific terms), have the meanings as normally understood by a person skilled in the art, unless otherwise defined. For the purpose of
10 conciseness and/or clarity, the well-known functions or constructions may not be described in detail any longer.

The singular forms “a/an”, “said” and “the” as used in the specification, unless clearly indicated, all contain the plural forms. The wordings “comprising”, “including” and
15 “containing” used in the specification indicate the presence of the claimed features, but do not preclude the presence of one or more other features. The wording “and/or” as used in the specification includes any and all combinations of one or more of the relevant items listed.
20 The phrases “between X and Y” and “between about X and Y” as used in the specification should be construed as including X and Y. The phrase “between about X and Y” as used in the present specification means “between about X and about Y”, and the phrase “from about X to Y” as used
25 in the present specification means “from about X to about Y”.

In the specification, when one element is referred to as being “on” another element, “attached to” another element, “connected” to another element, “coupled” to

another element, or “in contact with” another element, the element may be directly located on another element, attached to another element, connected to another element, coupled to another element, or in contact with another element, or there may be an intermediate element. By contrast, where one element is referred to as being “directly” on another element, “directly attached to” another element, “directly connected to” another element, “directly coupled” to another element, or “in direct contact with” another element, there will not be an intermediate element. In the specification, where one feature is arranged to be “adjacent” to another feature, it may mean that one feature has a portion that overlaps with an adjacent feature or a portion that is located above or below an adjacent feature.

In the specification, the spatial relation wordings such as “upper”, “lower”, “left”, “right”, “front”, “rear”, “high”, “low” may describe a relation of one feature with another feature in the drawings. It should be understood that, the spatially relation wordings also encompass different orientations of the device in use or operation in addition to encompassing the orientations shown in the drawings. For example, when the device in the drawings is turned over, the features previously described as “below” other features may be described to be “above” other features at this time. The device may also be otherwise oriented (rotated 90 degrees or at other orientations). At this time, the relative spatial relations will be explained correspondingly.

The system described in the present specification may also utilize one or more controllers to receive information and transform the received information to generate an output. The controller may include any type of computing
5 means, calculation circuit or any type of processor or a processing circuit capable of executing a series of instructions stored in the memory. The controller may comprise a plurality of processors and/or a multi-core central processing unit (CPU) and may comprise any type
10 of processor, such as a microprocessor, a digital signal processor, a microcontroller, and the like. The controller may further comprise a memory to store data and/or algorithms to execute a series of instructions.

Any of the herein described methods, programs,
15 algorithms or codes may be converted to, or expressed in, a programming language or computer program. A "Programming Language" and "Computer Program" is any language used to specify instructions to a computer, and includes (but is not limited to) these languages and their
20 derivatives: Assembler, Basic, Batch files, BCPL, C, C+, C++, Delphi, Fortran, Java, JavaScript, Machine code, operating system command languages, Pascal, Perl, PL1, scripting languages, Visual Basic, metalanguages which themselves specify programs, and all first, second, third,
25 fourth, and fifth generation computer languages. Also included are database and other data schemas, and any other metalanguages. For the purposes of this definition, no distinction is made between languages which are interpreted, compiled, or use both compiled and

interpreted approaches. For the purposes of this definition, no distinction is made between compiled and source versions of a program. Thus, reference to a program, where the programming language could exist in more than
5 one state (such as source, compiled, object, or linked) is a reference to any and all such states. The definition also encompasses the actual instructions and the intent of those instructions.

Any of the herein described methods, programs,
10 algorithms or codes may be contained on one or more machine-readable media or memory. The term "memory" may include a mechanism that provides (e.g., stores and/or transmits) information in a form readable by a machine such a processor, computer, or a digital processing device.
15 For example, a memory may include a read only memory (ROM), random access memory (RAM), magnetic disk storage media, optical storage media, flash memory devices, or any other volatile or non-volatile memory storage device. Code or instructions contained thereon
20 can be represented by carrier wave signals, infrared signals, digital signals, and by other like signals.

Figures 1 and 3 show an optical fiber ribbon 1. The optical fiber ribbon 1 has a plurality of optical fibers 12 bounded together by a coating 11. Each of optical fibers 12
25 includes a cladding layer and a core surrounded by the cladding layer. The coating 11 may be polymers or binders, such as acrylics. The amount of the plurality of optical fibers is for example 2, 4, 6, 8, 12, 24, 48 or any other amount.

As shown in Figure 3, the multi-fiber ferrule 2 is configured such that the plurality of optical fibers 12 is passed through and fixed therein to form a manufactured multi-fiber connector. Preferably, the multi-fiber ferrule 2 may be a plastic multi-fiber ferrule. The multi-fiber ferrule 2 includes a body. The body is provided at its rear portion with an optical fiber insertion cavity 21. The body is provided with at its front portion a plurality of insertion holes 22 into which the plurality of optical fibers are to be inserted. Each of the plurality of optical fibers is inserted from the optical fiber insertion cavity 21 of the multi-fiber ferrule 2 and into the respective one of the plurality of insertion holes 22 respectively. Preferably, the multi-fiber ferrule 2 is provided with a window 23. The window 23 is disposed preferably on the top portion of the ferrule 2. An adhesive used to fix the optical fibers relative to the multi-fiber ferrule can be applied into the multi-fiber ferrule 2 through the window.

The system for manufacturing a multi-fiber connector according to the present disclosure may comprise a fiber stripping means (not shown). The fiber stripping means is configured such that a certain length of the coating 11 is stripped from the optical fiber ribbon. Figure 1 schematically shows a state in which a certain length of the coating 11 of the optical fiber ribbon has been stripped to expose the optical fibers 12.

The fiber stripping means may be at least one of a mechanical stripping means and a laser stripping means. The mechanical stripping means may be any existing

automatic mechanical stripping means, and may also be any manual mechanical stripping means such as a thermal stripping plier and a cold stripping plier. The laser stripping means is a means which utilizes a thermal decomposition effect or a molecular chain destruction effect of laser, to machine the coating needed to be stripped so that the coating is stripped. The laser stripping means may include any existing laser stripping machine such as a CO₂ laser stripping machine. Although the present disclosure exemplifies the mechanical stripping means and the laser stripping means, the fiber stripping means of the present disclosure is not limited thereto and may be any means that can strip a coating from an optical fiber ribbon.

Optionally, the system for manufacturing a multi-fiber connector according to the present disclosure may also comprise a cleaning means (not shown). The cleaning means is configured to clean the plurality of optical fibers after a certain length of coating is stripped from the optical fiber ribbon. The cleaning means may be at least one of a gas cleaning means, a liquid cleaning means and a wiper for wiping the optical fiber or any means capable of cleaning the optical fibers.

The system for manufacturing the multi-fiber connector according to the present disclosure may further comprise a cutting means (not shown). The cutting means is configured such that the plurality of optical fibers exposed are cut such that respective end faces of the plurality of optical fibers are flush with each other. That is,

the cutting means causes the respective end faces of the plurality of optical fibers 12 after being cut to form a common plane. Figure 2 shows a schematic view of a plurality of optical fibers with the ends cut to be flush. By
5 such cutting, the problem of uneven or fragmentation possibly present in the end faces of the optical fibers after the coating is stripped is eliminated.

The cutting means preferably comprises a laser cutting means. The laser cutting means cuts the optical
10 fibers by heating the optical fibers with a laser source of the laser. Although the laser of the laser cutting means can select any power capable of effectuating cutting the optical fiber, the power of the laser is preferably 30w or more. The heating temperature and the heating time of the laser can
15 be appropriately selected according to the needs. The laser cutting means may for example be a CO₂ laser. Any form of laser may be used as the laser cutting means without departing from the scope of the present disclosure. The laser cutting may make the end faces of the optical fibers
20 completely flush with each other after cutting, and avoid scratches and contamination of the end faces, so that a perfect end face of the optical fibers may be obtained.

Alternatively, the cutting means may also include a cutting blade. The cutting blade is, for example, a diamond
25 cutter or a similar cutter.

The system for manufacturing the multi-fiber connector according to the present disclosure may further comprise a thermal annealing means for annealing the plurality of optical fibers upon cutting or after cutting the

optical fibers with a cutting blade. The thermal annealing means may for example be a temperature-controlled heating means. The thermal annealing temperature and time can be chosen as desired to achieve a desired performance of the optical fibers. Preferably, the thermal annealing temperature is about 800 ° C - 900 ° C. Preferably, the thermal annealing time is about 1 second or less.

The high temperature of the laser cutting or the thermal annealing process may make the surfaces of the optical fibers harder to improve its durability, so that the surface of the optical fibers is not easily scratched when two connectors cooperate, so as to prolong the service life of the optical fiber connector.

The system for manufacturing the multi-fiber connector according to the present disclosure may further comprise a fiber inserting means 8 (Figure 4). The fiber inserting means 8 is configured such that the plurality of optical fibers are inserted into the multi-fiber ferrule along an insertion direction. The fiber inserting means 8 is preferably an automatic fiber inserting machine. The automatic fiber inserting machine preferably includes an actuator such as a high-precision motor and a transmission mechanism such as a high-precision lead screw. The precision of the actuator and the transmission mechanism is preferably on the order of micrometers or higher so that the step length of movement of the plurality of optical fibers in the insertion direction is on the order of micrometers or less. The fiber inserting means 8 inserts

the cut plurality of optical fibers into the multi-fiber ferrule 2 through the optical fiber insertion cavity 21 and allows the front end faces of the plurality of optical fibers to pass through the insertion hole 22 of the multi-fiber ferrule 2.

5 The system for manufacturing the multi-fiber connector according to the present disclosure may further comprise a visual sensor means. The visual sensor means is configured such that a protrusion amount of the end faces of the plurality of optical fibers protruding from the
10 ferrule 2 is detected by the visual sensor means. Preferably, the visual sensor means includes an image sensor 3. The image sensor 3 is preferably at least one of a CCD image sensor and a CMOS image sensor. Preferably, the image sensor 3 may include a sensor 31, a lens 32, and
15 a frame 33. The image sensor 3 is preferably disposed above and/or below the multi-fiber ferrule 2. The image sensor may be disposed at any position capable of sensing the position of the front end faces of all the optical fibers without departing from the scope of the present invention.
20 The image sensor 3 preferably has a resolution on the order of micrometers or higher, so that the position of the front end faces of the optical fibers may be sensed with high precision.

 In one preferred embodiment, the visual sensor means
25 further includes a processor 4 connected to the sensor 31 and configured to process the image sensed by the image sensor 3 so as to generate an information representative of the protrusion amount.

 Preferably, the visual sensor means further comprises

a memory 5. The memory 5 may be connected to the processor 4.

Preferably, the memory 5 may be used to store a reference image. The processor 4 may also be configured to compare the received image sensed by the image sensor with the reference image and to generate the information representative of the protrusion amount according to the comparison result.

Preferably, the memory 5 may store an image processing program, and the processor 4 may be configured to call the image processing program to process the received image sensed by the image sensor so as to generate the information representative of the protrusion amount.

The system for manufacturing the multi-fiber connector according to the present disclosure may further comprise a controller 6. The controller 6 is configured such that the movement of the plurality of optical fibers in the multi-fiber ferrule 2 is controlled according to the detected protrusion amount so that the protrusion amount becomes a predetermined value. Preferably, the controller 6 is connected to the processor 4 for receiving the information representative of the protrusion amount generated by the processor 4. The controller 6 controls the action of the actuator of the fiber inserting means 8 according to the received information representative of the protrusion amount.

The system for manufacturing the multi-fiber connector according to the present disclosure may

comprise a fiber fixing means 7. The fiber fixing means 7 is configured such that the plurality of optical fibers is fixed with respect to the multi-fiber ferrule when the protrusion amount becomes the predetermined value.

5 Preferably, the fiber fixing means 7 includes an adhesive applicator (not shown) configured to apply an adhesive into the multi-fiber ferrule 2 through a window 23 of the multi-fiber ferrule. The adhesive applicator is preferably an automated adhesive applicator. The use of an
10 automatic adhesive applicator may improve the consistency of the adhesive application and make the adhesive more plumply applied. Preferably, the adhesive may include glue such as epoxy, acrylate, or any other suitable glue.

15 Preferably, the controller 6 controls the action of the adhesive applicator so that the adhesive applicator applies an adhesive into the multi-fiber ferrule through the window of the multi-fiber ferrule after the end faces of the plurality of optical fibers completely pass through the multi-fiber
20 ferrule. In this way, it is possible to avoid adhering the adhesive on the end faces of the optical fibers.

 Preferably, the controller 6 is configured such that: the controller 6 controls the actuator to move the plurality of optical fibers along a retraction direction opposite to the
25 insertion direction when it is judged that the protrusion amount is larger than the predetermined value.

 Preferably, the controller 6 controls the actuator to move the plurality of optical fibers along the insertion direction when the controller 6 judges that the protrusion

amount is smaller than the predetermined value or the front end faces of the optical fibers are not protruded.

Preferably, the fiber fixing means further includes a rapid curer. The rapid curer is configured to rapidly cure the applied adhesive. Preferably, the rapid curer includes at least one of a UV curer and a thermal curer. The thermal curer preferably is an infrared curer.

Preferably, the controller 6 controls the rapid curer so that the rapid curer rapidly cures the adhesive when the protrusion amount becomes the predetermined amount. Thereby, the protrusion amount of the front end faces is accurately fixed at the predetermined value satisfying the requirements.

In addition, the window 23 of the multi-fiber ferrule 2 according to the present disclosure may be designed to be larger than the size of a conventional window. Preferably, the length of the window 23 in the insertion direction is large enough such that the gluing effect between the plurality of optical fibers and the multi-fiber ferrule may not be affected even when the plurality of optical fibers moves in the retraction direction to adjust its protrusion amount. Preferably, the length of the window 23 in the insertion direction may be about 3.1 millimeter or about 3.6 millimeter.

The predetermined value of the protrusion amount is preferably 5 μm or less. The predetermined value may be more preferably 3 μm or less, further more preferably 1 μm or less. By using a high-precision image sensor cooperating with a high-precision actuator and

transmission mechanism, it is possible to achieve a high-precision control the protrusion amount.

The method for manufacturing the multi-fiber connector according to the present disclosure will be further described below. The means, devices, parameters, features as well as their combinations and the like described above in the present disclosure may be used in the method described below, and the description of the same or similar means, devices, parameters and features will not be repeated any longer.

In one embodiment, the method of the present disclosure comprises the steps of:

a fiber stripping step, in which a certain length of the coating is stripped from an optical fiber ribbon;

a cutting step, in which the plurality of optical fibers exposed are cut such that respective end faces of the plurality of optical fibers are flush with each other;

a fiber inserting step, in which the plurality of optical fibers are inserted into the multi-fiber ferrule along an insertion direction;

a protrusion amount detection step, in which a protrusion amount of the end faces of the plurality of optical fibers protruding from the multi-fiber ferrule is detected by a visual sensor means;

a protrusion amount control step, in which movement of the plurality of optical fibers in the multi-fiber ferrule is controlled according to the detected protrusion amount so that the protrusion amount becomes a predetermined value; and

an optical fiber fixing step, in which the plurality of optical fibers are fixed with respect to the multi-fiber ferrule when the protrusion amount becomes the predetermined value.

5 By cutting the respective end faces of the exposed plurality of optical fibers to make them flush with each other, detecting and controlling the protrusion amount of the plurality of optical fibers by the visual sensor means, and fixing the plurality of optical fibers with respect to the
10 multi-fiber ferrule when the protrusion amount becomes the predetermined value, it is possible to allow that the end of the manufactured multi-fiber connector meets the requirements without the need of a polishing step.

Preferably, in the cutting step, the cutting length can
15 be controlled. Preferably, the cutting length can be controlled in a manner such that the optical fibers can pass through the multi-fiber ferrule and protrude from the end face of the ferrule by at least the predetermined value. Preferably, the cutting length can be controlled in a manner
20 such that the uncoated optical fibers is long enough to be fixed. Preferably, the cutting length can be controlled in a manner such that there are both uncoated optical fibers and coated optical fibers at the window 23 when the optical fibers are fixed.

25 By controlling the cutting length and setting the size of the window, it is possible that there are both coated optical fibers and uncoated optical fibers with an enough length when the optical fibers are fixed by curing the adhesive for example, thus a good fixing effect is achieved.

Preferably, in the fiber inserting step, the end surfaces of the plurality of optical fibers completely pass through the multi-fiber ferrule. Preferably, an adhesive is applied into the multi-fiber ferrule after the end faces of the plurality of optical fibers completely pass through the multi-fiber ferrule. Preferably, after that, in the protrusion amount control step, the plurality of optical fibers are moved along a retraction direction opposite to the insertion direction when it is judged that the detected protrusion amount is larger than the predetermined value. In this manner, the end faces of the optical fibers may not be adhered with the adhesive as compared with the case where the adhesive is applied before the plurality of optical fibers are inserted, so that subsequent treatment steps may be omitted and the protrusion amount may be efficiently controlled to the predetermined value.

Although a case where the adhesive is applied into the ferrule after the end faces of the plurality of optical fibers completely pass through the multi-fiber ferrule has been described in the above embodiments, the present disclosure is not limited thereto. The adhesive applicator may also apply an adhesive at other moments, such as when the plurality of optical fibers are not inserted into the ferrule, when the plurality of optical fibers are inserted into the ferrule and their front end faces have passed through the window, and/or when it is detected that the protrusion amount becomes the predetermined value. In this way, the plurality of optical fibers may be more adequately applied with the adhesive.

Although the above embodiments describe the case where the end faces of the plurality of optical fibers completely pass through the multi-fiber ferrule in the fiber inserting step, those skilled in the art may conceive that in the fiber inserting step, it is also possible that the end faces of the plurality of optical fibers do not completely pass through the multi-fiber ferrule but only partially insert into the multi-fiber ferrule without departing from the scope of the present disclosure. Under such circumstance, in the protrusion amount control step, the plurality of optical fibers are moved along the insertion direction when it is judged that the detected protrusion amount is smaller than the predetermined value or the end surfaces of the optical fibers are not protruded.

Preferably, in the optical fiber fixing step, rapidly curing the adhesive when the protrusion amount becomes the predetermined value. As mentioned above, the rapidly curing may use at least one rapid curing manner of ultraviolet curing, thermal curing such as infrared curing, and the like. By the rapidly curing, the plurality of optical fibers are rapidly fixed in the multi-fiber ferrule once the detected protrusion amount becomes equal to the predetermined value, thereby ensuring that the protrusion amount meets the requirements accurately.

Preferably, in the protrusion amount detection step, the visual sensor means senses a sensed image containing the end faces of the plurality of optical fibers. Preferably, the processor compares the sensed image with a reference image stored in the memory, so as to obtain the

protrusion amount according to a comparison result. Preferably, the processor may also process the sensed image by calling an image processing program stored in the memory so as to obtain the protrusion amount.

5 The present disclosure also relates to a multi-fiber connector manufactured by the above-described method.

Although the present disclosure is described with the multi-fiber connector as an example, those skilled in the art may conceive that the method and system of the present
10 disclosure may also be equivalently applied to the manufacture of a single-fiber connector.

Although the exemplary embodiments of the present disclosure have been described, a person skilled in the art should understand that, he or she can make various
15 changes and modifications to the exemplary embodiments of the present disclosure without departing from the spirit and scope of the present disclosure. Accordingly, all the changes and modifications are to be encompassed within the protection scope of the present disclosure as defined
20 by the claims. The present disclosure is defined by the appended claims, and equivalents of these claims are also contained.

WHAT IS CLAIMED IS:

1. A system for manufacturing a multi-fiber connector comprising a plurality of optical fibers and a multi-fiber ferrule, characterized in that, the system comprises:

a cutting means, which is configured to cut the plurality of optical fibers exposed such that respective end faces of the plurality of optical fibers are flush with each other;

a fiber inserting means, which is configured to insert the plurality of optical fibers into the multi-fiber ferrule along an insertion direction;

a visual sensor means, which is configured to detect a protrusion amount of the end faces of the plurality of optical fibers protruding from the multi-fiber ferrule;

a controller, which is configured to control a movement of the plurality of optical fibers in the multi-fiber ferrule according to the detected protrusion amount so that the protrusion amount becomes a predetermined value; and

a fiber fixing means, which is configured to fix the plurality of optical fibers with respect to the multi-fiber ferrule when the protrusion amount becomes the predetermined value.

2. The system for manufacturing a multi-fiber connector according to claim 1, characterized in that, the fiber fixing means includes an adhesive applicator that is configured to apply an adhesive into the multi-fiber ferrule after the end faces of the plurality of optical fibers

completely pass through the ferrule.

3. The system for manufacturing a multi-fiber connector according to claim 2, characterized in that, the fiber inserting means includes an actuator, and the controller is configured to control the action of the actuator such that the plurality of optical fibers are moved along a retraction direction opposite to the insertion direction when it is judged that the detected protrusion amount is larger than the predetermined value after the end faces of the plurality of optical fibers completely pass through the multi-fiber ferrule.

4. The system for manufacturing a multi-fiber connector according to claim 3, characterized in that, the controller is configured to control the action of the actuator such that the plurality of optical fibers are moved along the insertion direction when it is judged that the detected protrusion amount is smaller than the predetermined value or the end surfaces of the optical fibers are not protruded.

5. The system for manufacturing a multi-fiber connector according to claim 2, characterized in that, the fiber fixing means further includes a rapid curer, which is configured to rapidly cure the adhesive when the protrusion amount becomes the predetermined value.

6. The system for manufacturing a multi-fiber connector according to claim 5, characterized in that, the rapid curer is at least one of a UV curer and a thermal curer.

7. The system for manufacturing a multi-fiber connector according to claim 1, characterized in that, the visual sensor means includes an image sensor, a processor and a memory, wherein the image sensor is configured to sense a sensed image containing the end faces of the plurality of optical fibers, the memory stores a reference image, and the processor is configured to compare the sensed image with the reference image and obtain the protrusion amount according to a comparison result.

8. The system for manufacturing a multi-fiber connector according to claim 1, characterized in that, the visual sensor means includes at least one of a CCD image sensor and a CMOS image sensor.

9. The system for manufacturing a multi-fiber connector according to claim 1, characterized in that, the visual sensor means has a resolution on the order of micrometers or higher.

10. The system for manufacturing a multi-fiber connector according to claim 1, characterized in that, the cutting means includes a laser.

1/2

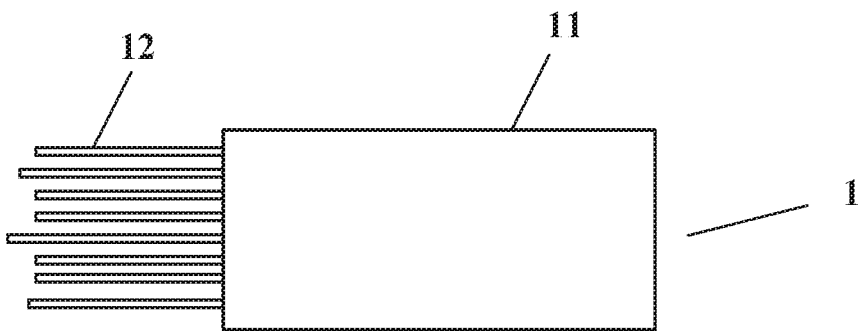


Fig. 1

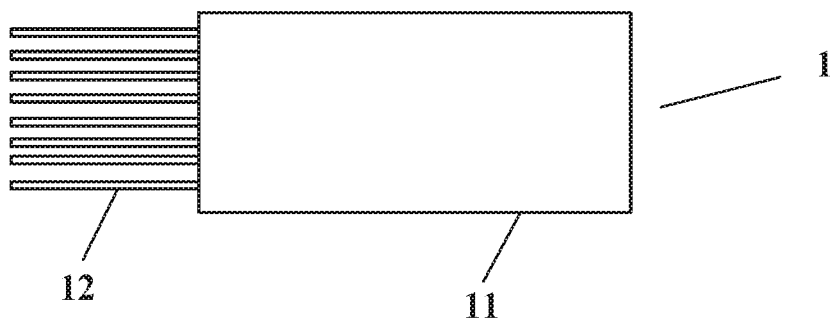


Fig. 2

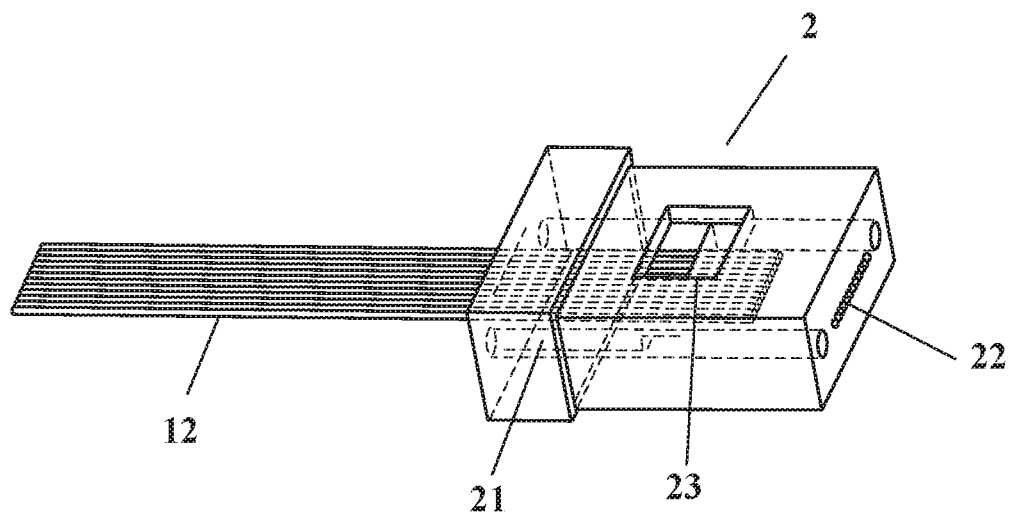


Fig. 3

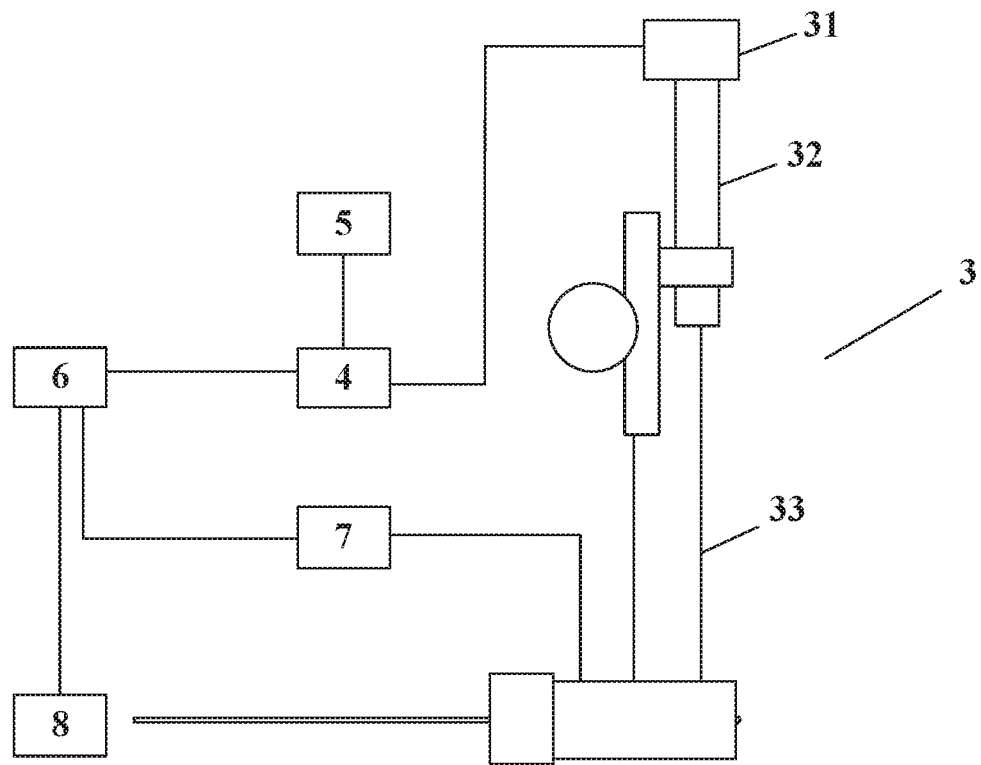


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2019/026471**A. CLASSIFICATION OF SUBJECT MATTER****G02B 6/38(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G02B 6/38; A01R 43/04; B32B 31/00; G02B 6/00; G02B 6/36

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: fiber, ferrule, cut, insert, sensor, adhesive

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5770001 A (AKIRA NAGAYAMA et al.) 23 June 1998 See column 7, line 51 - column 10, line 21, column 18, line 2 - column 23, line 16, claim 18 and figures 1, 6-10, 19A-19B.	1-10
A	US 7197224 B2 (DAVID ROBERT CAMERON ROLSTON et al.) 27 March 2007 See column 9, lines 30-60 and figures 17-19.	1-10
A	US 2015-0030291 A1 (TYCO ELECTRONICS CORPORATION) 29 January 2015 See paragraphs [0019]-[0037] and figure 1.	1-10
A	US 5351334 A (OH G. CHUN et al.) 27 September 1994 See column 5, line 41 - column 6, line 12 and figure 1.	1-10
A	US 5208977 A (CLAUDE RICARD) 11 May 1993 See column 4, line 50 - column 5, line 19 and figure 1.	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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23 July 2019 (23.07.2019)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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