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(54) Method and apparatus for ceramic ferrule bore lap processing.

(57) In a method and an apparatus for lap processing of ceramic ferrule bores, a plurality of ceramic blanks (1) are held in a floating state on a processing wire (6) stretched between a supply reel (12) and a take-up reel (14). A selected one of these ceramic blanks (1) is chucked in a chuck (20) and rotated. At the same time, the processing wire (6) is reciprocated while grinding power is supplied to it from a powder feeder (40). After a chosen lapping time, the selected ceramic blank is released from the chuck and the next selected ceramic blank is similarly processed.

Injection-molded blanks having tapered central bores can thus be satisfactorily bore processed, as well as blanks having non-tapered bores.

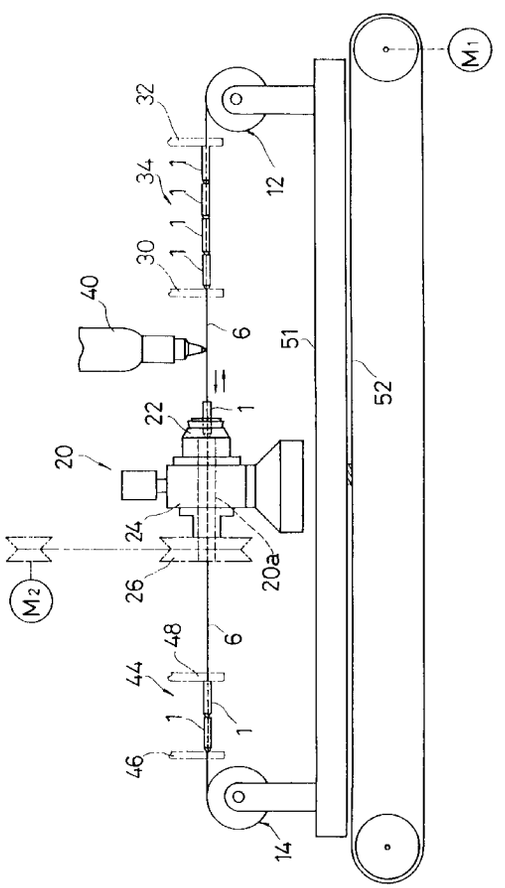

FIG. 1

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This invention relates generally to precision ferrules for optical connectors used for connecting optical fibers and, more particularly, to a method and an apparatus for ceramic ferrule bore lap processing to form a bore in a ferrule with high precision.

In recent years, ceramic ferrules are used popularly as precision ferrules for optical connectors. An optical fiber can be centered by merely inserting the optical fiber through a very small bore of the ceramic ferrule. In the manufacture of a ferrule, therefore, bore lap machining (i.e., boring and polishing) with very high precision is required.

Among the precision ferrules are a capillary ferrule as shown in Fig. 3(A), which has a ceramic ferrule 110 provided in an end of a stainless steel casing 100, and an integral ceramic ferrule as shown in Fig. 3(B), which substantially entirely comprises a ceramic ferrule 110 provided at one end with a stainless steel casing 100.

Among raw materials (i.e., blanks) which are used to produce the above ceramic ferrules 110 are an extrusion-molded blank 1 as shown in Fig. 4(A), which is formed by extrusion molding and has a central bore 2 having a substantially constant diameter, and an injection-molded blank 1 as shown in Fig. 4(B), which is formed by injection molding and has a tapered central bore 2a.

The extrusion-molded blank 1 is bore machined in a manner as described below to be used broadly as the ceramic ferrule 110.

As shown in Fig. 5, a plurality of, for instance 20 to 30, extrusion-molded ceramic blanks, through which a centering wire 6′ is passed, are secured by solder 10 to a holder 8 with the wire 6′ held taut. Then, the centering wire 6′ is removed, and instead a tapered wire 6 for processing is inserted. Then, the blanks 1 are rotated together with the holder 8 while supplying grinding powder of an adequate grain size, and at the same time the wire 6 is reciprocated. In this way, a plurality of blanks 1 are bore processed simultaneously.

When a predetermined extent of bore polishing is completed, the solder 10 is removed, and the blanks 1 are removed from the holder 8 and washed.

The injection-molded blank 1 has features that it can be manufactured very precisely and that its central bore 2 may be made to be close to the inner diameter of the product. However, if the above method of processing is to be used, it is necessary to provide a large processing margin, which is undesired in view of making use of the features of the injection molding.

According to the results of researches and experiments conducted by the inventors, the method of bore lap processing on ceramic ferrules using extrusion-molded blanks, although having an advantage that a large quantity of blanks can be processed at a time, inevitably dictates taking a large grinding margin (i.e., processing margin) to solve the problem of fluctuations of the central bore diameter with individual blanks. Consequently, excess time is required for the bore lap processing.

In addition, with this method, when the blank 1 is brought into contact with the wire 6 obliquely, a bore having a tumbler-like shape is formed in the blank, thus deteriorating the circularity.

Further, an injection-molded blank having a tapered central bore can not be bore lap processed because of the difficulty of aligning the central hole.

An object of the invention, accordingly, is to provide a method and an apparatus for ceramic ferrule bore lap processing, which permit satisfactory bore processing of an injection-molded blank having a tapered central hole as well, permits stable finish bore diameter and bore circularity to be obtained, permits reduction of the processing margin and permits bore processing without need of any skill and with satisfactory operation control.

To attain the above object of the invention, there is provided a method of ceramic ferrule bore lap processing, which comprises the steps of holding a plurality of ceramic blanks in a floating state with a stretched processing wire passed through the ceramic blanks, performing bore processing on a selected one of the ceramic blanks by rotating the selected ceramic blank while reciprocating the processing wire by supplying grinding particles thereto, and then performing similar bore processing on an another selected one of the ceramic blanks, thereby effecting bore processing on the ceramic blanks.

The above-mentioned present method is suitably carried out by an apparatus for ceramic ferrule bore lap processing, which comprises a stretched processing wire, driving means for feeding the processing wire while causing reciprocation thereof, chuck means penetrated by the processing wire and rotated while taking hold of a selected one of a plurality of blanks penetrated by the processing wire, and powder supply means for supplying grinding powder to the processing wire.

The invention will now be described in more detail by way of example with reference to the accompanying drawings in which:

Fig. 1 is a schematic view showing an apparatus for carrying out a method of ceramic ferrule bore lap processing according to the invention;

Figs. 2(A) and 2(B) are sectional views showing the shape of an injection-molded blank in respective steps of processing;

Figs. 3(A) and 3(B) are sectional views showing precision ferrules;

Figs. 4(A) and 4(B) are sectional views showing ceramic ferrules; and

Fig. 5 is a view for explaining prior art ceramic blank bore processing.

Now, a method and an apparatus for ceramic ferrule bore lap processing according to the invention

will now be described in detail with reference to the drawings. The embodiment concerns injection-molded blanks used to manufacture ceramic ferrules 110 for the integral ceramic ferrule shown in Fig. 3(B).

Fig. 2(A) shows an injection-molded blank 1 immediately after being injection-molded. Prior to the bore processing on this blank, burrs generated on the end 1b of the blank opposite the tapered end 1a at the time of gate removal in the injection molding are removed. Also, curved portions and tapers are removed using a center-less grinder or the like. Thus, the blank shown in Fig. 2(B) is obtained.

This preliminarily processed blank 1 is bore processed, that is, bore ground or polished, by the method of bore lap processing according to the invention.

Fig. 1 schematically shows a bore lap processing apparatus for carrying out the method according to the invention. In this embodiment, a processing wire 6 is stretched between a right and a left reel 12 and 14 mounted on the drive base 51. It can be fed while causing its reciprocation with suitable drive means, for instance by driving a belt 52 connected to the drive base 51 with a motor M1.

In this embodiment, the processing wire 6 has a diameter slightly smaller than the finish bore diameter and is tapered by etching to reduce its diameter on the left side.

According to the invention, the wire 6 penetrates a blank chuck assembly 20. As will be described later, the blank chuck assembly 20 has a chuck 22 for holding the blank 1 and a driver 24 for rotating the chuck 22. The operation of the chuck 22 is controlled pneumatically or hydraulically. The driver 24 has a pulley 26 driven from a motor M2 via a belt.

A plurality of, for instance 10 to 15, preliminarily processed blanks 1 are aligned by passing the wire 6 through them. The blanks 1 are not secured but held in a floating state at a predetermined position (i.e., a work stock position) by stoppers 46 and 48, for instance. Then, only one blank 1 is moved manually or with a pawl (not shown) from the work stock position 44 along the wire 6 to be chucked in the chuck 22 of the chuck assembly 20.

Then, the chuck 22 is rotated with the pulley 26 in a predetermined direction by driving the motor M2 and the driver 24. Meanwhile, the wire 6 is reciprocated as the belt connected to the driver base 51 is driven by the motor M1. Further, an adequate amount of diamond powder of a predetermined grain size for grinding is supplied, for instance at predetermined time intervals, to the wire 6 from a diamond powder feeder 40. Thus, the wire 6 with grinding particles attached thereto is fed to the position of the chuck 22, i.e., the bore grinding region of the blank 1.

When a predetermined extent of bore processing on the blank 1 is completed, the reciprocation of the wire 6 and rotation of the chuck 22 are stopped. Then, the chuck 22 is manipulated to free the blank 1 from the chuck 22. Then the wire 6 is returned to the initial position. In consequence, the blank 1 is carried along with the wire 6 from the position of the chuck 22 to a work stock position 34 to be held there in a floating state by stoppers 30 and 32.

During the above sequence of operations, the blanks 1 in the work stock positions 34 and 44 are held stationary by the stoppers without preventing the movement of the wire 6.

Subsequently, the next blank 1 held in the upstream side work stock position 44 is fed to the chuck 22 and bore processed in the manner as described above.

In this way, according to the invention the blanks 1 are bore processed one by one, and then the finish bore diameter and circularity of the blanks 1 are stabilized. In addition, since the bore processing on one blank is not influenced by that of blanks, the processing margin can be minimized, thus permitting great reduction of the processing time.

While the above embodiment of the invention concerned injection-molded blanks, the method and apparatus according to the invention are suitably applicable as well to the bore lap processing of extrusion-molded blanks.

Further, the apparatus according to the invention is not limited to that in the above embodiment, and the processing wire driver may be replaced with other suitable ones.

As has been described in the foregoing, the method and apparatus for ceramic ferrule lap processing according to the invention have the following effects.

(1) Satisfactory bore processing is possible with an injection-molded blank having a tapered central hole.

(2) It is possible to obtain stable finish bore diameter and circularity, reduce the processing margin and reduce the processing time.

(3) Nevertheless, no skill is needed, and satisfactory operation control can be obtained.

Claims

1. A method of lap processing a ceramic ferrule bore, comprising the steps of holding a plurality of ceramic blanks (1) in a floating state with a stretched processing wire (6) passed through said ceramic blanks, performing bore processing on a selected one of said ceramic blanks (1) by rotating the selected ceramic blank while reciprocating the processing wire (6) by supplying grinding particles thereto, and then performing similar bore processing on another selected one of said ceramic blanks (1), thereby effecting bore processing on said ceramic blanks.

2. An apparatus for lap processing a ceramic ferrule bore, comprising:
   (a) a stretched processing wire (6);
   (b) driving means (52, M1) for feeding said processing wire (6) while causing reciprocation thereof;
   (c) chuck means (20) penetrated by said processing wire (6) and rotated while taking hold of a selected one of a plurality of blanks (1) penetrated by said processing wire (6); and
   (d) powder supply means (40) for supplying grinding powder to said processing wire (6).

3. An apparatus according to claim 2, wherein the processing wire (6) is tapered.

FIG. 1

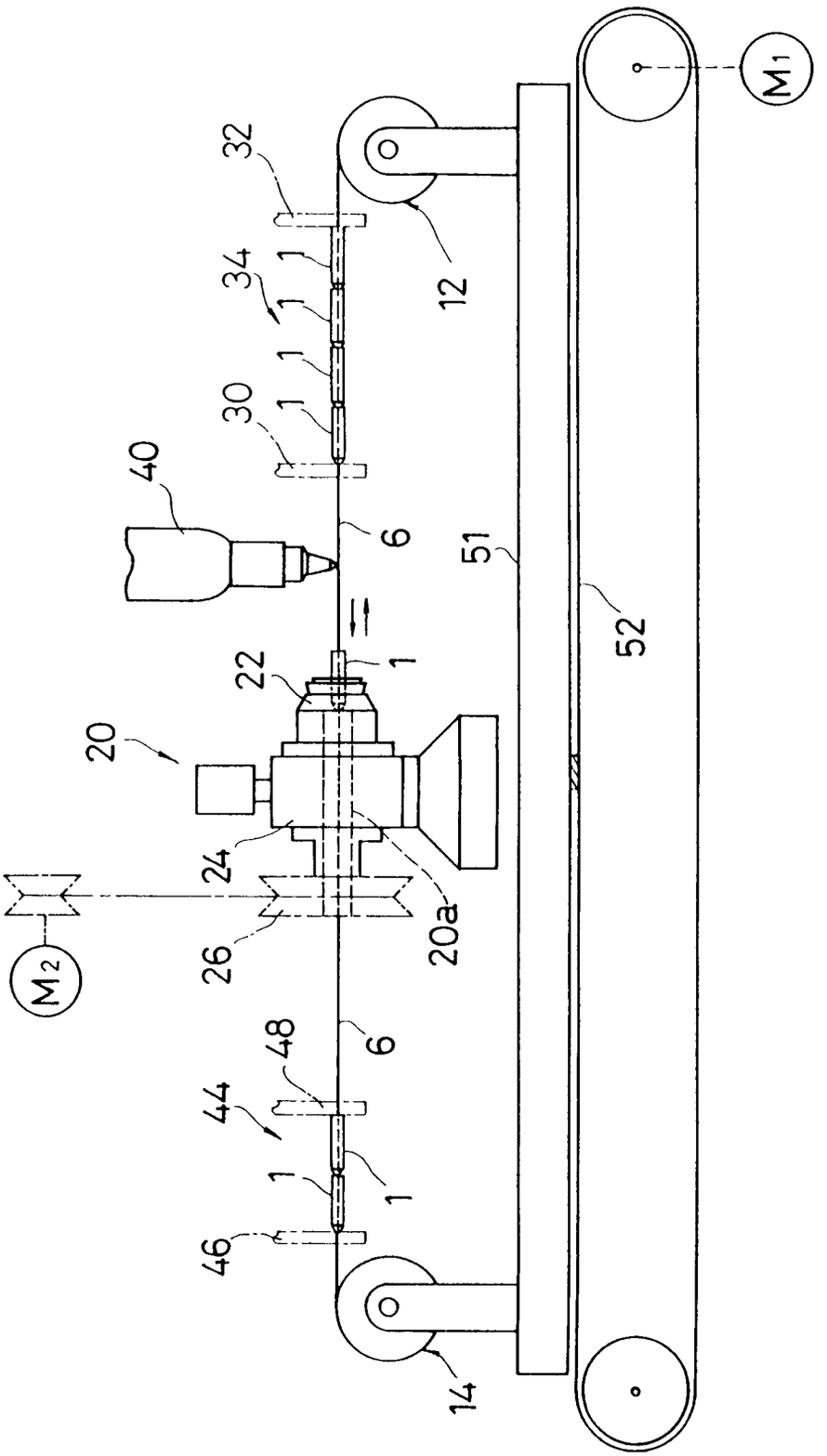


FIG.2(A)

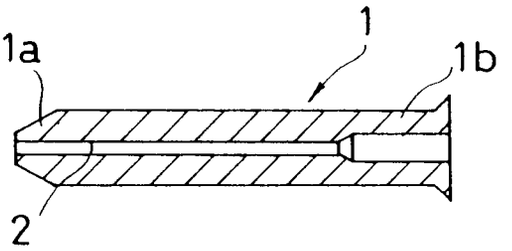


FIG.2(B)

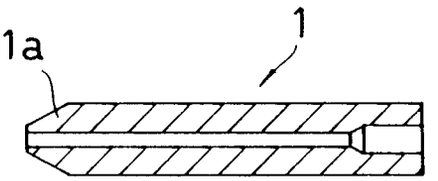


FIG.3(A)

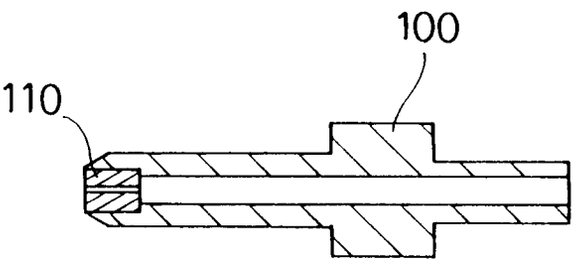


FIG.3(B)

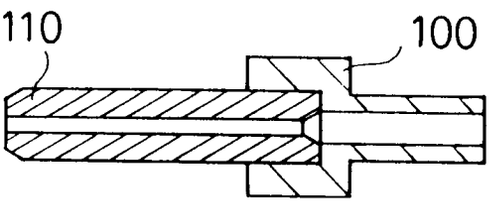


FIG.4(A)

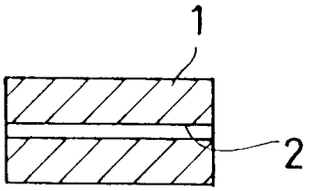


FIG.4(B)

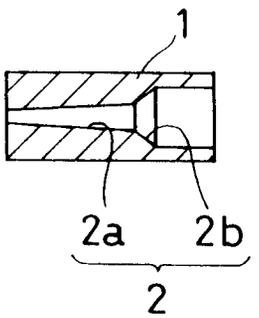
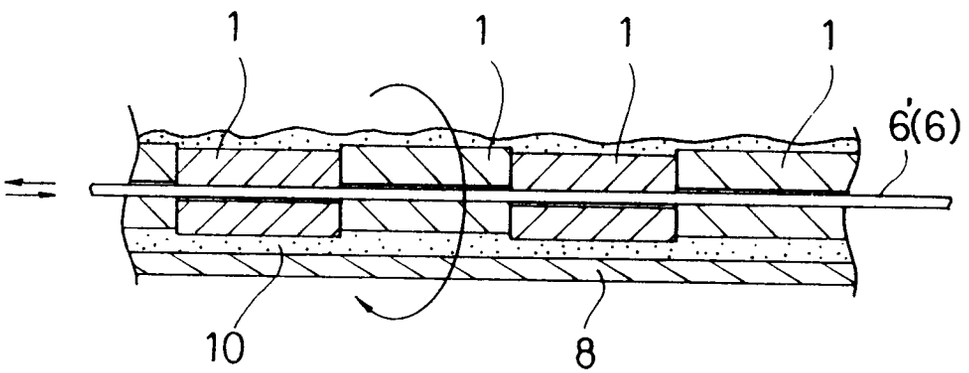


FIG.5



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EUROPEAN SEARCH REPORT

Application Number
EP 92 30 9644

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 135 (M-386)(1858) 11 June 1985 & JP-A-60 16 362 (KIYOSHI HAJIKANO) 28 January 1985 * abstract *	1	B24B1/04 B24B5/48 B24B37/02
A	CH-A-335 599 (GEBRÜDER PETER) * page 1, line 49 - line 71; figure 1 *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 8, no. 276 (M-346)(1713) 18 December 1984 & JP-A-59 146 753 (HITACHI SEISAKUSHO K.K.) 22 August 1984 * abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B24B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	11 FEBRUARY 1993	GARELLA M.G.C.D.

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