<table>
<tr><td rowspan="2">Patent Right</td><td>Date</td><td>November 16, 2022</td><td rowspan="2">Court</td><td rowspan="2">Intellectual Property High Court, Fourth Division</td></tr>
<tr><td>Case number</td><td>2021 (Gyo-Ke) 10140</td></tr>
<tr><td colspan="5">- A case in which, with regard to the invention defined in the form of a product-by-process claim, the court found an error in the JPO's determination that the invention satisfies the clarity requirement because there are circumstances where it was impossible or impractical to directly define the product by means of its structure or characteristics.</td></tr>
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Case type: Rescission of Trial Decision of Maintain

Result: Partially granted

References: Article 36, paragraph (6), item (ii) of the Patent Act

Related rights, etc.: Patent No. 3889689, Invalidation Trial No. 2019-800099

Summary of the Judgment

1. This case is a lawsuit to seek rescission of a decision made by the JPO (the "JPO Decision") to the effect that a request for a trial for invalidation of a patent relating to the invention titled "Electroformed tube manufacturing method and electroformed tube" (Patent No. 3889689) is groundless.

The major grounds for seeking rescission include the error in the determination on the violation of the clarity requirement and the error in the determination on the lack of an inventive step.

In this judgment, the court found that there is no error in the part of the JPO Decision that determined that Invention 1 (Claim 1) and Corrected Invention 5 (Claim 5) have an inventive step, but found that there is an error in the part of the JPO Decision that determined that Invention 6 (Claim 6) and Corrected Invention 9 (Claim 9) satisfy the clarity requirement. The court rescinded the latter part of the JPO Decision.

2. The claim of Invention 6, which is discussed in this summary, is described as follows. It is in the form of a product-by-process claim.

"An electroformed tube manufactured by forming an electrodeposit material or a surrounding material around a thin wire material that has, on an outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or a surrounding material, pulling the thin wire material from one end or both ends, deforming the material so as to reduce a sectional area thereof, and forming a clearance between the deformed thin wire material and the conductive layer, followed by pulling the deformed thin wire material and removing the deformed thin wire material while leaving the conductive layer inside the electrodeposit material or surrounding material, which is characterized in that:

the conductive layer has higher electric conductivity than the electrodeposit material or surrounding material, and

the inner shape of a hollow portion formed by removing the thin wire material has a circular sectional shape or a polygonal sectional shape, and the thickness of the electrodeposit material or surrounding material is 5 μm or more and 50 μm or less."

3. The JPO determined that Invention 6 satisfies the clarity requirement, for the reasons as summarized below.

"According to the statements of the description of the patent (the "Description"), the statement concerning the method of removing thin wire material, i.e., 'pulling the thin wire material from one end or both ends, deforming the material so as to reduce a sectional area thereof, and forming a clearance between the thin wire material and the electrodeposit material or a surrounding material, followed by gripping and pulling the thin wire material,' can be interpreted as describing the structure or characteristics wherein the electroformed tube has inner surface precision to a level where it can be used as, for example, a tube for a contact probe. It is impossible to assume how the structure or characteristics of the inner surface precision should be directly defined in order to express the structure or characteristics accurately, and it is not found that at the time of the filing of the patent application regarding the Invention, how to directly define such structure or characteristics accurately was not generally known. Therefore, it can be said that there were circumstances where it was impossible or utterly impractical to directly define the electroformed tube by means of its structure or characteristics. In that case, it cannot be said that the content of the invention is unclear due to the statement that defines the method of manufacturing the product in Invention 6."

4. In this judgment, the court ruled that Invention 6 does not satisfy the clarity requirement, for the following reason (the same applies to Corrected Invention 9). In the proceedings of the lawsuit to seek rescission of the JPO Decision, the Defendant (the patentee) admitted that there are no circumstances where it is impossible or impractical to directly define the product by means of its structure or characteristics.

"When a claim of a patent for an invention of a product recites the manufacturing process of the product, the recitation of the claim should be held to meet the requirement that the 'claimed invention is clear' as prescribed in Article 36, paragraph (6), item (ii) of the Patent Act, only if there are circumstances where it was impossible or utterly impractical to directly define the product subject to the invention by means of its structure or characteristics at the time of the filing of the application (2012 (Ju) 1204, judgment of the Second Petty Bench of the Supreme Court, June 5, 2015, Minshu Vol. 69, No. 4, at 700).

The basis for this view is as follows. When a claim of a patent for an invention of a product recites the manufacturing process of the product (product-by-process claim), the technical scope of the claimed invention is determined as being limited to products that have the same structure, characteristics, etc. as those of the product manufactured by the manufacturing process recited in the claim (the abovementioned Supreme Court judgment). It is generally unclear what structure or characteristics of the product are represented by the manufacturing process, or whether the technical scope of the claimed invention is limited to products manufactured by the manufacturing process, although the subject matter of the invention is the product, and this would prevent those who read the recitation of the claim, etc. from clearly understanding the content of the invention and make it impossible for them to predict the scope of the exclusive right to be conferred to the patentee, leading to unjustly harming the interests of third parties.

It then follows that, even in the case where the claim of a patent for an invention of a product recites the manufacturing process of the product, unlike the general case mentioned above, if the structure or characteristics of the product to be manufactured by that manufacturing process are unambiguously clear at the time of the filing of the application based on the statements of the claim, the description, and drawings, as well as common general technical knowledge, the interests of third parties would not be unjustly harmed; therefore, in such case, the claimed invention is not considered to be in violation of the clarity requirement even when there are no circumstances where it is impossible or impractical to directly define the product by means of its structure or characteristics."

"Needless to say, the inner surface precision of the electroformed tube manufactured by the manufacturing method of Invention 6 is not clear from what is recited in the claim, and the Description does not state or suggest anything about the inner surface precision of the electroformed tube manufactured by the manufacturing method of Invention 6.

As the method of removing the thin wire material, the Description states the following methods: [i] heating and thermally expanding the electrodeposit material, etc. or cooling and contracting the thin wire material, to thereby form a clearance between the electrodeposit material, etc. and the thin wire material; [ii] submerging the material into a liquid or applying the liquid to the material, whereby a place with which the thin wire material and the electrodeposit material, etc. are brought into contact is formed so as to easily slip; [iii] pulling the material from one end or both ends, deforming the material so as to reduce a sectional area thereof, and forming the clearance between the thin wire material and the electrodeposit material, etc., followed by gripping and pulling the material, sucking the material, physically pushing away the material, or blowing a gas or a liquid to push away the material; or [iv] melting the material with heat or a solvent. However, the Description contains no statement concerning the technical relationship between these methods and the inner surface precision of the electroformed tube to be manufactured, nor does it contain any statement or suggestion to the effect that the manufacturing method of Invention 6 (included in the method mentioned in [iii] above) signifies a specific inner surface precision that is different from that of an electroformed tube manufactured by other methods. It is also not found that there was common general technical knowledge as to whether the inner surface precision differs depending on the methods mentioned above.

Accordingly, it cannot be said that the structure or characteristics of the electroformed tube manufactured by the manufacturing method of Invention 6 are unambiguously clear."

"For the reasons stated above, Invention 6 can be considered to be clear only if there are circumstances where it was impossible or impractical to directly define the electroformed tube of Invention 6 by means of its structure or characteristics at the time of the filing of the application. The Defendant admits that there are no such circumstances."

Judgment rendered on November 16, 2022
2021 (Gyo-Ke) 10140 Case of seeking rescission of the JPO decision
Date of conclusion of oral argument: September 26, 2022

Judgment

Plaintiff: Nansin Co., Ltd.

Defendant: LuzCom, Inc.

Main text

1. The part related to Claim 6 and Claim 9 in the decision made by the Japan Patent Office (the "JPO") on October 18, 2021, for the case of Invalidation Trial No. 2019-800099, shall be rescinded.
2. The remaining claims of the Plaintiff shall be dismissed.
3. Court costs shall be divided into two parts and the Plaintiff shall bear one part of the costs and the Defendant shall bear the other part of the costs.

Facts and reasons

No. 1 Claim

The decision made by the JPO on October 18, 2021, for the case of Invalidation Trial No. 2019-800099, shall be rescinded.

No. 2 Outline of the case

This case is a lawsuit to seek rescission of a decision made by the JPO to the effect that a request for a trial for invalidation of a patent is groundless.

1. Outline of procedures at the JPO (There are no disputes between the parties.)

(1) On September 24, 2002, the Defendant filed a patent application (Patent Application No. 2002-278121; hereinafter referred to as the "Application") for an invention titled "Manufacturing method of electroformed tube and electroformed tube" and, on December 8, 2006, the Defendant obtained a registration establishing a patent right (Patent No. 3889689; the number of claims: 9; hereinafter the patent related to the registration is referred to as the "Patent").

On September 19, 2017, a request for a trial for correction concerning the Patent (Correction Trial No. 2017-390094) was filed and, on November 13, 2017, a trial decision to approve corrections of Claim 1 in the claims and [0011] in the description was made and the decision became final and binding around that time (hereinafter the correction is referred to as the "Prior-instance Correction").

(2) On November 21, 2019, the Plaintiff filed a request for a trial for invalidation with regard to Claims 1, 5, 6 and 9 of the Patent (Invalidation Trial No. 2019-800099).

On January 18, 2021, the JPO gave an advance notice of a trial decision to invalidate the patent with regard to the inventions pertaining to Claims 1, 5, 6 and 9 of the Patent. In response, the Defendant made a request for correction to correct the claims related to Claims 5 and 9 of the Patent on March 29, 2021 (hereinafter this correction is referred to as the "Correction").

The JPO rendered a trial decision on October 18, 2021 with the following conclusion: "Correction of the claims of Patent No. 3889689 regarding Claims 5 and 9 after correction as stated in the corrected claims attached to the correction request form shall be approved. The request for trial concerning the inventions pertaining to Claims 1, 5, 6, and 9 of Patent No. 3889689 is groundless" (hereinafter referred to as the "JPO Decision") and a certified copy of the decision was served to the Plaintiff on October 29, 2021.

(3) On November 22, 2021, the Plaintiff filed the present action to seek rescission of the JPO Decision.

2. Statement of the claims etc.

The statements of the claims for the inventions pertaining to Claims 1, 5, 6, and 9 of the Patent after the Prior-instance Correction (hereinafter referred to as "Invention 1" and the like in the order of the claim number) and the statements of the claims for the inventions pertaining to Claims 5 and 9 of the Patent after the Correction (hereinafter referred to as "Corrected Invention 5" and the like according to the claim number; and Inventions 1 and 6 and Corrected Inventions 5 and 9 are collectively referred to as the "Invention") are as stated below respectively. In addition, the descriptions and drawings attached to the written applications of the Application throughout the period before and after the Prior-instance Correction are simply referred to as the "Description."

(1) Invention 1

A manufacturing method of an electroformed tube, which is a method of manufacturing an electroformed tube by forming an electrodeposit material or a surrounding material by electroforming around a thin stainless steel wire material that has, on the outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or the surrounding material, and by removing the thin wire material while leaving the conductive layer on the inner surface of the electrodeposit material or the surrounding material, which is characterized by;

wherein the conductive layer is formed by electrolytic plating and has a higher electric conductivity than the electrodeposit material or the surrounding material; and

wherein the thin wire material is pulled from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and a clearance between the deformed thin wire material and the conductive layer is formed, and the deformed thin wire material is removed by holding and pulling it, and thereby an electroformed tube wherein a thickness of the electrodeposit material or the surrounding material is 50 μm or less is manufactured.

(2) Invention 5 and Corrected Invention 5

A. Invention 5

The manufacturing method of the electroformed tube as stated in Claim 1,

which is characterized by an electrodeposit material or a surrounding material made of nickel and a conductive layer made of gold.

B. Corrected Invention 5 (underlined parts are differences from Invention 1)

A manufacturing method of an electroformed tube, which is a method of manufacturing an electroformed tube by forming an electrodeposit material or a surrounding material by electroforming around a stainless-steel thin wire material that has, on the outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or the surrounding material, and by removing the thin wire material while leaving the conductive layer on the inner surface of the electrodeposit material or the surrounding material, and which is characterized by;

wherein the conductive layer is formed by electrolytic plating and has a higher electric conductivity than the electrodeposit material or the surrounding material;

wherein parts without the electrodeposit material or the surrounding material are formed at both ends of the thin wire material;

wherein the thin wire material is pulled from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and a clearance between the deformed thin wire material and the conductive layer is formed, and the deformed thin wire material is removed by holding and pulling it, and thereby an electroformed tube wherein a thickness of the electrodeposit material or the surrounding material is 50 μm or less is manufactured; and

wherein the electrodeposit material or the surrounding material is made of nickel and the conductive layer is made of gold.

(3) Invention 6

An electroformed tube manufactured by forming an electrodeposit material or a surrounding material by electroforming around a thin wire material that has, on the outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or a surrounding material, pulling the thin wire material from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and forming a clearance between the deformed thin wire material and the conductive layer, and by pulling the deformed thin wire material and removing the deformed thin wire material while leaving the conductive layer inside the electrodeposit material or the surrounding material, which is characterized by;

wherein the conductive layer has a higher electric conductivity than the electrodeposit material or the surrounding material; and

wherein the inner shape of a hollow part formed by removing the thin wire material has a circular cross-sectional shape or a polygonal cross-sectional shape, and the thickness of the electrodeposit material or the surrounding material is 5 µm or more and 50 µm or less.

(4) Invention 9 and Corrected Invention 9

A. Invention 9

The electroformed tube stated in Claim 6 or 7,
which is characterized by an electrodeposit material or a surrounding material made of nickel and a conductive layer made of gold.

B. Corrected Invention 9 (underlined parts are differences from Invention 6)

An electroformed tube manufactured by forming an electrodeposit material or a surrounding material by electroforming around a thin wire material that has, on the outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or the surrounding material, <u>forming parts without the electrodeposit material or the surrounding material at both ends of the thin wire material,</u> pulling the thin wire material from one end or both ends to deform the material so as to reduce a cross-sectional area thereof, and forming a clearance between the deformed thin wire material and the conductive layer, and by pulling the deformed thin wire material and removing the deformed thin wire material while leaving the conductive layer inside the electrodeposit material or the surrounding material, which is characterized by;

wherein the conductive layer has a higher electric conductivity than the electrodeposit material or the surrounding material; and

wherein the inner shape of a hollow part formed by removing the thin wire material has a circular cross-sectional shape or a polygonal cross-sectional shape, and the thickness of the electrodeposit material or the surrounding material is 5 µm or more and 50 µm or less<u>, and</u>

<u>wherein the electrodeposit material or the surrounding material is made of nickel and the conductive layer is made of gold.</u>

3. Summary of the grounds for the JPO Decision

The JPO Decision determined as follows: [i] the Correction is lawful since, out of the Correction, the corrected matters (hereinafter referred to as "corrected matter A") that integrated and sorted corrected matters related to corrected matter 1 (to establish Claim 5, which cited Claim 1 before, as an independent claim by dissolving the relationship of citation) and related to corrected matter 2 (to correct Claim 5 as stated in 2. (2) B. above) as stated in a correction request form dated March 29, 2021 (hereinafter referred to as the "Correction Request Form") and the corrected matters (hereinafter referred to as "corrected matter B") that integrated and sorted corrected matters related to corrected matter 3 (to establish Claim 9, which cited Claim 6 before, as an independent claim by dissolving the relationship of citation), related to corrected matter 4 (to delete Claim 9 before the correction, which cited Claim 7), and related to corrected matter 5 (to correct Claim 9 as stated in 2. (4) B. above) as stated in the Correction Request Form, are corrected matters that meet the correction requirements; [ii] since the detailed explanation of the invention in the Description is regarded to be stated clearly and fully, it does not violate enablement requirements; [iii] since the Invention is an invention where a means to solve problems is fully reflected, it is regarded to be stated in the detailed explanation of the invention; [iv] Invention 6 and Corrected Invention 9 are clearly stated; and [v] it cannot be considered that a person skilled in the art could have easily made the Invention based on the invention stated in Exhibit Ko 1 "Unexamined Patent Application Publication No. 2001-192882" (hereinafter referred to as "Exhibit Ko 1 Document") that was distributed in Japan before the Application was filed (hereinafter the process invention is referred to as "Exhibit Ko 1 Process Invention" and the product invention is referred to as "Exhibit Ko 1 Product Invention"), matters stated in Exhibit Ko 2 "Unexamined Patent Application Publication No. 2002-80991" (hereinafter referred to as "Exhibit Ko 2 Document") (hereinafter the matters are referred to as "Exhibit Ko 2 Technical Matters"), and common general technical knowledge at the time when the Application was filed.

The summary of the JPO Decision regarding each issue is as follows.

(1) Whether the Correction has legality

A. Corrected matter A

Limiting the operation in Invention 5 related to the citation of Invention 1 "wherein the thin wire material is pulled from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and a clearance between the deformed thin wire material and the conductive layer is formed, and the deformed thin wire material is removed by holding and pulling it" to the operation that is implemented after "parts without the electrodeposit material or the surrounding material are formed at both ends of the thin wire material" in advance, which is related to corrected matter A, is suggested in [0084] and [FIG. 6] in the Description; and a person skilled in the art can understand that the process "to arrange the form by providing machining to electrodeposit material 55 and partition component 88" ([0106]) includes the process to remove electrodeposit material 55 on the end and can understand the form to manufacture an electroformed tube by providing an electrodeposit material or a surrounding material by electroforming on both ends of a thin wire material and then removing it, and thereby forming parts without the electrodeposit material or the surrounding material on both ends of the thin wire material. Therefore, corrected matter A is not an addition of new matters and other correction requirements are met.

B. Corrected matter B

Limiting the operation in Invention 9 related to the citation of Invention 6 "pulling the thin wire material from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and forming a clearance between the deformed thin wire material and the conductive layer, and by pulling the deformed thin wire material and removing the deformed thin wire material while leaving the conductive layer inside the electrodeposit material or the surrounding material" to the operation that is implemented after "forming parts without the electrodeposit material or the surrounding material at both edges of the thin wire material" in advance, which is related to corrected matter B, is not an addition of new matters and other correction requirements are met, as stated in A. above.

(2) Whether there is a violation of the enablement requirements (Grounds for Invalidation 1)

The Invention is to deform a thin wire material by pulling it from one end or both ends so as to reduce a cross-sectional area thereof. The thin wire material subject to pulling contains [i] one that has parts without a conductive layer (parts where a thin wire material is exposed) on both of its ends and [ii] one that does not have parts without a conductive layer (the thin wire material that has no parts where the thin wire material is exposed); and there are cases a) where, on both ends of the thin wire material, a conductive layer is provided by electrolytic plating on the outer surface of the thin wire material; however, an electrodeposit material or a surrounding material is not provided by electroforming, and b) where on both ends of the thin wire material, a conductive layer is provided by electrolytic plating on the outer surface of the thin wire material and an electrodeposit material or a surrounding material is also provided by electroforming.

A. In the case of [i] above

Taking into account the statements in [0084] and [FIG. 6] in the Description, it is understood that when the part where a conductive layer is not provided on both ends is pulled, the thin wire material is pulled out and removed while leaving the conductive layer on the inner surface of the electrodeposit material or the surrounding material in the same way as in the Invention and the following effects are shown: it becomes difficult for the pull force to directly apply to the conductive layer, the conductive layer and base wire material can easily be separated, and it becomes difficult to destroy adhesion between the conductive layer and the electrodeposit material.

B. In the case of [ii] a) above

On the assumption of using a stainless-steel thin wire material and a gold-plated conductive layer, when a thin wire material on which a conductive layer is provided by electrolytic plating on the outer surface to both ends is pulled, the fragile (gold-plated) conductive layer breaks. On the other hand, stainless-steel thin wire material is strong, and its surface is covered with a passive film, but adhesion with the conductive layer is not strong. Therefore, the thin wire material deforms so as to reduce the cross-sectional area thereof when it is pulled and a clearance is formed between the deformed thin wire material and the conductive layer. Accordingly, the thin wire material can be pulled out and removed while leaving the conductive layer on the inner surface of the electrodeposit material or the surrounding material (Exhibit Ko 47).

C. In the case of [ii] b) above

A person skilled in the art can work the following process within the range of his/her creativity and ingenuity to the extent where it is normally expected without performing excessive trial and error: after removing or breaking an electrodeposit material or a surrounding material on both ends, the thin wire material is deformed by holding and pulling both of its ends so as to reduce a cross-sectional area of the thin wire material and then the thin wire material is pulled and removed (Exhibits Ko 21 through 23 and 50 through 52).

(3) Whether there is a violation of the support requirements (Grounds for Invalidation 2)

A. Invention 1 and Corrected Invention 5

The problem to be solved by Invention 1 and Corrected Invention 5 is regarded as providing a method of easily manufacturing tubes for contact probes, etc., and other electroformed tubes with a fine inner diameter that can be used as a component suitable for conducting the electricity (the first problem) ([0003], [0006], [0008], and [0045] in the Description).

In order to solve the first problem, the following two are required: [i] an electroformed tube wherein a conductive layer is provided on its inner surface is manufactured ([0045]; hereinafter referred to as the "structural requirement (manufacturing process) of an electroformed tube") and [ii] the thin wire material "is pulled from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and a clearance between the deformed thin wire material and the conductive layer is formed," and then "removing" the thin wire material "by holding and pulling" it ([0041] and [0042]; hereinafter referred to as the "removal requirement (manufacturing process) of a thin wire material"). Invention 1 and Corrected Invention 5 satisfy these two requirements and the means for solving the first problem is fully reflected therein.

B. Invention 6 and Corrected Invention 9

The problem to be solved by Invention 6 and Corrected Invention 9 is regarded as providing a method of manufacturing tubes for contact probes, etc., and other electroformed tubes with a fine inner diameter that can be used as a component suitable for conducting the electricity (the second problem) ([0003], [0006], [0008], and [0045] in the Description).

In order to solve the second problem, the following two are required: [iii] it is an electroformed tube wherein a conductive layer is provided on its inner surface so that "electric conductivity is higher than in the case of an electrodeposit material or surrounding material alone depending on the material of the conductive layer" ([0045]; hereinafter referred to as the "structural requirement (product) of an electroformed tube") and [iv] it is a structure that is manufactured by "pulling the thin wire material from one end or both ends to deform the material so as to reduce a cross-sectional area thereof, and forming a clearance between the thin wire material and the electrodeposit material or the surrounding material," and "by holding and pulling" it ([0041] and [0042]; hereinafter referred to as the "removal requirement (product) of a thin wire material"). Invention 6 and Corrected Invention 9 satisfy these two requirements and the means for solving the second problem is fully reflected therein.

(4) Whether there is a violation of the clarity requirements (Grounds for Invalidation 3)

In the past, in cases of creating a tube with a fine inner diameter by electroforming a thin wire material, it was not easy to remove the thin wire material. However, it is understood that when using the pulling out method where "pulling the thin wire material from one end or both ends to deform the material so as to reduce a cross-sectional area thereof, and forming a clearance between the thin wire material and the electrodeposit material or the surrounding material, and holding and pulling it" (3. in [0041] in the

Description), which corresponds to the method stated in claims of Invention 6 and Corrected Invention 9, the thin wire material can be removed easily and an electroformed tube with a fine inner diameter, which can be used as a tube, etc. for contact probes, can be manufactured ([0005], [0006], [0041], and [0042] in the Description).

According to the statements in the Description, it can be interpreted that the statement related to the pulling out method of the thin wire material indicates the structure or characteristics of a fine tube manufactured by electroforming that a thin wire material is appropriately removed and an electroformed tube has an inner surface precision to a level where it can be used, for example, as a tube for a contact probe.

It is impossible to assume how to directly define the structure or characteristics of the inner surface precision, which is achieved through the specification of the manufacturing method of the products of Invention 6 and Corrected Invention 9, in order to express the relevant structure or characteristics accurately, and it is not found that how to directly define this structure or characteristics accurately was generally known at the time of filing of an application for the Invention. Therefore, it can be said that there were circumstances where it was impossible or utterly impractical to define the electroformed tube directly by means of its structure or characteristics.

In that case, it cannot be said that the statements that specify the manufacturing method of the products of Invention 6 and Corrected Invention 9 make the content of said inventions unclear.

(5) Whether there is a lack of an inventive step (Grounds for Invalidation 4)

A. Finding of Exhibit Ko 1 Process Invention and Exhibit Ko 1 Product Invention

(A) Exhibit Ko 1 Process Invention

A manufacturing method of ferrules by providing 10 μm gold-plating (resistivity: 2.05×10^{-6} Ωcm) to a stainless-steel wire with a circular cross-sectional shape, a diameter of 0.126 mm, and a length of 355 mm; obtaining a core wire with a diameter of 0.136 mm; setting the core wire on an electroforming jig; setting a nickel metal plate in an electroforming bath, of which the main ingredient is nickel sulfamate; dipping the metal plate in the electroforming bath; setting the core wire as a cathode and the nickel plate as an anode; providing electroforming at the current density of approximately 10 A/dm^2 for 18 hours; and obtaining a nickel electroformed product with a diameter of approximately 2.5 mm in average; and

cutting the electroformed product to a length of 12 mm by NC automatic processing machine; boring one end; setting the processed product vertically by facing the non-bored surface up; hitting the core wire with a hammer that has a projection from the top in the wire punching machine; pulling part of the core wire that projects from beneath the processed product; and thereby removing the core wire and grinding the end surface.

(b) Exhibit Ko 1 Product Invention

A ferrule that is manufactured by providing 10 μm gold-plating (resistivity: 2.05×10^{-6} Ωcm) to a stainless-steel wire with a circular cross-sectional shape, a diameter of 0.126 mm, and a length of 355 mm; obtaining a core wire with a diameter of 0.136 mm; setting the core wire on an electroforming jig; setting a nickel metal plate in an electroforming bath, of which the main ingredient is nickel sulfamate; dipping the metal plate in the electroforming bath; setting the core wire as a cathode and the nickel plate as an anode; providing electroforming at the current density of approximately 10 A/dm^2 for 18 hours; and obtaining a nickel electroformed product with a diameter of approximately 2.5 mm in average; and

cutting the electroformed product to a length of 12 mm by NC automatic processing machine; boring one end; setting the processed product vertically by facing the non-bored surface up; hitting the core wire with a hammer that has a projection from the top in the wire punching machine; pulling part of the core wire that projects from beneath the processed product; and thereby removing the core wire and grinding the end surface.

B. Differences between Invention 1 and Exhibit Ko 1 Process Invention

(A) Difference 1

Invention 1 is for "removing the thin wire material while leaving the conductive layer on the inner surface of the electrodeposit material or the surrounding material." However, Exhibit Ko 1 Process Invention is not clear whether "a conductive layer" is left "on the inner surface of the electrodeposit material or the surrounding material" when "removing the thin wire material."

(B) Difference 2

Concerning the plating method of "a conductive layer," Invention 1 is "electrolytic plating," while Exhibit Ko 1 Process Method does not specify the plating method.

(C) Difference 3

Concerning the removal method of the "thin wire material," in Invention 1, "the thin wire material is pulled from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and a clearance between the deformed thin wire material and the conductive layer is formed, and the deformed thin wire material is removed by holding and pulling it," while Exhibit Ko 1 Process Invention explains as "cutting the electroformed product to a length of 12 mm by NC automatic processing machine; boring one end; setting the processed product vertically by facing the non-bored surface up; hitting the core wire with a hammer that has a projection from the top in the wire punching machine; pulling part of the core wire that projects from beneath the processed product; and thereby removing the core wire."

(D) Difference 4

Concerning the "thickness" of "the electrodeposit material or the surrounding material," in Invention 1, "a thickness of the electrodeposit material or the surrounding material is 50 µm or less," while in Exhibit Ko 1 Process Invention, "thickness" of "an electroformed tube" is approximately 1.182 mm (1182 µm) or approximately 1.187 mm (1187 µm) (in "Difference 4" in the JPO Decision, it is found that "in Invention 1, 'the thickness of the electrodeposit material or the surrounding material is 5 µm or more and 50 µm or less'" and "5 µm or more" is added; however, this is found to be a misdescription (there is no dispute between the parties)).

C. Whether Difference 4 could have been easily conceived of by a person skilled in the art

A ferrule for optical fiber connection, which is the subject of manufacturing in Exhibit Ko 1 Process Invention, is generally a microporous pipe with a diameter of approximately 0.126 mm, an outer diameter of 2.5 mm, and a length of approximately 12 mm ([0002] in Exhibit Ko 1). Based on the dimensions stated, a regular thickness is found to be approximately 1187 µm. The optical connector is to facilitate connection by putting an optical fiber, which has a diameter of approximately 0.125 mm and is thin and easy to break, through a cylindrical tube to secure it and by accurately aligning the positions of cores that are at the center of the optical fiber. A ferrule is an optical connector's component for surely securing the optical fiber on the connector for the connection ([0003]in Exhibit Ko 1). Therefore, it is obvious that the ferrule requires sufficient strength.

On the other hand, the extremely thin thickness of an electroformed tube, which is 50 µm or less, in Invention 1 may not obtain sufficient strength. It does not generate a motivation to determine the thickness of a ferrule that is manufactured under Exhibit Ko 1 Process Invention to be 50 µm or less and it is even a precluding factor from the perspective of insufficient strength.

Therefore, a person skilled in the art could not have easily conceived of the structure of Invention 1 related to Difference 4.

D. Summary on Invention 1

Given the above, without the need to make determinations on Differences 1 through 3, Invention 1 could not have been easily conceived of by a person skilled in the art based on Exhibit Ko 1 Process Invention and common general technical knowledge.

E. Invention 6

(A) Invention 6 and Exhibit Ko 1 Product Invention are different in Differences 5 and 6, which are the same purport as Differences 3 and 1 in B. above respectively, and are different in Difference 7 below.

(Difference 7)

Concerning the "thickness" of "the electrodeposit material or the surrounding material," in Invention 6, "the thickness of the electrodeposit material or the surrounding material is 5 μm or more and 50 μm or less," while in Exhibit Ko 1 Product Invention, the "thickness" of an "electroformed tube" is approximately 1.182 mm (1182 μm) or approximately 1.187 mm (1187 μm).

(B) Difference 7 is the same difference as Difference 4. Difference 4 could not have been easily conceived of by a person skilled in the art, as stated in C. above. Given the above, Invention 6 could not have been easily made by a person skilled in the art based on Exhibit Ko 1 Product Invention and common general technical knowledge.

F. Corrected Invention 5

(A) Corrected Invention 5 and Exhibit Ko 1 Process Invention are different in Differences 1, 2, and 4 as stated in B. above and are also different in Difference 3' below.

(Difference 3')

Concerning the removal method of the "thin wire material," in Corrected Invention 5, "parts without the electrodeposit material or the surrounding material are formed at both ends of the thin wire material," and "the thin wire material is pulled from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and a clearance between the deformed thin wire material and the conductive layer is formed, and the deformed thin wire material is removed by holding and pulling it," while Exhibit Ko 1 Process Invention explains as "cutting the electroformed product to a length of 12 mm by NC automatic processing machine; boring one end; setting the processed product vertically by facing the non-bored surface up; hitting the core wire with a hammer that has a projection from the top in the wire punching machine; pulling part of the core wire that projects from beneath the processed product; and thereby removing the core wire."

(B) As stated in C. above, Difference 4 could not have been easily conceived of by a person skilled in the art. Given the above, Corrected Invention 5 could not have been easily made by a person skilled in the art based on Exhibit Ko 1 Process Invention and common general technical knowledge, etc.

G. Corrected Invention 9

(A) Corrected Invention 9 and Exhibit Ko 1 Product Invention are different in Differences 6 and 7 as stated in E. above and also different in Difference 5' below.

(Difference 5')

Concerning the removal method of the "thin wire material," Corrected Invention 9 explains as "forming parts without the electrodeposit material or the surrounding material at both ends of the thin wire material, pulling the thin wire material from one end or both ends to deform the material so as to reduce a cross-sectional area thereof, and forming a clearance between the deformed thin wire material and the conductive layer, and by pulling the deformed thin wire material," while Exhibit Ko 1 Process Invention explains as "cutting the electroformed product to a length of 12 mm by NC automatic processing machine; boring one end; setting the processed product vertically by facing the non-bored surface up; hitting the core wire with a hammer that has a projection from the top in the wire punching machine; pulling part of the core wire that projects from beneath the processed product."

(B) As stated in E. above, Difference 7 could not have been easily conceived of by a person skilled in the art. Given the above, Corrected Invention 9 could not have been easily made by a person skilled in the art based on Exhibit Ko 1 Product Invention and common general technical knowledge, etc.

4. Grounds for rescission

(1) Error in the determination concerning the correction requirements (Grounds for Rescission 1)

(2) Error in the determination concerning the violation of the enablement requirements (Grounds for Invalidation 1) (Grounds for Rescission 2)

(3) Error in the determination concerning the violation of the support requirements (Grounds for Invalidation 2) (Grounds for Rescission 3)

(4) Error in the determination concerning lack of an inventive step (Grounds for Invalidation 4) (Grounds for Rescission 4)

(5) Error in the determination concerning the violation of the clarity requirements (Grounds for Invalidation 3) (Grounds for Rescission 5)

(omitted)

No. 4 Judgment of this court

1. Invention

The Description (Exhibit Ko 95) contains statements as described in Attachment 1 "Matters stated in the Description (extract)." According to these statements, the following matters are found to be disclosed with regard to the Invention.

(1) Technical field

The Invention is related to the manufacturing method of an electroformed tube with a fine inner diameter and the electroformed tube ([0001]).

(2) Prior art and its problems

In a probe device to inspect the electric continuity of electrodes, in order to respond to the latest integrated circuits, it is required to increase the number of contact probes (increasing the number of pins), to reduce wire diameter (thinning the wire), and to reduce the interval between the contact probes (narrowing the pitch). Tubes for current contact probes have an outer diameter of 110 μm and an inner diameter of 88 μm, which is the smallest in the world, but additional reduction in size is required ([0003]).

Based on electroforming technology, a metal film of 5 μm at a minimum may be deposited on the outer surface of a thin wire material for which the hollow part is circular in cross-section and the diameter is 10 μm to 85 μm; however, it is not easy to remove the thin wire material from electrodeposited metal since the electrodeposited metal adheres to the outer surface of the thin wire material ([0006]).

Therefore, the present invention aims to provide a manufacturing method of an electroformed tube with a fine inner diameter and the electroformed tube ([0008]).

(3) Means of solving problems

In order to achieve the aim as stated in (2) above, the Invention adopted the structure stated in Claims 1, 5, 6, and 9.

(4) Functions and effects

A. By pulling a thin wire material from one end or both ends to deform the material so as to reduce a cross-sectional area thereof and forming a clearance between the thin wire material and the electrodeposit material formed by electroforming, and thereby removing the thin wire material by holding and pulling it from the electrodeposit material, etc., for example, even from the electrodeposit material, etc. that is formed on the outer surface of the thin wire with a diameter from 10 μm to 85 μm so that the electrodeposit material, etc. has a thickness of 5 μm or more and 50 μm or less, the thin wire material can be removed, and an electroformed tube with a fine inner diameter can be manufactured ([0041], [0042], and [0116]).

B. If an electroformed tube is manufactured by increasing the volume of electrodeposit material, etc. on the end side that is formed on a thin wire material, when removing the thin wire material by pulling it out from or pushing it away from the electrodeposit material, etc., jig or tool, etc. can be get caught on the end surface of the part where the amount of electrodeposit material, etc. was increased, and therefore, the thin wire material can be easily removed ([0043] and [0117]).

C. If the deformation amount of lateral strain when a thin wire material is extended by pulling it outward is arranged to be 5% or more of the cross-sectional area, a sufficient clearance is formed for removing the thin wire material between the thin wire material and the electrodeposit material, etc. Therefore, it is highly possible that the thin wire material can be removed from the electrodeposit material, etc. without any difficulties ([0044] and [0118]).

D. If a thin wire material where a conductive layer is provided on the outer surface is used and the thin wire material is removed so that the conductive layer remains on the inner surface of an electroformed tube, an electroformed tube provided with gold-plating, etc. on the inner surface can be manufactured and the electric conductivity can be made higher than in the case of the electrodeposit material, etc. alone depending on the material of the conductive layer provided on the inner surface of the electroformed tube. Therefore, it can be used as a component that is suitable for conducting the electricity ([0045] and [0119]).

E. A product with multiple pieces of hollow parts that are formed by removing a thin wire material can be used by replacing it with a component that was manufactured by aligning multiple tubes that have only one hollow part ([0047] and [0121]).

F. Concerning a thin wire material with a part where a conductive layer is not provided on both ends, if the part where the conductive layer is not provided is pulled outward, it becomes difficult for the pull force to directly apply to the conductive layer, the conductive layer and the base wire material can be easily separated, and it becomes difficult to destroy the adhesion between the conductive layer and the electrodeposit material, etc. ([0049] and [0123]).

(5) Embodiment of the invention

A. An electroformed tube that has a fine inner diameter (hollow part) and can be used as a tube, etc. for contact probes is manufactured by electroforming a thin wire material using an electroforming device, pulling the thin wire material from one end or both ends so as to reduce a cross-sectional area thereof and forming a clearance between the electrodeposit material and the thin wire material, and removing the thin wire material by holding and pulling it ([0050] through [0070], [0073], [0075], and [FIG. 1]).

B. If a large diameter part, where the outer diameter is large, is formed at one end of the electrodeposit material, a jig or tool can get caught on the end surface of the large diameter part, and therefore, the thin wire material can be easily removed ([0076] and [FIG. 2]).

C. A thin wire material can be used if it has an outer diameter of 10 μm or more and 85 μm or less. When nearly 1,500 N/mm^2 of pull force is applied, it is only necessary that the deformation amount of lateral strain is 5% or more of the cross-sectional area

([0078] and [0079]). In addition, if it is possible to electrodeposit around the thin wire material so that it has a thickness of at least nearly 5 μm or more, an electroformed tube can be formed even after the thin wire material is removed ([0080]).

D. A thin wire material, of which the core part is made of metal or synthetic resin, etc. and on the outer surface of which a conductive layer (for example, gold-plating) is provided, can be used. In this case, an electroformed tube provided with a conductive layer on its inner peripheral surface can be formed by removing only the thin wire material while leaving the conductive layer on the inner peripheral surface of the electrodeposit material ([0081]). Since the aforementioned electroformed tube has good electric conductivity, it can be used as a component that is suitable for conducting the electricity, such as a tube, etc. for contact probes ([0082]).

In cases of removing a thin wire material provided with a conductive layer on its outer periphery from deposited metal by deforming the thin wire material so as to reduce a cross-sectional area thereof, by forming a part where the conductive layer is not provided (masked part) on both ends of the thin wire material and pulling said part, it becomes difficult for the pull force to directly apply to the conductive layer, the conductive layer and the base wire material can be easily separated, and it becomes difficult to destroy the adhesion between the conductive layer and electrodeposit material ([0084] and [FIG. 6]).

E. An electroformed tube that has multiple pieces of hollow parts can be manufactured by using a jig that can provide multiple thin wire materials in a tensioned state ([0085] through [0107] and [FIG. 7] through [FIG. 9]).

2. Whether there are Grounds for Rescission 1 (Error in the determination related to the correction requirements)

(1) Corrections in Inventions 5 and 9

The Correction includes a correction by adding the matter "wherein parts without the electrodeposit material or the surrounding material are formed at both ends of the thin wire material" (corrected matter 2 that constitutes corrected matter A and corrected matter 5 that constitutes corrected matter B) concerning Inventions 5 and 9.

The Description has the following statements: as a thin wire material, a thin wire material provided with a conductive layer on its outer peripheral surface can be used; for example, if an electrodeposit material is formed on a thin wire material that is provided with gold-plating on its outer peripheral surface, an electroformed tube provided with gold-plating on its inner peripheral surface is formed by removing the thin wire material alone by leaving the gold-plating on the inner peripheral surface of the electrodeposit material ([0081] and [FIG. 4]); and in cases of removing a thin wire material provided with a conductive layer (for example, gold-plating) on its outer peripheral surface by deforming the thin wire material so as to reduce a cross-sectional area thereof, it is preferred to form a part where the conductive layer is not provided (masked part) on both ends of the thin wire material and to pull said part where the conductive layer is not provided, and thereby it becomes difficult for the pull force to directly apply to the conductive layer, the conductive layer and the base wire material can be easily separated, and it becomes difficult to destroy the adhesion between the conductive layer and electrodeposit material ([0084] and [FIG. 6]).

In addition, referring to [FIG. 6], the thin wire material is exposed at both ends of the thin wire material and the part where both the conductive layer and the electrodeposit material, etc. are not provided, in other words, a part where electrodeposit material, etc. is not provided at both ends of the thin wire material is formed.

As described above, it can be said that the Description is found to make statements concerning corrected matter 1 and the correction by adding corrected matter 1 is made within the matters stated in the Description.

(2) The Plaintiff's allegation

As stated in No. 3, 1. (1) above, the Plaintiff alleged as follows: in order for corrected matter 1 not to fall under the addition of a new matter, both of the following methods must be disclosed in the Description: [i] a method of providing masking to a thin wire material so that electrodeposit material, etc. is not formed on both ends of the thin wire material from the beginning; and [ii] a method of forming electrodeposit material, etc. on the thin wire material once and then removing the electrodeposit material, etc. that was formed at both ends of the thin wire material ex-post facto; however, at least method [ii] was not disclosed; and therefore, the correction by adding corrected matter 1 falls under the addition of a new matter.

However, as stated in (1) above, the Description stated that thin wire material can be easily removed by exposing the thin wire material at the end thereof. In addition, Exhibit Ko 50 Document, which was issued in 1968, stated that a pipeline with a diameter of 1 mm or less is manufactured by electroforming. In concrete terms, the following method is stated: after providing nickel-plating to a copper wire, the nickel is removed from the end of the copper wire; the copper wire is gradually extended; after the copper breaks, the broken pieces of the copper wire are removed, and thereby a nickel pipeline is manufactured. In addition, there are multiple publicly known documents issued around 2001 concerning a method of removing the coating from coated thin wire material (Exhibit Ko 21 Document and Exhibits Ko 22, 23, and 51).

Therefore, concerning the specific method of removing electrodeposit material, etc. and exposing thin wire material, it is found to be sufficient to use these methods that have been used conventionally or other appropriate method. Therefore, the addition of corrected matter 1, including the method [ii] above, is not seen as the addition of a new matter.

Accordingly, the Plaintiff's allegation above is unacceptable.

(3) Summary

As described above, Grounds for Rescission 1 are groundless.

3. Grounds for Rescission 5 (Error in the determination related to the violation of the clarity requirements)

Grounds for Rescission 5 are examined based on the case below.

(1) Criteria

When a claim of a patent for an invention of a product states the manufacturing process of the product, the statement of the claim should be held to meet the requirements that the 'claimed invention is clear' as prescribed in Article 36, paragraph (6), item (ii) of the Patent Act, only if there are circumstances where it was impossible or utterly impractical to directly define the product subject to the invention by means of its structure or characteristics at the time of the filing of the application (2012 (Ju) 1204, judgment of the Second Petty Bench of the Supreme Court, June 5, 2015, Minshu Vol. 69, No. 4, at 700).

The basis for this view is as follows. When a claim of a patent for an invention of a product states the manufacturing process of the product (product-by-process claim), the technical scope of the claimed invention is determined as being limited to products that have the same structure, characteristics, etc. as those of the product manufactured by the manufacturing process stated in the claim (the aforementioned Supreme Court judgment). It is generally unclear what structure or characteristics of the product are represented by the manufacturing process, or whether the technical scope of the claimed invention is limited to products manufactured by the manufacturing process, although the subject matter of the invention is the product, and this would prevent those who read the statement of the claim, etc. from clearly understanding the content of the invention and make it impossible for them to predict the scope of the exclusive right to be conferred to the patentee, leading to unjustly harming the interests of third parties.

It then follows that, even in the case where the claim of a patent for an invention of a product states the manufacturing process of the product, unlike the general case mentioned above, if the structure or characteristics of the product to be manufactured by that manufacturing process are unambiguously clear at the time of the filing of the application based on the statements of the claim, the description, and drawings, as well as common general technical knowledge, the interests of third parties would not be unjustly harmed; therefore, in such case, the claimed invention is not considered to be in violation of the clarity requirements even when there are no circumstances where it is impossible or impractical to directly define the product by means of its structure or characteristics.

(2) Examination

A. Invention 6 and Corrected Invention 9 are inventions related to "an electroformed tube." Invention 6 is specified by the manufacturing method of being "manufactured by forming an electrodeposit material or a surrounding material by electroforming around a thin wire material that has, on the outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or the surrounding material, pulling the thin wire material from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and forming a clearance between the deformed thin wire material and the conductive layer, and by pulling the deformed thin wire material and removing the deformed thin wire material while leaving the conductive layer inside the electrodeposit material or the surrounding material." And Corrected Invention 9 includes a specification by the manufacturing method of being "manufactured by forming an electrodeposit material or a surrounding material by electroforming around a thin wire material that has, on the outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or the surrounding material, forming parts without the electrodeposit material or the surrounding material at both ends of the thin wire material, pulling the thin wire material from one end or both ends to deform the material so as to reduce a cross-sectional area thereof, and forming a clearance between the deformed thin wire material and the conductive layer, and by pulling the deformed thin wire material and removing the deformed thin wire material while leaving the conductive layer inside the electrodeposit material or the surrounding material."

B. Then, whether the structure or characteristics of an electroformed tube that is manufactured by the manufacturing method of Invention 6 and Corrected Invention 9, in concrete terms, whether the inner surface precision of an electroformed tube alleged by the Defendant is unambiguously defined or not is examined below.

First, needless to say, the inner surface precision of the electroformed tube manufactured by the manufacturing method of Invention 6 and Corrected Invention 9 is not clear from what is stated in the claim, and the Description does not state or suggest anything about the inner surface precision of the electroformed tube manufactured by the manufacturing method of Invention 6 and Corrected Invention 9.

As the method of removing the thin wire material, the Description states the following methods: [i] heating and thermally expanding the electrodeposit material, etc. or cooling and contracting the thin wire material to form a clearance between the electrodeposit material, etc. and the thin wire material; [ii] submerging the material into a liquid or applying a liquid to the material, thereby making the place where the thin wire material and the electrodeposit material, etc. are brought into contact slippery; [iii] pulling the material from one end or both ends, deforming the material so as to reduce a cross-sectional area thereof, and forming the clearance between the thin wire material and the electrodeposit material, etc., followed by holding and pulling the material, sucking the material, physically pushing away the material, or blowing a gas or a liquid to push away the material; or [iv] melting the material with heat or a solvent ([0041] and [0116]). However, there is no statement of the technical relationship between the aforementioned method and the inner surface precision of the manufactured electroformed tube. Furthermore, there is no statement or suggestion that the manufacturing method as stated in Invention 6 and Corrected Invention 9 (included in method [iii] above) means a specific inner surface precision that is different from that of the electroformed tube manufactured by other methods. It is also not found that there was common general technical knowledge as to whether the inner surface precision differs depending on the methods mentioned above.

Accordingly, it cannot be said that the structure or characteristics of the electroformed tube manufactured by the manufacturing method of Invention 6 and Corrected Invention 9 are unambiguously clear.

C. For the reasons stated above, Invention 6 and Corrected Invention 9 can be considered to be clear only if there are circumstances where it was impossible or impractical to directly define the electroformed tube of Invention 6 and Corrected Invention 9 by means of its structure or characteristics at the time when the Application was filed. The Defendant admits that there are no such circumstances.

(3) Allegation of the Defendant

As stated in No. 3, 5. (2) B. above, the Defendant alleged as follows: the structure or characteristics of an electroformed tube that is manufactured by the manufacturing method of Inventions 5 and 9 can be understood from the statement in the Description in that "a sufficient clearance is formed for removing the thin wire material between the thin wire material and the electrodeposit material, etc., and therefore, it is highly possible that the thin wire material can be removed from the electrodeposit material, etc. without any difficulties" ([0044]); and in consideration of the statements in the documents (Exhibits Ko 1 and 2) and the content of the Test Production and Analysis Report (Exhibit Ko 29), it is unambiguously obvious, based on the statements in the claims and the Description, that the relevant tube shows the structure or characteristics that the electroformed tube has good inner surface precision.

However, based on the statements of the Description [0044] as pointed out by the Defendant, it can only be understood that if a sufficient clearance is formed for removing the thin wire material between the thin wire material and the electrodeposit material, etc., it is highly possible that the thin wire material can be removed from the electrodeposit material, etc. without any difficulties; however, it is impossible to understand to the extent that the electroformed tube manufactured by the manufacturing method of Invention 6 and Corrected Invention 9 shows the structure or characteristics of an electroformed tube having good inner surface precision. In addition, the statements in Exhibit Ko 1 Document and Exhibit Ko 2 Document as alleged by the Defendant only state the difficulty of manufacturing, but not the inner surface precision. The analysis results in the Test Production and Analysis Report (Exhibit Ko 29) do not indicate the common general technical knowledge at the time when the Application was filed; and, it was not revealed at all that the content stated in said report was the common general technical knowledge at the time when the Application was filed.

Given the above, it cannot be said to be unambiguously clear based on the claims, statements in the Description, and common general technical knowledge that the electroformed tube that is manufactured by the manufacturing method of Inventions 6 and 9 expresses the structure or characteristics of the electroformed tube with good inner surface precision.

Accordingly, the Defendant's allegation above is unacceptable.

(4) Summary

As described above, it cannot be said that Invention 6 and Corrected Invention 9 are clearly defined and the Grounds for Rescission 5 are well-founded.

4. Whether there are Grounds for Rescission 2 (Error in the determination related to the violation of enablement requirements)

(1) Examination

As stated in 3. above, since Invention 6 and Corrected Invention 9 do not fulfill the clarity requirements and are invalid, Invention 1 and Corrected Invention 5 alone are examined below (the same applies in 5. and 6. below.)

Concerning the manufacturing method of an electroformed tube, the detailed explanation of the invention in the Description states that after electroforming a thin wire material using an electroforming device, deforming the thin wire material by pulling it from one end or both ends so as to reduce a cross-sectional area thereof, forming a clearance between an electrodeposit material and the thin wire material, and then removing the thin wire material by holding and pulling it, etc. ([0061] through [0114], [FIG. 1], [FIG. 6] through [FIG. 9]).

Furthermore, the following statements and figures are indicated or shown: if the method of forming a large diameter part where the outer diameter is large is formed at one end of an electrodeposit material and pulling the thin wire material, etc. is used, the thin wire material can be easily removed ([0076] and [FIG. 2]); when nearly 1,500 N/mm^2 of pull force is applied outward on the thin wire material, it is only necessary that the deformation amount of lateral strain is 5% or more of the cross-sectional area ([0079]); if it is possible to electrodeposit around the thin wire material so that it has a thickness of at least nearly 5 μm or more, an electroformed tube can be formed even after the thin wire material is removed ([0080]); when a thin wire material made of stainless-steel and provided with a conductive layer (gold-plating) on its outer surface is used, an electroformed tube on which gold-plating is provided on its inner peripheral surface can be formed ([0081]); and in cases of removing a thin wire material provided with a conductive layer (gold-plating) on its outer periphery by deforming it so as to reduce a cross-sectional area thereof, by forming a part where a conductive layer is not provided on both ends of the thin wire material and pulling the part where a conductive layer is not provided, it becomes difficult for the pull force to directly apply to the conductive layer, the conductive layer and base wire material can be easily separated, it becomes difficult to destroy adhesion between the conductive layer and the electrodeposit material; additionally, a figure wherein neither a conductive layer or electrodeposit material, etc. is provided on both ends of the thin wire material and the thin wire material is exposed is shown ([0084] and [FIG. 6]).

It can be said that a person skilled in the art who came across these statements could have understood the following: an electroformed tube can be manufactured by forming an electrodeposit material, etc. around a thin wire material made of stainless-steel and provided with a conductive layer, deforming the thin wire material by pulling it from one end or both ends so as to reduce a cross-sectional area thereof, forming a clearance between the thin wire material and the conductive layer, and removing the deformed thin wire material by holding and pulling it; and a thin wire material can be easily removed by forming a large diameter part and exposing the thin wire material at the end thereof or by arranging the thickness of the electrodeposit material or deformation amount of the lateral strain of the thin wire material at appropriate values.

Based on the above, the detailed explanation of the invention in the Description is clearly and fully stated to the extent that a person skilled in the art can work Invention 1 and Corrected Invention 5.

(2) The Plaintiff's allegation

The Plaintiff alleged, as stated in No. 3, 2 (1) A. through C. above, that the Description did not state or suggest thin wire material removal methods [i] through [iii] and these methods cannot be found as well-known art; therefore, a person skilled in the art is required to perform excessive trial and error to find a thin wire material removal method that achieves the manufacturing method of an electroformed tube as stated in Invention 1 and Corrected Invention 5.

However, it is not necessary at all to classify the removal methods into removal methods [i] through [iii] as alleged by the Plaintiff and to state a concrete working method for all of these methods respectively. As stated in (1) above, a person skilled in the art who came across the statements of the Description could have understood that the thin wire material can be easily removed by exposing the thin wire material at the end thereof. In addition, as explained in 2. (2) above, concerning the specific method of removing electrodeposit material, etc. and exposing the thin wire material, a person skilled in the art has naturally understood that conventional methods or appropriate methods are sufficient, and therefore, a person skilled in the art is not forced to perform excessive trial and error.

Accordingly, the Plaintiff's allegation above is unacceptable.

(3) Summary

As described above, Grounds for Rescission 2 are groundless.

5. Whether there are Grounds for Rescission 3 (Error in the determination related to the violation of support requirements)

As stated in 1. (2) above, the problem of Invention 1 and Corrected Invention 5 is to provide a method of easily manufacturing tubes for contact probes, etc., and other electroformed tubes with a fine inner diameter that can be used as a component suitable for conducting the electricity ([0003], [0006], and [0008] in the Description).

In addition, as stated in 1. (5) above, the Description states that an electroformed tube is manufactured by electroforming a thin wire material using an electroforming device, deforming the thin wire material by pulling it from one end or both ends so as to reduce a cross-sectional area thereof, forming a clearance between an electrodeposit material and the thin wire material, and then removing the thin wire material by holding and pulling it, etc. ([0050] through [0070], [0073], [0075], [0076], [0078] through [0082], [0084], [FIG. 1], [FIG. 2], and [FIG. 6] in the Description).

And as stated in 1. (4) D. and (5) D. above, it is also stated that an electroformed tube that can be used as a component suitable for conducting the electricity, such as tubes for contact probes, etc., can be manufactured by using a thin wire material provided with a conductive layer, such as gold-plating, etc., on the outer peripheral surface and by removing the thin wire material so that the conductive layer remains on the inner peripheral surface of the electroformed tube ([0045], [0081], and [0082]).

Based on the above, it can be said that a person skilled in the art who came across the statements in the Description is considered to have understood the following: concerning Invention 1 and Corrected Invention 5 that specify to deform a thin wire material by pulling it from one end or both ends so as to reduce a cross-sectional area thereof, to form a clearance between the electrodeposit material and the thin wire material, to hold and pull the thin wire material, to form an electrodeposit material, etc. around a stainless-steel thin wire material provided with a conductive layer on its outer peripheral surface, and to remove the thin wire material while leaving the conductive layer on the inner surface of the electrodeposit material, etc., they are within the range that can be found to solve the problem as stated in A. above based on the statements in B. above. Therefore, Invention 1 and Corrected Invention 5 are considered to fulfill the support requirements.

The Plaintiff alleged that Invention 1 and Corrected Invention 5 do not fulfill the support requirements; however, the allegation cannot be accepted due to the same reasons as 4. (2) above.

As described above, Grounds for Rescission 3 are groundless.

6. Whether there are Grounds for Rescission 4 (Error in the determination related to the lack of an inventive step)

(1) Findings of Exhibit Ko 1 Process Invention

The statements in Exhibit Ko 1 Document are as stated in Attachment 2 "Matters indicated in Exhibit Ko 1 Document (Abstract)." According to the statements, it is found that Exhibit Ko 1 Process Invention, which is almost the same content as found by the JPO Decision, is at least stated. Despite the statement in Exhibit Ko 1 Document, "by providing 10 μm gold-plating (resistivity: $2.05 \times 10^{-6}\Omega$cm) to a stainless-steel wire with a circular cross-sectional shape, a diameter of 0.126 mm diameter, and a length of 355 mm; obtaining a core wire with a diameter of 0.136 mm" ([0023]), since when 10 μm gold-plating is provided on the surface of a stainless-steel wire with a diameter of 0.126 mm, the core wire diameter is 0.146 mm (0.126 mm + 10 μm + 10 μm), the phrase, "core wire with a diameter of 0.136 mm," in the aforementioned statement is found to be a misdescription of "core wire with a diameter of 0.146 mm". In addition, Exhibit Ko 1 Document has statements that "Manufacturing method of a fine cylinder for forming metal ferrule" ([Title of the invention]) and manufacturing method (manufacturing process) of "... fine cylinder for forming a ferrule" ([Claim 1] through [Claim 4]). In consideration of what is shown in [FIG. 1] with said statements, Exhibit Ko 1 Process Invention is not the "manufacturing method of a ferrule," but should be more precisely stated to be an invention of a "manufacturing method of a fine cylinder for forming a ferrule."

Therefore, Exhibit Ko 1 Process Invention can be found at least to be the following invention (a wavy line is provided for the part that is substantially different from Exhibit Ko 1 Process Invention as found by the JPO Decision).

"A manufacturing method of a fine cylinder for forming a ferrule by providing 10 μm gold-plating (resistivity: $2.05 \times 10^{-6}\Omega$cm) to a stainless-steel wire with a circular cross-sectional shape, a diameter of 0.126 mm, and a length of 355 mm; obtaining a core wire with a diameter of 0.146 mm; setting the core wire on an electroforming jig; setting a nickel metal plate in an electroforming bath, of which the main ingredient is nickel sulfamate; dipping the metal plate in the electroforming bath; setting the core wire as a cathode and the nickel plate as an anode; providing electroforming at the current density of approximately 10 A/dm^2 for 18 hours; and obtaining a nickel electroformed product with a diameter of approximately 2.5 mm in average; and

cutting the electroformed product to a length of 12 mm by NC automatic processing machine; boring one end; setting the processed product vertically by facing the non-bored surface up; hitting the core wire with a hammer that has a projection from the top in the wire punching machine; pulling part of the core wire that projects from beneath the processed product; and thereby removing the core wire and grinding the end surface."

(2) Findings of Difference 4

Based on the findings of Exhibit Ko 1 Process Invention as stated in (1) above, in cases where gold-plating remains on the inner surface of an electroformed product, the thickness of the nickel electroformed product with a diameter of approximately 2.5 mm in Exhibit Ko 1 Process Invention is calculated by deducting the diameter of the core wire alone and the result is approximately 1.187 mm [(2.5 mm - 0.126 mm)/2], and in cases where gold-plating does not remain at all on the inner surface of the electroformed product, it is calculated by deducting the core wire diameter and gold-plating thickness and the result is approximately 1.177 mm [(2.5 mm - 0.146 mm)/2].

Based on the above, Invention 1 and Exhibit Ko 1 Process Invention are different at least in the following Difference 4C and the difference includes Difference 4B (a wavy line is provided for the part that is substantially different from Difference 4B that

was alleged by the Plaintiff).
(Difference 4C)

"Concerning the 'thickness' of 'the electrodeposit material or the surrounding material' in Invention 1, 'the thickness of the electrodeposit material or the surrounding material is 50 μm or less,' while in Exhibit Ko 1 Process Invention, the 'thickness' of 'the electroformed product' is approximately 1.177 mm (1177 μm) or approximately 1.187 mm (1187 μm)."

The findings of Exhibit Ko 1 Process Invention and Difference 4 were changed as stated above; however, this point does not have an impact on the following conclusion.

(3) Whether a person skilled in the art could have easily conceived of Difference 4C

A. The ease in conceiving of Difference 4C is examined below based on Difference C.

Exhibit Ko 1 Process Invention is related to the manufacturing method of a fine cylinder for forming a metal ferrule. A ferrule that is used in the telecommunications field has a microporous pipe, which is provided with pores with a diameter of approximately 0.126 mm, an outer diameter of 2.5 mm, and a length of approximately 12 mm, and that is a component for surely securing a thin and fragile optical fiber with a thickness of approximately 0.125 mm ([0002] and [0003] in Exhibit Ko 1 Document). It had been publicly known that pore pipes were manufactured by electroforming; however, there were the following problems: since the inner diameter of a ferrule is very thin, it is difficult to dissolve the core wire with etching solution and the core wire easily becomes broken when pulling it out ([0005] and [0006]); and concerning the method of manufacturing a ferrule by electroforming nickel, etc. on the outer surface of a core wire (stainless-steel wire) with a diameter of 0.126 mm and cutting it, and then pulling out the core wire, the longer the core wire length is, the more uneven the outer diameter of the obtained electroformed product tends to become since the current density becomes small at the part of the core wire that is distant from the power source ([0007] and [0008]). Based on these problems, Exhibit Ko 1 Process Invention is to provide an efficient method of manufacturing a fine cylinder with an even outer diameter and a small inner diameter for the purpose of forming a high coaxial ferrule when manufacturing a microporous pipe for a ferrule with a long length and a small diameter of 0.126 mm by electroforming ([0001] and [0009]).

B. Exhibit Ko 1 Process Invention is an invention related to a manufacturing method of a fine cylinder for forming a ferrule. Generally, the fact that a ferrule or a fine cylinder for forming a ferrule has an inner diameter of 0.126 mm and a diameter of 2 mm to 2.5 mm is found to be common general technical knowledge at the time when the Application was filed (Exhibits Ko 1, 22, 23, 84 through 88, and 94). Based on this fact, the thickness is generally found to be approximately 1187 μm [(2.5 mm - 0.126 mm)/2] through approximately 937 μm [(2.0 mm - 0.126 mm)/2]. It is difficult to find that a person skilled in the art considers, based on the aforementioned thickness, that the thickness of a ferrule, which is a component for securing an optical fiber, or a fine cylinder for forming a ferrule can be naturally changed to 50 μm or less, which is approximately one-twentieth or less than the thickness in common general technical knowledge.

Based on the above, in Exhibit Ko 1 Process Invention, which is a method of efficiently manufacturing a fine cylinder for forming a ferrule, there is absolutely no motivation to change the thickness of "approximately 1.177 mm (1177 μm)" or "approximately 1.187 mm (1187 μm)" to "50 μm or less."

Therefore, a person skilled in the art could not have easily conceived of Difference 4. In addition, since Difference 4B that is alleged by the Plaintiff is Difference 4C after deleting part of the alternative descriptions, if Difference 4C consisting of both of the alternative descriptions could not have been easily conceived of by a person skilled in the art, it is obvious that Difference 4B, which is part of the alternative descriptions, could not have been easily conceived of by a person skilled in the art.

Accordingly, in any case, there is no error in the determination of the JPO Decision in that it determined that Invention 1 cannot be easily made based on Exhibit Ko 1 Process Invention.

(4) The Plaintiff's allegation

A. As stated in No. 3, 4. (1) A. (B) a. above, the Plaintiff alleged that since the numerical limitation of "50 μm or less" in Invention 1 is determined arbitrarily, has no technical meaning, and is not specified to cause any qualitatively different effects or critical significance, it could have easily been conceived of by a person skilled in the art to adopt the structure of Invention 1 related to Difference 4 in accordance with the common general technical knowledge at the time when the Application was filed that the thickness of a metal electroformed tube should be set at 50 μm or less.

However, as stated in (1) above, Invention 1 is related to a manufacturing method of an electroformed tube that can be used as a tube for probe devices. The electroformed tube is required to increase the number of contact probes (increasing the number of pins), to reduce wire diameter (thinning the wire), and to reduce the interval between the contact probes (narrowing the pitch) in order to respond to the latest integrated circuits. When the Application was filed, a tube with an outer diameter of 110 μm and an inner diameter of 88 μm was considered to be the smallest in the world. However, additional reduction in size is required ([0003]). Therefore, the tube diameter must be finer. In order to meet the requirements, in addition to the fine inner diameter of the tube, thin tube thickness is also essential requirement. Invention 1 is an invention related to this technology field. Based on the above, the fact that the tube thickness is considerably thin has technical meaning as particulars for identifying the invention of an electroformed tube thickness in Invention 1. This cannot be regarded as a matter of design variation that is arbitrarily implemented by a person skilled in the art. Therefore, specific motivation is required to specify the numerical limitation as "50 μm or less" and it cannot be considered that if there is a common general technical knowledge to determine a metal electroformed tube thickness to be 50 μm or less, it can immediately lead to find motivation.

Accordingly, the Plaintiff's allegation above is unacceptable.

B. As stated in No. 3, 4. (1) A. (B) b. above, the Plaintiff alleged that since Exhibit Ko1 Document treats the manufacturing method of a fine cylinder for forming a ferrule and a manufacturing method of general pore tubes as a common technology field, replacing the manufacturing method of a ferrule in Exhibit Ko 1 Process Invention with the manufacturing method of a general pore tubes could have been easily conceived of by a person skilled in the art and there are actually ferrules with a thickness of 0.15 mm.

Even if there are common parts in pore tube manufacturing methods and those parts exist as cross-sectional common general technical knowledge, concerning the manufacturing method in the Exhibit Ko 1 Process invention, if there is no need to reduce the thickness, there is no motivation to reduce the thickness using said technology in the first place. In addition, concerning the manufacturing method of a fine cylinder for forming a ferrule, which is a component to secure an optical fiber, in Exhibit Ko 1 Process Inversion, it is difficult to find that reduction of the ferrule thickness related to the manufacturing is in the direction of development of ferrule manufacturing methods. Accordingly, the Plaintiff's allegation in this regard is not appropriate.

Exhibit Ko 1 Document cited Exhibit Ko 25 Document (stating a manufacturing method of "a feed tube to distribute a propellant, such as hydrazine, etc., in a propulsion unit, such as a rocket, satellite, etc." ([0002])) and Exhibit Ko 3 Document (stating a manufacturing method of a hollow structure categorized in micro-parts, such as an optical switch, etc. ([0001], [0006], and [0032])) ([0005] and [0014] in Exhibit Ko 1 Document). However, regarding the pore tube manufacturing method in Exhibit Ko 25 Document, while Exhibit Ko 1 Document stated that "when manufacturing a metal ferrule for optical fiber connectors, this method can be used in principle," it also states as follows: "The problem is that since the inner diameter of a ferrule is approximately

0.126 mm, which is very thin, it is extremely difficult to dissolve the core wire of a fine cylinder for forming a ferrule with etching solution. In addition, the core wire easily becomes broken when pulling it out." ([0006] in Exhibit Ko 1 Document) Therefore, it should be regarded as stating problems when manufacturing a ferrule by using the technologies stated in Exhibit Ko 25 Document and, rather, it can be understood that the technology field in Exhibit Ko 1 Document and the technology field of Exhibit Ko 25 Document are stated by distinguishing them. In addition, Exhibit Ko 1 Document cited the manufacturing method of the hollow structure in Exhibit Ko 3 Document only as an example of documents disclosing the technology of manufacturing a pipe with a fine diameter by electroforming and removing core material by etching ([0014]) and does not state to handle the technology stated in Exhibit Ko 1 Document and the technology stated in Exhibit Ko 3 Document as technologies in a common technology field, etc. Furthermore, Exhibit Ko 94 Document discloses the technology related to metal ferrules based on the assumption that they are used for optical fiber connectors ([0001] and [0002]), and states as follows: "The outer diameter of the optical fiber is specified to be 0.125 mm by the standard, and therefore, the inner diameter of a ferrule is approximately 0.126 mm. The length of the ferrule is approximately 12 mm and the outer diameter is approximately 2.5 mm." ([0007]). Thus, it does not suggest to reduce the thickness of a ferrule.

In addition, it is seen that there was a product that is called "ferrule" with a tube thickness of 0.15 mm at the time when the Application was filed (Exhibit Ko 108-1); however, its inner diameter is 1.1 mm (1100 μm) to 10.30 mm (10300 μm) and it is found to be a ferrule for electric wires (Exhibits Ko 108-2 and 109). They are found to be totally different in use from a ferrule that is to be manufactured using a fine cylinder for forming a ferrule related to the manufacturing method in Exhibit Ko 1 Process Invention.

Consequently, the aforementioned Plaintiff's allegation also cannot be accepted.

(5) Corrected Invention 5

Corrected Invention 5 specifies forming of a part where the electrodeposit material, etc. is not formed on both ends of a thin wire material, the electrodeposit material, etc. made of nickel, and the conductive layer made by gold-plating, in addition to the specification in Invention 1. There is at least Difference 4C with Exhibit Ko 1 Process Invention. Therefore, based on the same reasons as Invention 1, Corrected Invention 5 could not have been easily conceived of by a person skilled in the art based on Exhibit Ko 1 Process Invention and common general technical knowledge. Consequently, in any case, there is no error in the determination of the JPO Decision.

(6) Summary

As described above, Grounds for Rescission 4 are groundless.

7. Conclusion

As described above, since Grounds for Rescission 5 are well-founded, part of the JPO Decision related to Invention 6 and Corrected Invention 9 is rescinded. Since other grounds for rescission are groundless, the request for rescission of the part related to Invention 1 and Corrected Invention 5 is dismissed. The judgment is rendered as indicated in the main text.

Intellectual Property High Court, Fourth Division
Presiding judge: KANNO Masayuki
Judge: MOTOYOSHI Hiroyuki
Judge: NAKAMURA Kyo

(Attachment 1)

Matters stated in the Description (Abstract)

(The part with a statement of "▲1▼," etc. was replaced with "[i]," etc. Underlined parts indicate corrected parts by the Previous-instance Correction.)

[Detailed explanation of the invention]

[0001]

[Technical field of the invention]

The present invention relates to a method of manufacturing an electroformed tube and an electroformed tube, and a thin wire material for manufacturing the electroformed tube, and, in more detail, it relates to a manufacturing method of an electroformed tube with a fine inner diameter and an electroformed tube. In addition, the present invention relates to thin wire material for manufacturing an electroformed tube with a fine inner diameter.

[0002]

[Prior arts and their problems]

Conventionally, when an integrated circuit, such as an LSI, etc., is manufactured, inspection is conducted to ensure that the semiconductor pattern is completed as designed and that electric continuity is good. This inspection is performed using a device with multiple contact probes (referred to as a "probe device" in the Description) and by having it touch to each electrode forming the pins of the contact probe. The contact probe has a structure in which a spring is provided inside an ultra-fine tube having the required length and a pin is provided so as to be retractable into the tube.

[0003]

Recently, the development of semiconductor manufacturing technology has been remarkable, and the density of integration tends to increase. In association with these [changes/trends], in order to respond to the latest integrated circuits with probe devices to inspect the electric continuity of electrodes, it is required to increase the number of contact probes (increasing the number of pins), to reduce wire diameter (thinning the wire), and to reduce the interval between the contact probes (narrowing the pitch). A tube for current contact probes having an outer diameter of 110 μm and an inner diameter of 88 μm is regarded to be the smallest in the world (see, for example, Non-patent Document 1).

However, as described above, semiconductor manufacturing technology has evolved more and more, and it is required to miniaturize the contact probes even further.

[0004]

In addition, the need for a tube with a fine inner diameter is increasing also in fields other than the semiconductor industry, such as the fields of biotechnology and medical care, etc.

In other words, the development of said tube having a fine inner diameter is strongly demanded throughout the entire industry.

[0005]

The present inventor has conducted research on electroforming and has succeeded in manufacturing a small-diameter tube by electroforming in the past. The electroformed tube manufactured at that time has a hollow part with a circular cross-sectional shape and an inner diameter of 126 μm (see, for example, Patent Document 1). Therefore, the present inventor obtained the idea that a tube with a fine inner diameter (hollow part) for a contact probe can be manufactured using electroforming technology.

[0006]

Further research led the present inventor to success in depositing a minimum of 5 μm metallic film on the outer surface of thin wire material using thin wire material with a diameter of 10 μm to 85 μm. Thus, the present inventor found that a tube with a fine diameter (hollow part) can be manufactured if the aforementioned thin wire material can be removed from the metal.

However, removing the thin wire from the electrodeposited (deposited) metal was not easy because the electrodeposited metal adhered to the outer surface of the thin wire material.

[0008]

(Objective of the present invention)

The objectives of the present invention are:

[i] to provide a manufacturing method of an electroformed tube with a fine inner diameter, an electroformed tube, and a thin wire material to manufacture the electroformed tube;

[ii] to provide the manufacturing method of an electroformed tube wherein a thin wire material can be easily removed by arranging the material so that a jig or tool, etc. can be get caught on the electrodeposit material or the surrounding material when removing the thin wire material from the electrodeposit material or the surrounding material;

[iii] to provide the manufacturing method of an electroformed tube, an electroformed tube, and thin wire material to manufacture the electroformed tube by providing a conductive layer, such as a gold-plating, etc., on the inner surface so that electric conductivity is higher than in the case of an electrodeposit material or surrounding material alone;

...
[v] to provide the manufacturing method of an electroformed tube with multiple hollow parts and an electroformed tube;
...
[vii] to provide the manufacturing method of an electroformed tube in which it becomes difficult for the pull force to directly apply to the conductive layer that is provided on the inner surface, the conductive layer and the base wire material can be easily separated, and it becomes difficult to destroy the adhesion between the conductive layer and the electrodeposit material or the surrounding material when removing the thin wire material.
[0011]
[Means of solving problems]

The means used by the present invention to achieve the aforementioned objectives are stated below:
Concerning the first invention,

a manufacturing method of an electroformed tube, which is a method of manufacturing an electroformed tube by forming an electrodeposit material or a surrounding material by electroforming around a thin stainless-steel wire material that has, on the outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or the surrounding material, and by removing the thin wire material while leaving the conductive layer on the inner surface of the electrodeposit material or the surrounding material, which is characterized by;

wherein the conductive layer is formed by electrolytic plating and has a higher electric conductivity than the electrodeposit material or the surrounding material; and wherein the thin wire material is pulled from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and a clearance between the deformed thin wire material and the conductive layer is formed, and the deformed thin wire material is removed by holding and pulling it, and thereby an electroformed tube wherein a thickness of the electrodeposit material or the surrounding material is 50 μm or less is manufactured.
[0018]
Concerning the fifth invention,

a manufacturing method of an electroformed tube related to the first invention characterized by;

wherein the electrodeposit material or the surrounding material is made of nickel and the conductive layer is made of gold.

[0027]

Concerning the sixth invention,

an electroformed tube manufactured by forming an electrodeposit material or a surrounding material by electroforming around a thin wire material that has, on the outer surface, a conductive layer made of a metal material that is different from the electrodeposit material or the surrounding material, pulling the thin wire material from one end or both ends to deform it so as to reduce a cross-sectional area thereof, and forming a clearance between the deformed thin wire material and the conductive layer, and by pulling the deformed thin wire material and removing the deformed thin wire material while leaving the conductive layer inside the electrodeposit material or the surrounding material, which is characterized by;

wherein the conductive layer has a higher electric conductivity than the electrodeposit material or the surrounding material; and

wherein the inner shape of a hollow part formed by removing the thin wire material has a circular cross-sectional shape or a polygonal cross-sectional shape, and the thickness of the electrodeposit material or the surrounding material is 5 μm or more and 50 μm or less.

...

Concerning the ninth invention,

An electroformed tube related to the sixth or seventh invention characterized by;

wherein the electrodeposit material or the surrounding material is made of nickel and the conductive layer is made of gold.

[0041]

(Functions)

According to the present invention, the thin wire material can be removed from the electrodeposit material or the surrounding material that is formed by electroforming.

The thin wire material can be removed by any of the following methods: [i] heating and thermally expanding the electrodeposit material or the surrounding material or cooling and contracting the thin wire material to form a clearance between the electrodeposit material or the surrounding material and the thin wire material; [ii] submerging the material into a liquid or applying a liquid to the material, thereby making the place where the thin wire material and the electrodeposit material or the surrounding material are brought into contact slippery; [iii] pulling the material from one end or both ends, deforming the material so as to reduce a cross-sectional area thereof, and forming the clearance between the thin wire material and the electrodeposit material or the surrounding material, followed by holding and pulling the material, sucking the material, physically pushing away the material, or blowing a gas or a liquid to push away the material; or [iv] melting or dissolving the material with heat or a solvent.

[0042]

If the aforementioned methods are used when removing the thin wire material, the thin wire material can be removed, for example, by using a thin wire material with a diameter of 10 μm to 85 μm, even from the electrodeposit material or surrounding material that is formed so that the thin wire material has a thickness of 5 μm or more and 50 μm or less on its outer surface. Therefore, by using the thin wire material removal method, for example, an electroformed tube with a fine inner diameter that can be used as a tube for a contact probe can be manufactured.

[0043]

According to a method of manufacturing an electroformed tube by increasing the volume of electrodeposit material or surrounding material on the end side that is formed on the thin wire material, for example, when removing the thin wire material by pulling it out from or pushing it away from the electrodeposit material or the surrounding material, a jig or tool, etc. can get caught on the end surface of the part where the amount of the electrodeposit material and the surrounding material was increased. Therefore, in this case, the thin wire material can be removed while securing the electrodeposit material or the surrounding material, and therefore, the thin wire material can be easily removed.

[0044]

According to the manufacturing method of an electroformed tube wherein the deformation amount of lateral strain when a thin wire material is extended by pulling it outward is arranged to be 5% or more of the cross-sectional area, a sufficient clearance is formed for removing the thin wire material between the thin wire material and the electrodeposit material or the surrounding material. Therefore, it is highly possible to remove the thin wire material from the electrodeposit material or the surrounding material without any difficulties. If the deformation amount of lateral strain is 5% or less of the cross-sectional area, the clearance is insufficient and there may be cases where a hindrance occurs when removing the thin wire material.

[0045]

According to a manufacturing method of an electroformed tube by using a thin wire material where the conductive layer is provided on the outer surface and by removing the thin wire material so that the conductive layer is left on the inner surface of the electroformed tube, an electroformed tube provided with a gold-plating, etc. on its inner surface can be manufactured. The aforementioned electroformed tube, for example, can be arranged to have a higher electric conductivity than in the case of an electrodeposit material or surrounding material alone, depending on the material of the conductive layer that is provided on the inner surface. In this case, said electroformed tube can be used as a component that is suitable for conducting the electricity.

An electroformed tube with a higher electric conductivity than in the case of an electrodeposit material or surrounding material alone can be manufactured in the same way for an electroformed tube wherein a conductive layer that is made of a material different from the electrodeposit material or the surrounding material is provided on its inner surface or for a thin wire material wherein a conductive layer made of a material different from the electrodeposit material or the surrounding material is provided on its outer surface.

[0047]

A product with multiple pieces of hollow parts that are formed by removing a thin wire material can be used by replacing with a component that were manufactured by aligning multiple tubes that has only one hollow part. When using the electroformed tube, it can eliminate time and effort needed to align and set individual tubes. In addition, since the intervals between the hollow parts are secured by the electrodeposit material or the surrounding material, they are not misaligned.

[0049]

Concerning a thin wire material with a part where a conductive layer is not provided formed on both ends, if the part where the conductive layer is not provided is pulled outward, it becomes difficult for the pull force to directly apply to the conductive layer, the conductive layer and the base wire material can be easily separated, and it becomes difficult to destroy the adhesion between the conductive layer and the electrodeposit material or the surrounding material.

[0050]

[Embodiment of the invention]

The embodiment of the present invention is explained in additional detail based on the drawings.

FIG. 1 is a cross-sectional explanatory view showing an example of an electroforming device to manufacture an electroformed tube related to the present invention.

First, the electroforming device to manufacture an electroformed tube is explained.

[0051]

Electroforming device 100 has electroforming bath 10 and outer bath 11, which stores electroforming bath 10 inside it. Electroforming bath 10 and outer bath 11 have an open top and electrolytic solution (electroforming solution) 20 is always supplied to electroforming bath 10 during operation. In this manner, electrolytic solution 20 overflows from the top of electroforming bath 10 and flows into outer bath 11. As electrolytic solution 20 in the present embodiment, for example, nickel sulfamate solution combined with a brightening agent and a pitting prevention agent is used.

[0052]

Electrolytic solution 20 that overflows from electroforming bath 10 and flows into outer bath 11, is filtered by a filtration device (not shown in the figure) and then is supplied again into electroforming bath 10. In other words, electrolytic solution 20 constantly circulates between electroforming bath 10 and outer bath 11 during operation. In addition, a publicly known means can be used as a means to supply electrolytic solution 20 into electroforming bath 10 (not shown in the figure).

[0053]

Electrolytic solution 20 for the part overflowing from the top of electroforming bath 10 in the present embodiment is called overflow part 12 for convenience. In electroforming device 100, electroforming is implemented in overflow part 12. Electroforming procedures will be described later.

[0054]

Under electroforming bath 10, horizontal adjuster 13 is provided. Horizontal adjuster 13 maintains electroforming bath 10 nearly horizontally, thereby nearly horizontal overflow part 12 is formed over the entire top of electroforming bath 10 and electrolytic solution 20 can be distributed uniformly to locations in overflow part 12.

[0055]

Code 4 indicates a holding jig for holding thin wire material 30, which becomes a mold component (base material) for electroforming. Holding jig 4 includes horizontal component 40 with the required length, and a pair of suspended components 41 and 41 that are suspended on both ends of horizontal component 40. Holding jig 4 is provided so that suspended components 41 and 41 are positioned on the sides of electroforming bath 10.

[0056]

Stick-type wire material securing components 42 and 43 with the required length are provided on suspended components 41 and 41 by extending out nearly in the horizontal direction respectively. Wire material securing components 42 and 43 are provided on suspended components 41 and 41 in a rotatable manner. Electrode 44 is provided at the end of the wire material securing component 42 on the electroforming bath 10 side. In addition, at the end of another wire material securing component 43 on the electroforming bath 10 side, tension device 45 that pulls thin wire material 30 and electrode 44 are provided. One end and the other end of thin wire material 30 are secured respectively on wire material securing components 42 and 43 in a tensioned state by tension device 45.

[0057]

Rotating shaft 46 is provided in a rotatable manner between suspended components 41 and 41. Code 47 indicates a driving motor that drives rotating shaft 46. Rotating shaft 46 penetrates suspended components 41 and 41 and gears 480 and 481 are secured on both ends of rotating shaft 46.

[0058]

Wire material securing components 42 and 43 above are provided by penetrating through suspended components 41 and 41. Gear 482 is secured on wire material securing component 42, which penetrates through suspended component 41. In the same manner, gear 483 is secured on wire material securing component 43, which penetrates through suspended component 41. In this manner, gear 480 and gear 482, and gear 481 and gear 483 are engaged. Accordingly, when driving motor 47 is operated and gears 480 and 481 are rotated along with rotating shaft 46, gears 482 and 483 and wire material securing components 42 and 43 are rotated, and thereby thin wire material 30 can be rotated. The rotational speed of thin wire material 30 is not particularly limited. For example, it is controlled to be 15 r.p.m. or less.

[0059]

At the outer end of wire material securing components 42 and 43, conductive electrode contact components 49 and 49 are provided respectively. When holding jig 4 is provided on top of electroforming bath 10, electrode contact components 49 and 49 come into contact with electrode units 14 and 14 that are provided between electroforming bath 10 and outer bath 11. Electrode units 14 and 14 are connected to a negative electrode of the power source. Accordingly, electrode contact components 49 and 49 are electrically connected to the negative electrode of the power source while coming into contact with electrode units 14 and 14.

[0060]

Code 15 indicates an electrode unit that is electrically connected to the positive electrode of the power source. Electrode unit 15 is provided at the bottom of electroforming bath 10. For example, concerning electrode unit 15, a mesh or perforated case made of titanium steel can be used in which a metallic pellet for electroforming (for example, nickel pellet) is stored.

[0061]

The manufacturing method of an electroformed tube using electroforming device 100 is explained below.

First, one end and the other end of thin wire material 30 are secured on wire material securing components 42 and 43 respectively and thin wire material 30 is tensed between wire material securing components 42 and 43. At this time, electrolytic solution 20 is supplied into electroforming bath 10, overflows from the top of electroforming bath 10 (forming overflow part 12), and flows into outer bath 11. In addition, the overflow part 12 is adjusted so that electroforming bath 10 is set nearly horizontally by horizontal adjuster 13 and electrolytic solution 20 is distributed uniformly to each location.

[0062]

In the present embodiment, thin wire material 30 is made of stainless-steel having nearly a circular cross-section with a diameter of 50 μm, and the deformation amount of lateral stretch is 10% of the cross-sectional area when nearly 1,500 N/mm^2 of pull force is applied outward.

[0063]

Next, driving motor 47 is operated to rotate gears 480 and 481 along with rotating shaft 46. Thereby, gears 482 and 483 and wire material securing components 42 and 43 are rotated and then thin wire material 30 rotates.

[0064]

Electrode contact components 49 and 49 come into contact with electrode units 14 and 14; suspended components 41 and 41 are positioned on the sides of electroforming bath 10; and thin wire material 30 alone is dipped in overflow part 12. Since electrode unit 15 is electrically connected to the positive electrode of the power source when electrode contact components 49 and 49 come into contact with electrode units 14 and 14, thin wire material 30 is electrically connected to the negative electrode of the power source and electroforming starts. In this manner, metal (nickel [by/according to] electrolytic solution 20 indicated in the present embodiment) is electrodeposited (deposited) around thin wire material 30. The metal to be electrodeposited around thin wire material 30 is an electrodeposit material (or surrounding material).

[0065]

Thin wire material 30 is dipped in overflow part 12 for the required time, and electroforming is performed until the outer diameter of an electrodeposited metal becomes nearly 70 μm over the whole length. When the target outer diameter is achieved, thin wire material 30 is taken out from overflow part 12 and electroforming is stopped. The amount of electrodeposition of the metal (deposition amount), in other words, the thickness of metal electrodeposited on the thin wire material can be controlled in advance by electric current, electric voltage, electroforming time, etc.

[0066]

In electroforming device 100, overflow part 12 is adjusted so that electrolytic solution 20 is uniformly distributed at each location, and since thin wire material 30 is rotated, even if a nonuniform part of the current density is generated in electrolytic solution 20, differences in metal electrodeposition status (deposition status) in thin wire material 30 hardly occur. Therefore, metal is electrodeposited around thin wire material 30 so as to have a nearly uniform thickness over the entire length. Thus, an electroformed tube with high precision can be manufactured by only removing thin wire material 30.

[0067]

In addition, electroforming device 100 performs electroforming at overflow part 12, and overflow electrolyte solution 20 circulates by returning to electroforming bath 10 again. In other words, during electroforming, it is only necessary to form overflow part 12, and therefore, electroforming can be implemented with a small amount of electrolytic solution 20.

[0068]

In electroforming device 100, since wire material securing components 42 and 43 that secure thin wire material 30 are provided outside overflow part 12, wire material securing components 42 and 43 are not dipped into electrolytic solution 20. Therefore, wire material securing components 42 and 43, etc. do not react with electrolytic solution 20 to generate impurities. In addition, electrolytic solution 20 is unlikely to be taken out while adhering to wire material securing components 42 and 43, etc. and electrolytic solution 20 is not wastefully reduced from electroforming bath 10.

[0069]

Then, thin wire material 30 around which metal is electrodeposited is removed from wire material securing components 42 and 43 and thin wire material 30 is removed from electrodeposit material (surrounding material) that is formed at the end.

[0070]

Since electrodeposit material adheres to the outer surface of thin wire material 30, it is difficult to remove thin wire material 30 simply by holding, pulling, sucking, physically pushing away, or pushing away by ejecting a gas or a liquid. Accordingly, thin wire material 30 is removed by any of the following methods (1) to (4).

[0071]

(1) The electrodeposit material is heated and thermally expanded, or thin wire material

30 is cooled and contracted, and thereby a clearance is formed between the electrodeposit material and thin wire material 30, and thin wire material 30 is removed by any of the methods of holding and pulling it, sucking it, physically pushing it away, or pushing it away by ejecting a gas or a liquid.

[0072]

(2) The part where thin wire material 30 and the electrodeposit material are brought into contact is formed to be slippery by dipping the material into a liquid in which detergent has been dissolved or by applying the liquid. Then, thin wire material 30 is removed by any of the methods of holding and pulling it, sucking it, physically pushing it away, or pushing it away by ejecting a gas or a liquid.

[0073]

(3) Thin wire material 30 is pulled from one end or both ends to deform it so as to reduce a cross-sectional area thereof. Then, a clearance is formed between the electrodeposit material and thin wire material 30 and thin wire material 30 is removed by any methods of holding and pulling it, sucking it, physically pushing it away, or pushing it away by ejecting a gas or a liquid.

[0074]

(4) Thin wire material 30 is removed by melting it by heat or by dissolving it in an alkaline solution or acidic solution, etc.

[0075]

By removing thin wire material 30 in this manner, an electroformed tube with a fine inner diameter (hollow part) is manufactured by the remaining electrodeposit material. This electroformed tube can be used as a tube for a contact probe, etc.

[0076]

In the present embodiment, a thin wire material is removed from electrodeposit material having a nearly uniform thickness over its entire length, but it is not limited thereto. For example, as shown in FIG. 2, large diameter part 500 having a large outer diameter may be formed on one end of electrodeposit material 50 and thin wire material 30 can be removed by any of the methods of holding and pulling it, sucking it, physically pushing it away, or pushing it away by ejecting a gas or a liquid. By forming large diameter part 500 in this manner, when pulling thin wire material 30 out or pushing it away, a jig or tool can get caught on the end surface of large diameter part 500. Therefore, in this case, thin wire material 30 can be removed while securing the electrodeposit material, and therefore, the thin wire material can be easily removed. In addition, an operation to increase the electrodeposited amount on a part may be performed by transferring to another electroforming device.

[0077]

In addition, in the above-described embodiment, thin wire material with a diameter of 50 μm and nearly a circular cross-section is used as thin wire material 30. However, the thickness and the cross-sectional shape of the thin wire material are not limited thereto. ...

[0078]

It has been found in experiments conducted by the present inventors that, if the aforementioned thin wire material has a nearly circular cross-sectional shape, when its outer diameter is 10 μm or more and 85 μm or less, and if the outer shape is a polygonal cross-section shape, when its inscribed circle diameter is 10 μm or more and 85 μm or less, the thin wire material can be used for manufacturing an electroformed tube with a fine inner diameter.

[0079]

In addition, as thin wire material 30 indicated in the present embodiment, a thin wire material is used with which the deformation amount of lateral stretch is 10% of the cross-sectional area when nearly 1,500 N/mm^2 of pull force is applied outward. However, the deformation amount of lateral strain of the thin wire material is not particularly limited thereto. According to experiments conducted by the present inventors, it seems to be acceptable if the deformation amount is at least 5% or more of the cross-sectional area.

[0080]

In the present embodiment, an electroformed tube is formed by electrodepositing metal at a thickness of nearly 10 μm around thin wire material 30 with nearly a circular cross-sectional shape and a diameter of 50 μm so that the total outer diameter becomes nearly 70 μm; however, the thickness of the electrodeposited metal is not particularly limited thereto. According to experiments conducted by the present inventors, it is known that if it is possible to electrodeposit around thin wire material 30 so that it has a thickness of at least nearly 5 μm, an electroformed tube can be formed even after thin wire material 30 is removed.

[0081]

In the present embodiment, thin wire material 30 made of stainless-steel is used and metal is directly electrodeposited around thin wire material 30. However, if a thin wire material which can be used in electroforming device 100 is arranged to be conductive, it is not particularly limited. For example, it is possible to use a thin wire material wherein the core part is made of metal or synthetic resin, etc. and a conductive layer (plating (metallic layer (film)) or carbon, etc.) is provided on its outer surface, etc. By using such thin wire material, for example, as shown in FIG. 4, in cases where electrodeposit material 52 is formed on thin wire material 32 provided with gold-plating 321 on its outer peripheral surface, base wire material 320 alone can be removed while leaving gold-plating 321 on the inner peripheral surface of electrodeposit material 52. In this case, an electroformed tube provided with gold-plating 321 on its inner peripheral surface can be formed.

[0082]

An electroformed tube provided with gold-plating 321 on its inner peripheral surface can have a higher electric conductivity than in the case where gold-plating 321 is not provided. Therefore, for example, it can be used as a component suitable for conducting the electricity, such as a tube for a contact probe, etc.

[0083]

Furthermore, for example, a thin wire material that is provided with a conductive layer by the aforementioned plating, etc. and is provided another conductive layer made of a material different from that of said conductive layer on the outer peripheral side of said conductive layer can also be used. ...

[0084]

As described above, in cases of removing the thin wire material provided with a conductive layer (for example, gold-plating) on its outer periphery from deposited metal by deforming the thin wire material so as to reduce a cross-sectional area thereof, it is preferable to form a part where the conductive layer (for example, gold-plating 340) is not provided on both ends of thin wire material 34 as shown in FIG. 6 (masked parts 341 and 341) and then to pull the part where the conductive layer is not provided. Then, it becomes difficult for the pull force to directly apply to the conductive layer, the conductive layer and the base wire material can be easily separated, and it becomes difficult to destroy the adhesion between the conductive layer and electrodeposit material 54.

[0085]

FIG. 7 is a cross-sectional explanatory view showing other examples of an electroforming device to manufacture an electroformed tube related to the present invention;

FIG. 8 is an exploded perspective explanatory view showing a manufacturing jig to be used in the electroforming device shown in FIG. 7; and

FIG. 9 is an enlarged cross-sectional explanatory view showing an electroformed tube to be manufactured using the manufacturing jig shown in FIG. 8.

Electroforming device 101 is a type wherein a thin wire material is provided in the longitudinal direction (in the vertical direction in FIG. 7) in a tensioned state.

[0086]

Electroforming device 101 has electroforming bath 60. Electroforming bath 60 has bath unit 61 inside and is formed into a box shape with an open top. On the upper periphery of electroforming bath 60, cover placing unit 62 extending outward is provided over the entire periphery, and cover 64 is placed on cover placing unit 62 to close the opening of electroforming bath 60.

[0087]

Hook unit 63 is provided on the top of bath unit 61. On hook unit 63, anode 66 that is electrically connected to the positive electrode of the power source is provided. On anode 66, housing body 660 is provided and housing body 660 is filled with many nickel balls. Code 65 indicates a cathode that is electrically connected to the negative electrode of the power source. On cathode 65, cathode wire 650 is suspended downward to connect with manufacturing jig 8, which is indicated below.

[0088]

In the present embodiment, housing body 660 is filled with nickel balls; however, the filling of housing body 660 is not limited thereto, but is selected depending on the type of metal to be deposited. …

[0089]

Jig securing frame body 7 is stored inside bath unit 61. Jig securing frame body 7 is equipped with five stacks of manufacturing jigs 8.

[0090]

Bath unit 61 of electroforming bath 60 is filled with electrolytic solution 21. Electrolyte solution 21 is placed so that anode 66 and jig securing frame body 7 are completely immersed. In the present embodiment, as electrolyte solution 21, a solution with a main content of nickel sulfamate is used.

[0091]

FIG. 8 is referred to. On manufacturing jig 8, multiple pieces of thin wire material 35 can be provided in a tensioned state and manufacturing jig 8 is to manufacture an electroformed tube having multiple hollow parts. In addition, since thin wire material 35 as described in the present embodiment is the same as that used in electroforming device 100, an explanation is omitted.

[0092]

Manufacturing jig 8 has a plate-shape jig main body 80, which has the required length. Penetrating opening unit 81 is formed nearly at the center of jig main body 80. On both ends (shorter side) of jig main body 80, which are the top and bottom ends in

FIG. 8, multiple pieces (in concrete terms, 8 pieces each) of securing components 82 and 83 that secure thin wire material 35 are provided in the width direction with the required interval. The screw type of securing components 82 and 83 are used in the present embodiment; however, they are not particularly limited thereto.

[0093]

In addition, in the further inner part than securing components 82 and 83, multiple pieces of guiding pins 84 (in concrete terms, 8 pieces each) are provided with a narrower interval than the interval with which securing components 82 and 83 are provided.

[0094]

Furthermore, near the opening unit 81 that is a more inner part than guiding pins 84, positioning components 85 and 85 are provided to determine the position for providing thin wire material 35 in a tensioned state. Positioning components 85 and 85 are belt-shaped plates having nearly the same length as jig main body 80 and a V-shaped groove (it is not shown in the figure since it is covered by latch 850 (to be described below)) to engage and place thin wire material 35 nearly at the center is formed. This groove is formed along the entire width (in the vertical direction in FIG. 8) of positioning component 85 and by providing multiple connective pieces (in concrete terms, at 8 sites) in the length direction (in the horizontal direction in FIG. 8).

[0095]

The top surface of each positioning component 85 has nearly the same width as positioning component 85. Latch 850 that is formed with a short plate is provided so that engaged thin wire material 35 will not come out of the groove. In the present embodiment, the groove of positioning component 85 is formed so that a 10 μm clearance can be provided between the groove and adjacent thin wire material 35; however, it is not limited thereto and an interval of thin wire material 35 can be set as necessary.

[0096]

Manufacturing jig 8 can be provided with multiple pieces (in concrete terms, 8 pieces) of thin wire material 35. Each thin wire material 35 is attached as follows.

First, tension spring 86 is attached to the other end (lower side in FIG. 8) of thin wire material 35. Then, one end (upper side in FIG. 8) of thin wire material 35 is secured with securing component 82. Thin wire material 35 that is secured with securing component 82 is passed through between adjacent guiding pines 84 and 84, is engaged in a groove that is formed at each positioning component 85 and is bridged between positioning components 85 and 85.

[0097]

The other end of thin wire material 35 that is engaged in the groove is passed through between adjacent guiding pins 84 and 84 in the same way as the upper end, and tension spring 86 is secured with securing component 83. Thin wire material 35 is attached in a state where a part corresponding to opening 81 of thin wire material 35 is tensed by the pull force of tension spring 86.

[0098]

In manufacturing jig 8, thin wire material 35 is attached with a clearance of 10 μm between adjacent ones; however, in FIG. 8, the interval is exaggerated for easy understanding.

[0099]

Code 87 indicates a holding component for attaching partition component 88. Holding component 87 is formed with a rectangular plate shape body that has nearly the same size as the opening shape of opening 81.

[0100]

Partition component 88 has nearly the same length in the vertical direction in FIG 8 as holding component 87 and has a thin belt-shape form. To explain it more in detail, partition component 88 has insulating base material 880 with a thickness of nearly 8 μm and has a structure wherein conductive layer (film) 881 is provided by plating, etc. with a thickness of nearly 2 μm to 3 μm on both front and rear surfaces of insulating base component 880. A material that forms conductive layer 881 is not particularly limited as long as it has conductivity. However, it is preferable to use a material having good adhesion (cohesiveness) with electrodeposit material by electroforming.

[0101]

Multiple pieces (in concrete terms, 7 pieces) of conductive layer 881 are attached in a detachable manner to partition component 88 and are aligned by facing each other with the required interval nearly at the center of the surface of holding component 87 and extending to the entire length in the vertical direction in FIG. 8. In the present embodiment, since the aforementioned thin wire material 35 is designed to be attached on jig main body 80 by forming nearly a 10 μm clearance, partition component 88 is attached at the same interval of nearly 10 μm in order to correspond to said clearance.

[0102]

Holding component 87 that is provided with partition component 88 is attached to jig main body 80 by inserting partition component 88 from a side (in the arrow direction) between thin wire materials 35 that are provided in a tensioned state vertically through opening 81 and by sandwiching partition component 88 with the tension of thin wire material 35. In other words, thin wire material 35 and partition component 88 (specifically, conductive layer 881) come into contact.

[0103]

After holding component 87 is attached to jig main body 80 in the aforementioned way and connecting cathode wire 650 (not shown in FIG. 8) so that the electricity flows through thin wire material 35, manufacturing jig 8 is stored in jig securing frame body 7 of bath unit 61 and dipped in electrolytic solution 21 for electroforming. Although a specific explanation is omitted, a masking process is provided to parts other than opening 81 of manufacturing jig 8 in order to avoid dipping of electrolytic solution 21.

[0104]

By using electroforming device 101, when the electricity is applied, electrodeposit material is formed around thin wire material 35 and on the surface of conductive layer 881. When thin wire material 35 and partition component 88 are surrounded to the extent required by electrodeposit material 55, electroforming is stopped. Amount of electrodeposit (deposition amount) of electrodeposit material 55 can be controlled in advance by electric current, electric voltage, electroforming time, etc.

[0105]

Manufacturing jig 8, for which electroforming is stopped, is taken out from electrolytic solution 21 and is decomposed again into jig main body 80 and holding component 87. At this time, since partition component 88 is secured between thin wire materials 35 by the deposited electrodeposit material 55, it is separated from holding component 87. Then, thin wire material 35 and partition component 88 that were integrated by electrodeposit material 55 are removed from jig main body 80.

[0106]

Then, thin wire material 35 is removed from electrodeposit material 55 by providing machining to electrodeposit material 55 and partition component 88 to arrange the shape (see FIG. 9). Since thin wire material 35 is removed by the same method as the products manufactured by electroforming device 100 above, the explanation will be omitted.

In this manner, an electroformed tube with multiple pieces (in concrete terms, 8 pieces) of hollow parts is manufactured.

[0107]

In the electroformed tube, partition component 88 is interposed between hollow parts formed by removing thin wire material 35 in a way of separating the hollow parts, so that electric conduction can take place independently for each part forming the periphery of each hollow part.

[0108]

Also with electroforming device 101, a core part can be made of metal, a synthetic resin, etc., and it is possible to use thin wire material that is provided with a conductive layer (plating (metal layer (film) or carbon, etc.) on its outer surface. …

[0109]

In the present embodiment, partition component 88 is provided between thin wire materials 35 and electroforming is performed; however, it is not limited thereto. For example, it is possible to perform electroforming without providing partition components but in a state of thin wire materials alone.

[0110]

An electroformed tube can also be manufactured using an electroforming device in a form other than electroforming devices 100 and 101 that are shown in the aforementioned embodiment. ...

[0111]

Numerical values representing specific dimensions (size and length) described in the present embodiment are for easy understanding and there is no intention to limit the dimensions particularly. ...

[0112]

The present embodiment showed a case where metal is electrodeposited by electroforming on the outer surface of thin wire material; however, it is not limited thereto. For example, an electroformed tube can be manufactured by providing a conductor (metal, etc.) to which electric current can be applied near the thin wire material, electrodepositing metal by electroforming on the conductor, and thereby also covering the thin wire material with electrodeposited metal.

[0113]

In the aforementioned embodiment, the electrolyte solution mainly contains nickel sulfamate; however, the electrolyte solution is not limited thereto and is selected based on the type of metal to be deposited. As the metal to be electrodeposited (deposited), for example, nickel or its alloys, iron or its alloys, copper or its alloys, cobalt or its alloys, tungsten alloy, fine particle dispersion metal, and other metals can be listed. ...

[0114]

In addition, a stirring means for stirring an electrolytic solution may be provided in the electroforming bath. ...

[0116]

[Effects of the Invention]

The present invention is provided with the aforementioned composition and has the following effects.

(a) According to the present invention, a thin wire material can be removed from an electrodeposit material or a surrounding material that is formed by electroforming. The thin wire material can be removed by any of the following methods: [i] heating and thermally expanding the electrodeposit material or the surrounding material or cooling and contracting the thin wire material to form a clearance between the electrodeposit material or the surrounding material and the thin wire material; [ii] submerging the material into a liquid or applying a liquid to the material, thereby making a place where the thin wire material and the electrodeposit material or the surrounding material are brought into contact slippery; [iii] pulling the material from one end or both ends, deforming the material so as to reduce a cross-sectional area thereof, and forming the clearance between the thin wire material and the electrodeposit material or the surrounding material, followed by holding and pulling the material, sucking the material, physically pushing away the material, or pushing the material away by ejecting a gas or a liquid; or [iv] melting or dissolving the material with heat or a solvent.

If the aforementioned methods are used when removing a thin wire material, the thin wire material can be removed, for example, by using a thin wire material with a diameter of 10 μm to 85 μm, even from the electrodeposit material or the surrounding material that is formed so that the thin wire material has a thickness of 5 μm or more and 50 μm or less on its outer surface. Therefore, by using the thin wire material removal method, for example, an electroformed tube with a fine inner diameter that can be used as a tube for a contact probe can be manufactured.

[0117]

(b) According to a method of manufacturing an electroformed tube by increasing the volume of an electrodeposit material or a surrounding material on the end side that is formed on a thin wire material, for example, when removing the thin wire material by pulling it out from or pushing it away from the electrodeposit material or the surrounding material, a jig or tool, etc. can be get caught on the end face of the part where the amount of the electrodeposit material and the surrounding material was increased. Therefore, in this case, a thin wire material can be removed while securing the electrodeposit material or the surrounding material, and therefore, the thin wire material can be easily removed.

[0118]

(c) According to the manufacturing method of an electroformed tube where the deformation amount of lateral strain when a thin wire material is extended by pulling it outward is arranged to be 5% or more of the cross-sectional area, a sufficient clearance is formed for removing the thin wire material between the thin wire material and the electrodeposit material or the surrounding material. Therefore, it is highly possible to remove the thin wire material from the electrodeposit material or the surrounding material without any difficulties. If the deformation amount of lateral strain is 5% or less of the cross-sectional area, the clearance is insufficient and there may be cases where a hindrance occurs when removing the thin wire material.

[0119]

(d) According to a manufacturing method of an electroformed tube by using a thin wire material where the conductive layer is provided on the outer surface and by removing the thin wire material so that the conductive layer is left on the inner surface of the electroformed tube, an electroformed tube provided with a gold-plating, etc. on its inner surface can be manufactured. The aforementioned electroformed tube, for example, can be arranged to have a higher electric conductivity than in the case of an electrodeposit material or a surrounding material alone, depending on the material of the conductive layer that is provided on the inner surface. In this case, said electroformed tube can be used as a component suitable for conducting the electricity.

An electroformed tube with a higher electric conductivity than in the case of an electrodeposit material or surrounding material alone can be manufactured in the same way for an electroformed tube wherein a conductive layer that is made of a material different from the electrodeposit material or the surrounding material is provided on its inner surface or for a thin wire material wherein a conductive layer made of a material different from the electrodeposit material or the surrounding material is provided on its outer surface.

[0121]

(f) A product with multiple pieces of hollow parts that are formed by removing a thin wire material can be used by replacing with a component that were manufactured by aligning multiple tubes that has only one hollow part. When using the electroformed tube, it can eliminate time and effort needed to align and set individual tubes. In addition, since intervals between the hollow parts are secured by the electrodeposit material or the surrounding material, they are not misaligned.

[0122]

(g) An electroformed tube wherein a partition body that is formed by providing a conductive layer on the outer surface of the insulating material is interposed between the hollow parts so that the electricity can be conducted independently for each part formed around each hollow part makes it possible to conduct the electricity independently for each hollow part.

[0123]

(h) Concerning a thin wire material with a part where a conductive layer is not provided formed on both ends, if the part where the conductive layer is not provided is pulled outward, it becomes difficult for the pull force to directly apply to the conductive layer, the conductive layer and the baseline material can be easily separated, and it becomes difficult to destroy the adhesion between the conductive layer and the electrodeposit material or the surrounding material.

[Concise explanations of figures]

[FIG. 1] A cross-sectional explanatory view showing an example of an electroforming device to manufacture an electroformed tube related to the present invention.

[FIG. 2] An explanatory view showing the state where the large-diameter part was formed at an end of an electrodeposit material.

[FIG. 4] A cross-sectional explanatory view showing a state in which an electrodeposit material is formed around a thin wire material that is provided with a conductive layer on the outer peripheral surface.

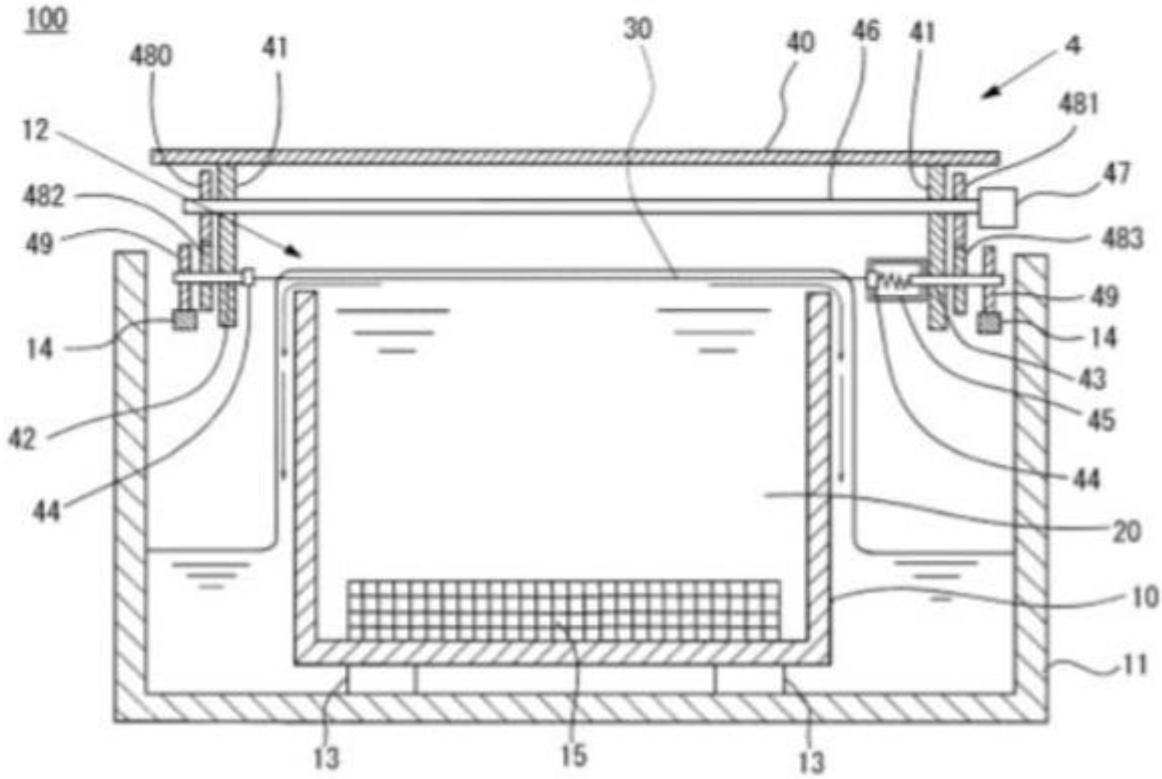
[FIG. 6] An explanatory view showing a state in which an electrodeposit material is formed around thin wire parts with a part where a conductive layer is not provided formed on both ends.

[FIG. 7] A cross-sectional explanatory view showing other examples of an electroforming device to manufacture an electroformed tube related to the present invention.

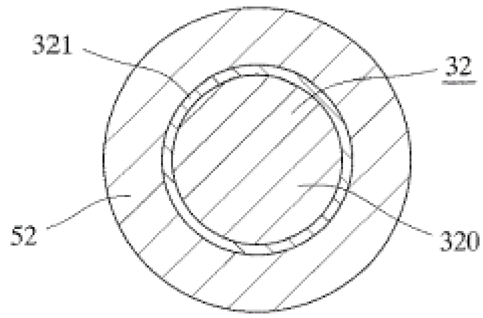
[FIG. 8] An exploded perspective explanatory view showing a manufacturing jig to be used in the electroforming device shown in FIG. 7.

[FIG. 9] An enlarged cross-sectional explanatory view showing an electroformed tube to be manufactured using the manufacturing jig shown in FIG. 8.

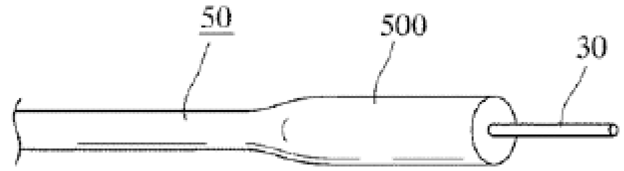
[FIG. 1]



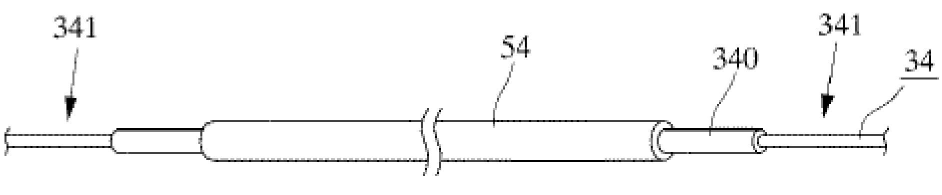
[FIG. 4]



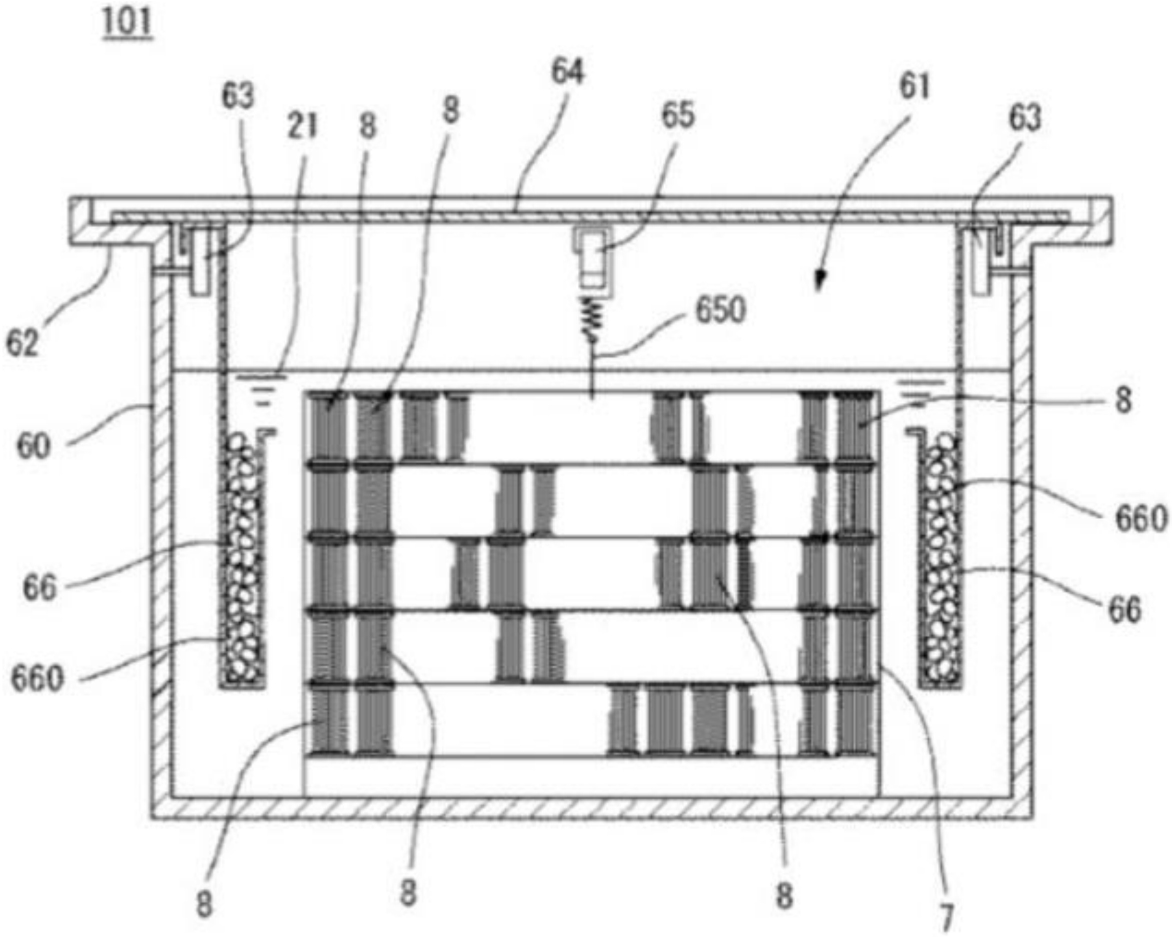
[FIG. 2]



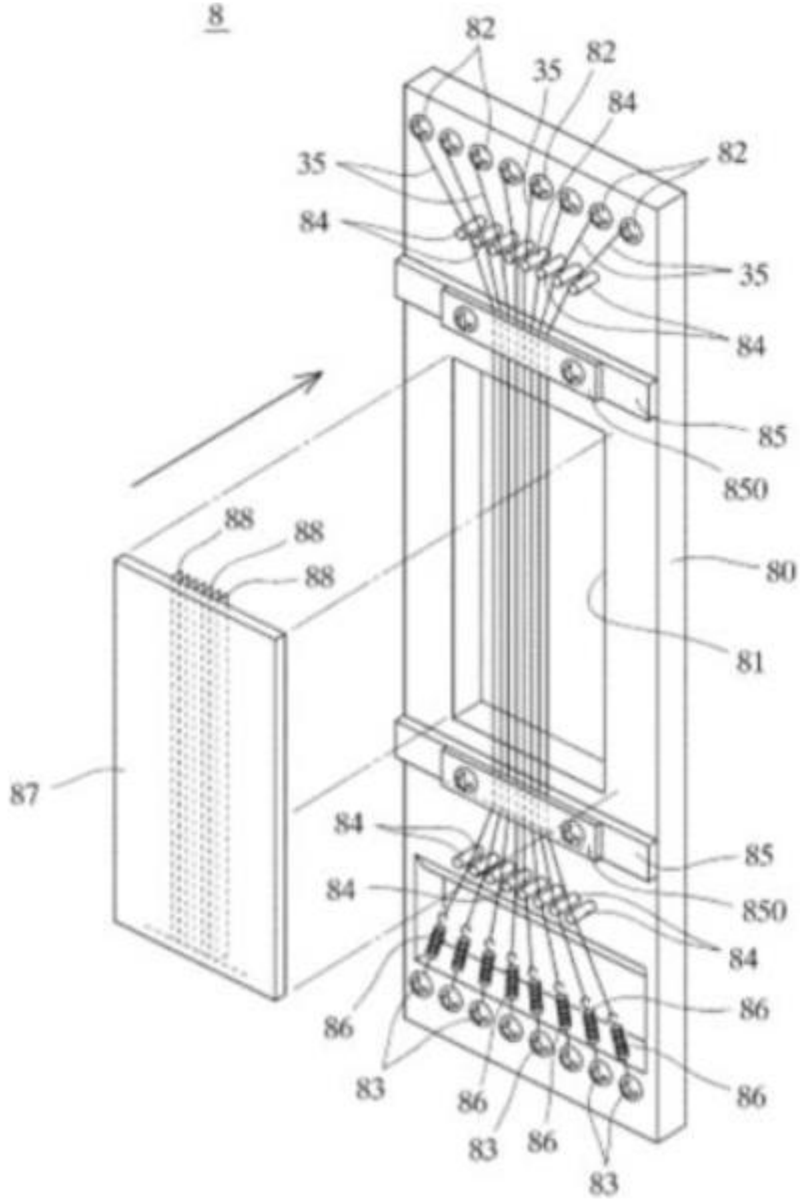
[FIG. 6]



[FIG. 7]



[FIG. 8]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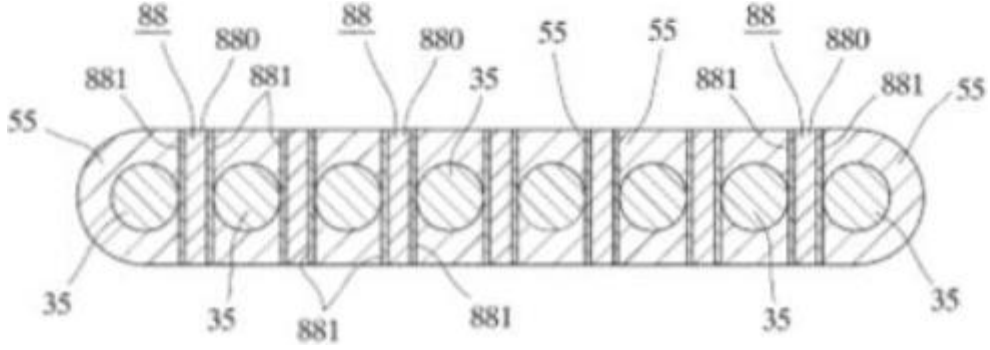
[FIG. 9]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(Attachment 2)

Matters stated in Exhibit Ko 1 Document (Abstract)

[Claims]

[Claim 1] A manufacturing method of a fine cylinder for forming a ferrule characterized by using a core wire with a resistivity of 5×10^{-6} Ωcm or less when providing electroforming to a core wire mold.

[Claim 2] A manufacturing method of a fine cylinder for forming a ferrule characterized by plating a thin layer of the first metal with a resistivity of 5×10^{-6} Ωcm or less on the core wire and then providing electroforming of the second metal to the predetermined diameter.

[Claim 3] A manufacturing method of a fine cylinder for forming a ferrule as defined in Claim 2, for which the core wire is a stainless-steel wire with an outer diameter of 0.126 mm.

[Claim 4] A manufacturing method of a fine cylinder for forming a ferrule as defined in any one of Claim 1 through Claim 3, wherein the first metal is made of any one of gold, silver, copper, aluminum, or an alloy mainly composed of these metals, and the second metal is made of nickel or alloy mainly composed of nickel.

[Detailed explanation of the invention]

[0001]

[Technical field of the invention] The present invention is related to a method of efficiently manufacturing a metal ferrule that is used for optical fiber connectors. In particular, the present invention relates to a method of efficiently manufacturing a fine cylinder for forming a ferrule, which is the intermediate body of a ferrule.

[0002]

[Prior art] A micropore pipe is useful from the perspective of industry. In particular, as shown in FIG. 1, the ferrules used in the telecommunications field are microporous pipes having pores with a diameter of approximately 0.126 mm, an outer diameter of approximately 2.5 mm, and a length of approximately 12 mm.

[0003] A ferrule is used as part of a component of a silica-based optical fiber connector. Since an optical fiber is thin and fragile, it is necessary to surely secure the optical fiber to a connector for its connection. The optical connector component for this purpose is a ferrule. In other words, the optical connector facilitates connection by putting an optical fiber, which has a thickness of approximately 0.125 mm, through a cylindrical tube to secure it and by accurately aligning the positions of the cores that are at the center of the optical fiber.

[0004] Currently used ferrules are made of zirconia or plastic and ferrules made of zirconia are the mainstream. In order to manufacture a ferrule made of zirconia, it requires expensive injection molding machines, extrusion molds, and molds. Molding machines and molds have a short life and energy cost is high since the molding of zirconia and resins are processed at a high temperature of 500 °C to 1200 °C. In order to keep the precision of the dimension of the pores at the center, the pores must be ground with a linear diamond polishing body. Since grinding is performed manually by highly skilled operators, productivity is low, and other problems are pointed out. In order to increase the precision of the outer diameter, the surface is ground. In addition, in order to increase the precision of the coaxiality of the inner diameter and the outer diameter, processing by a centerless grinder is performed. Even when the aforementioned processing is provided, the inner diameter, outer diameter, and coaxiality vary. Therefore, in actual situations, each piece is inspected one by one and is classified by its dimensions.

[0005] The present invention relates to a method of efficiently manufacturing a metal ferrule by electroforming in place of such expensive zirconia ferrules. Manufacturing pore pipes by electroforming is already known. For example, Japanese Unexamined Patent Application Publication No. 1999-193485 describes the manufacturing method of a tube with pores wherein a metal coating is formed on the surface of core material and the core material is removed, leaving the formed metal coating. In addition, Japanese Unexamined Patent Application Publication No. 1981-90995 and Japanese Unexamined Patent Application Publication No. 1992-311589 describe the method of manufacturing a thin pipe by electroforming a metal on the outer peripheral surface of a core wire which can be dissolved by chemicals, cutting the metal into the predetermined size, and dissolving and removing the core wire with chemicals.

[0006] When manufacturing a metal ferrule for optical fiber connectors, this method can be used in principle; however, the problem is that since the inner diameter of a ferrule is approximately 0.126 mm, which is very thin, it is extremely difficult to dissolve the core wire of a fine cylinder for forming a ferrule with etching solution. Also, there has been the problem that the core wire is easily broken when the core wire is pulled out.

[0007] The present inventors have devised a method of manufacturing ferrules using a stainless-steel wire having a diameter of 0.126 mm as the core wire, forming a fine cylinder for forming a ferrule having an outer diameter of 2.5 mm by electroforming nickel, etc. on the outer surface of the stainless-steel wire, cutting the cylinder into a length of 12 mm, for example, and then pulling out the core wire. In order to increase the production efficiency of this manufacturing method, it is possible to efficiently manufacture a ferrule by making the core wire as long as possible, for example, 30 cm to 40 cm, forming a fine cylinder for forming a ferrule with a length of 30 cm to 40 cm by electroforming the outer surface so that the outer diameter becomes uniform, and cutting it into the predetermined length.

[0008]

[Problem to be solved by the invention] However, as the core wire becomes longer, the outer diameter of the fine cylinder for forming a ferrule that is formed by electroforming on its outer surface becomes larger on the side near the power source, as shown in FIG. 3 (b), and the diameter on the side far from the power source becomes smaller. Accordingly, an electroformed body having an uneven outer diameter tends to be obtained. This is because the current density is large in the part near the power source, but the electric resistance of the core wire becomes larger as the core wire part becomes farther away from the power source and the current density becomes smaller, and the amount of electrodeposition on the surface of the core wire becomes smaller. As a result, a diameter becomes larger at the part closer to the power source where current density is large and the diameter becomes smaller at the part farther from the power source.

[0009] In particular, the present invention is to provide a method of efficiently manufacturing a fine cylinder for forming a ferrule with a uniform outer diameter, a small inner diameter, and a high coaxiality, when manufacturing a microporous pipe for a small ferrule with a long length and an inner diameter of 0.126 mm by electroforming.

[0014] In order to manufacture a pipe with a thin diameter by electroforming, for example, according to Japanese Unexamined Patent Application Publication No. 1998-335135, a soft magnetic thin film may be formed by electroplating on a chromium core material first. By cutting this into the predetermined length using a wire saw and immersing them in a chromium etching solution to etch the chromium core material, a hollow cylindrical body is obtained.

[0015] In this method, in order to increase productivity, it is recommended to apply electroforming to a core wire that is as long as possible, and then to cut it into the predetermined length.

[0016] As described above, for example, when electroforming a stainless-steel wire having a diameter of 0.125 mm and a circular cross-section as a core wire (see FIG. 2), an electroformed body is obtained in which the outer diameter is uneven, gradually decreasing from one end toward the other end as shown in FIG. 3 (b). As a result of conducting various studies to solve this problem of uneven diameters, the present inventors, etc. found that the resistivity of the core wire greatly influences the non-uniformity of the diameter. Using a metal that has a resistivity smaller than the predetermined value as the core wire made it possible to manufacture a fine cylinder for forming a ferrule with a uniform outer diameter even if a long core wire is used.

[0017] It is desirable to set the resistivity on the core wire surface to 0, and, for example, it is preferable to select a core wire with a resistivity of 5×10^{-6} Ωcm or less. If the resistivity is larger than this value, it is difficult to obtain an electroformed product having a uniform outer diameter when electroforming is performed using a long core wire. As examples of a material having a resistivity of 5×10^{-6} Ωcm or less, gold, silver, copper, aluminum, and alloys containing these materials as a main component are listed. In addition, since phosphor bronze has a low resistivity and high tensile strength, it can be suitably used.

[0018] The resistivity is preferably 5×10^{-6} Ωcm or less. A core wire having a resistivity of 5×10^{-6} Ωcm or less may be used, or a metal having a high resistivity, for example, a stainless-steel wire that is plated with a metal having a low resistivity on a thin layer of approximately 10 μm may be used. By performing electroforming using these core wires, the electrodeposition amount along the length direction of the core wire becomes uniform, and a fine cylinder for forming a ferrule having a uniform outer diameter can be obtained. Regarding the thickness of the layer to be plated with the first metal having low resistivity, it suffices if the thickness is enough to secure good electric conductivity, and the thickness is preferably from several μm to 10 and several μm.

[0019]

[Embodiment of the invention] The present invention is explained based on the embodiment below. The electroforming device is as shown in FIG. 2. Electroforming device 10 includes an anode and a cathode. For anode 15, metal plate, metal ball, etc., which is a metal to be electrodeposited, can be used. When using a metal ball, the metal ball can be used in a state where it is placed in a conductive bag, etc. The anode is connected to power source 11, for example, the positive electrode of a battery. The cathode is core wire 16 to provide electroforming and, for example, it is connected to the negative electrode of a battery. Core wire 16 is supported by support frame 14. While being supported by support frame 14, core wire 16 is immersed in electroforming liquid 18, is rotated by motor 12, and is provided with electroforming.

[0020] Stainless-steel is selected as a substrate of a wire to be used for a mold and the wire on which silver-, gold-, and copper-plating with a thickness of approximately 10 μm is provided on its surface can be used as a core wire. It is also possible to use a wire with a substrate of gold, silver, aluminum, copper, or an alloy mainly containing them. It is preferable for the surface of the core wire to be a smooth surface; however, there is minute unevenness in many cases. By plating the core wire with a metal having low resistivity on the surface, there is also an advantage that the outer surface of the core wire becomes smooth. In addition, since the stainless-steel wire or the phosphor bronze wire has high tensile strength, it is convenient to pull out the core wire from the fine cylinder for forming a ferrule.

[0021] Electroforming liquid 18 is determined depending on the type of metal to be electroformed. As a metal to be electroformed, nickel, iron, copper, cobalt, tungsten, or an alloy thereof can be used. In response to these metals, a liquid containing mainly the following can be used as an electroforming liquid: aqueous solutions of nickel sulfamate, nickel chloride, nickel sulfate, ferrous sulfinate, ferrous borofluoride, copper pyrophosphate, copper sulfate, copper borofluoride, copper silicofluoride, titanium copper fluoride, alkanol copper sulfonate, cobalt sulfate, sodium tungstate, etc.

[0022] Among these, in particular, it is preferred to use an electroforming liquid mainly containing nickel sulfinate in view of the ease of electroforming, the physical properties such as hardness of the product, chemical stability, and ease of welding, etc. When a current density of approximately 7 to 10 A/dm^2 of DC current is applied for one day, an electroformed product that grows to a diameter of 3 mm can be obtained. Core wire 16 is removed by pulling out or crushing the wire that is used as a mold from the electroformed product.

[0023]

[Working examples] Hereinafter, the present invention will be described based on working examples. A core wire with a diameter of 0.136 mm was obtained by providing 10 μm gold-plating (resistivity: 2.05×10^{-6} Ωcm) to a stainless-steel wire with a circular cross-section, a diameter of 0.126 mm and a length of 355 mm. As shown in FIG. 2, the core wire was set in an electroforming jig. On the other hand, a metal plate of nickel was set in an electroforming bath containing nickel sulfamate as the main component and immersed the plate in the electroforming bath. Electroforming was performed at a current density of approximately 10 A/dm^2 for 18 hours using a core wire as a cathode and nickel plate as an anode. By electroforming, a nickel-electroformed product with a mean diameter of approximately 2.5 mm was obtained. An outer diameter of the electroformed product is within the range of 2.5 mm ± 0.05 mm along the length direction, and a uniform electroformed product was obtained. Also, roundness and coaxialty were good.

[0024] This electroformed product was cut into a length of 12 mm by an NC automatic processing machine, and one end of the electroformed product was bored. The core wire was removed by setting the processed product vertically by facing the non-bored surface up, hitting the core wire with a hammer that has a projection from the top in the wire punching machine, and pulling part of the core wire that projects from beneath the processed product. The end face was ground to form a ferrule.

[0026]

[Effect of the invention] By coating with a material having a resistivity of 5×10^{-6} Ωcm or less on the core wire surface or using a material having a resistivity of 5×10^{-6} Ωcm or less as a core wire, a fine cylinder for forming a ferrule with a uniform outer diameter, a high roundness and coaxiality, and with a long length can be manufactured. The manufacturing of a ferrule by electroforming requires no expensive molding machines and molds but requires only inexpensive electroforming equipment as manufacturing equipment. In addition, since there is no process of baking at a high temperature, the energy cost is low. Furthermore, since electroforming has very good dimensional transfer accuracy, the precision of the product dimensions is so high that it is not necessary to sort them by measuring dimensions.

[Concise explanations of figures]

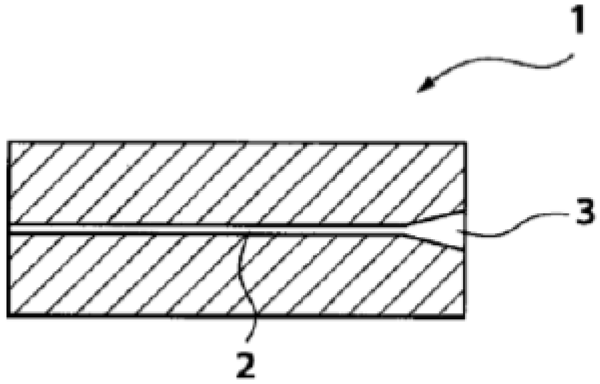
[FIG. 1] It is a figure showing a ferrule.

[FIG. 3] It is a figure showing an example of an electroformed product.

[Explanation of codes]

1. Ferrule, 2. Pore, 3. Optical fiber introduction hole

[FIG. 1]



[FIG. 3]