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(54) String for musical instrument

(57) A string for a musical instrument capable of producing an improved tone quality comprises a fiber as a core fiber composed of a vinylidene fluoride-based resin and a coating layer comprising a silicone-based resin formed over a surface of the fiber core.

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Description

BACKGROUND OF THE INVENTION:

The present invention relates to a string for a musical instrument, and more particularly to a string for a musical instrument, which comprises a fiber composed of a vinylidene fluoride-based resin and a coating layer composed of a silicone-based resin, formed on a surface of the fiber.

As is known in the art, nylon strings have been mainly utilized as strings for musical instruments, especially as strings for guitars. However, such nylon strings cause the change in the passage of time of tone quality due to their water-absorption properties and, therefore, are not necessarily satisfactory in tone quality such as musical interval, tone color and timbre, tuning ability, i.e., easiness in adjusting the musical interval, and a sound volume. In order to solve these problems, the present inventors have been previously proposed strings for musical instruments consisting essentially of vinylidene fluoride-based monofilament fiber. For example, Japanese Patent Publication (KOKOKU) No. 2-36958 (1990) discloses a musical instrument string consisting essentially of a vinylidene fluoride-based monofilament which has (1) a filament diameter of 0.4 to 1.5 mm∅, (2) a diameter dispersion of not more than 5 % per meter, (3) a roundness of the cross-section shape of the filament of not less than 95 %, (4) a specific gravity of not less than 1.6, (5) an inherent viscosity of 1.1 to 1.6 dl/g, (6) an apparent viscosity of 8,000 to 20,000 poises when measured at 260°C and a shear rate of 1/100 second, (7) a birefringence of 30×10^{-3} to 40×10^{-3}, (8) a tensile strength of not less than 50 kg/mm^2, (9) an elongation of 10 to 40 %, (10) a creep elongation of not more than 10 % when measured at a load of 20 % of the tensile strength, and (11) a Young's modulus of not less than 200 kg/mm^2.

However, there arises such a problem that the afore-mentioned musical instrument string is apt to have a metallic tone quality near that of a steel string so that the tone quality, especially at higher-pitched tones, is cacophonous or inconsonant to the ear.

Accordingly, it has been earnestly demanded to provide a string for musical instrument, which is composed of a vinylidene fluoride-based fiber and improved in its tone quality so as to generate sounds having a round and soft tone quality without the harsh metallic sounds.

As a result of intense studies by the present inventors, it has been found that by coating a silicone-based resin on a surface of a fiber composed of a vinylidene fluoride-based resin, the thus-obtained fiber for musical instrument string can exhibit a smooth continuity of harmonics while maintaining its clear and tightened tone quality, and can be prevented from generating harsh metallic sounds by reducing higher-pitched harmonics, whereby a gentle and soft tone quality can be produced. On the basis of the findings, the present invention has been attained.

SUMMARY OF THE INVENTION:

It is an object of the present invention to provide a string for a musical instrument, which comprises a fiber composed of a vinylidene fluoride-based resin and capable of improving a tone quality so as to produce a round and soft tone without harsh metallic sounds.

To accomplish the aim, in an aspect of the present invention, there is provided a string for a musical instrument, which comprises a fiber as a core fiber comprising a vinylidene fluoride-based resin and a coating layer comprising a silicone-based resin formed on a surface of the fiber.

BRIEF DESCRIPTION OF THE DRAWINGS:

Fig. 1 is a view showing a harmonics-spectrum with respect to a guitar as a musical instrument string of Example 1, which comprises a vinylidene chloride-based resin and is coated with a silicone-based resin;

Fig. 2 is a view showing a harmonics-spectrum with respect to a guitar as a musical instrument string of Example 2, which comprises a vinylidene chloride-based resin and is coated with a silicone-based resin;

Fig. 3 is a view showing a harmonics-spectrum with respect to a guitar as a musical instrument string of Example 3, which comprises a vinylidene chloride-based resin and is coated with a silicone-based resin;

Fig. 4 is a view showing a harmonics-spectrum with respect to a guitar as a musical instrument string of Comparative Example 1, which comprises a vinylidene chloride-based resin but is not coated with a silicone-based resin; and

Fig. 5 is a view showing a harmonics-spectrum with respect to a guitar as a musical instrument string of Example 4, which comprises a vinylidene chloride-based resin and is coated with a silicone-based resin.

DETAILED DESCRIPTION OF THE INVENTION:

The fiber used as the core fiber of the musical instrument string according to the present invention, is produced by melt-extruding a vinylidene fluoride-based resin in the form of fibers and then spinning, cooling and stretching the obtained fiber material, followed by heat-treating, if necessary. The vinylidene fluoride-based resins used may include not only a homopolymer of vinylidene fluoride but also copolymers composed of not less than 90 mol % of vinylidene fluoride and other monomers copolymerizable therewith. The other monomers copolymerizable with vinylidene fluoride may include, for example, ethylene tetrafluoride, ethylene hexafluoride, ethylene trifluoride, vinyl fluoride or the like. Further, commercially available vinylidene fluoride-based fibers for musical instruments can be also suitably used.

The fiber composed of a vinylidene fluoride-based resin (hereinafter occasionally referred to merely as "fiber") may be used in the form of either monofilament or multi-filament. The diameter of the monofilament may be usually in the range of 0.4 to 1.5 mm. The multi-filament may be used in the form of a folded and twisted yarn which is composed of usually 5 to 1,000, preferably 12 to 36 of monofilaments each having a filament diameter of not more than 0.2 mm. In addition, the multi-filament may be also in the form of a knitted fiber. Furthermore, the multi-filament may be in the form of a wound fiber comprising a monofilament as a core material and a finer fiber wound tightly around a surface of the monofilament, or in the form of a sheathed fiber composed of a monofilament as a core material and a braided fine fiber covering the monofilament.

In the case where the musical instrument string is in the form of a monofilament composed of a vinylidene fluoride-based resin, it is preferred that the string may have the physical properties: (1) a filament diameter of 0.4 to 1.5 mm∅, (2) a diameter dispersion of not more than 5 % per meter, (3) a roundness of the cross-section shape of the filament of not less than 95 %, (4) a specific gravity of not less than 1.6, (5) an inherent viscosity of 1.1 to 1.6 dl/g, (6) an apparent viscosity of 8,000 to 20,000 poises when measured at 260°C and a shear rate of 1/100 second, (7) a birefringence of 30×10^{-3} to 40×10^{-3}, (8) a tensile strength of not less than 50 kg/mm^2, (9) an elongation of 10 to 40 %, (10) a creep elongation of not more than 10 % when measured at a load of 20 % of the tensile strength, and (11) a Young's modulus of not less than 200 kg/mm^2.

On the other hand, in the case where the musical instrument string is in the form of twisted multi-filament yarn composed of a vinylidene fluoride-based resin, it is preferred that the string may have the physical properties: (a) a filament diameter of 0.05 to 5 mm∅, (b) an elongation of 10 to 50 %, (c) a tensile strength of not less than 30 kg/mm^2, (d) a creep elongation of not more than 15 % when measured after the string is exposed to a load of 20 % of the tensile strength for 24 hours, and (e) a Young's modulus of not less than 200 kg/mm^2. In this case, individual monofilaments constituting the twisted multi-filament yarn may each have the physical properties: (1) a filament diameter of 1 to 300 μm, (2) a diameter dispersion of not more than 20 % per meter, (3) a specific gravity of not less than 1.6, (4) an inherent viscosity of 0.85 to 1.6 dl/g, (5) an apparent viscosity of 12,000 to 100,000 poises when measured at 240°C and a shear rate of 1/50 second, and (6) a birefringence of 30×10^{-3} to 50×10^{-3}.

As the silicone-based resin used in the present invention, any commercially-available silicone-based resins can be used as far as they have appropriate film-forming properties. Examples of the suitable silicone-based resins may include dimethyl silicone resins, silicone resins modified with a higher fatty acid having not less than 15 carbon atoms, amino-modified silicone resins, epoxy-modified silicone resins, glycol-modified silicone resins, methyl-hydrodiene-silicone resins, methyl phenyl silicone resins, polysiloxane-based silicone resins, organometal salt-based silicone resins or the like. The amount of the silicone-based resin coated is usually in the range of 0.1 to 10 % by weight, preferably 0.5 to 5 % by weight based on the total weight of the core fiber and the coating layer. When the amount of the silicone-based resin coated is less than 0.1 % by weight, any effects by the coating may not be obtained. On the other hand, if the amount of the silicone-based resin coated is more than 10 % by weight, the effects by the coating is saturated and, therefore, no further increase in the effects by the coating cannot be expected.

Further, it is preferred that before being coated with the afore-mentioned silicone-based resin, the core fiber may be undercoated with other resins. The suitable resins used for the undercoat may include polyester-based resins, acrylic-based resins, polyamide-based resins, polyurethane-based resins, vinylidene fluoride copolymer-based resins or the like. The amount of the undercoat formed is usually in the range of 0.01 to 5 % by weight, preferably 0.05 to 3 % by weight based on the total weight of the fiber core and the undercoat. By preliminarily forming the undercoat on the surface of the core fiber, bonding strength between the core fiber and the coating layer can be increased, whereby the coating layer composed of the silicone-based resin is prevented from separating from the surface of the core fiber.

The polyester-based resins used for the undercoat may be prepared by the polycondensation of respective components selected from diols and dicarboxylic acids. Examples of the suitable diols may include ethylene glycol, propane diol, butane diol, neopentyl glycol, pentane diol, hexane diol, octane diol, decane diol, cyclohexane dimethanol, diethylene glycol, triethylene glycol, polyethylene glycol, tetramethylene glycol or the like. Examples of the dicarboxylic acids may include terephthalic acid, isophthalic acid, phthalic acid, naphthalene dicarboxylic acid, metal salts of 4-sulfonyl isophthalic acid, biphenyl dicarboxylic acid, succinic acid, glutaric acid, adipic acid, azelaic acid, sebacic acid, cyclohexane dicarboxylic acid, oxalic acid, malonic acid or the like.

The preferred acrylic-based resins used for the undercoat may be polymers produced by reacting not less than 30 mol % of one or more acrylic monomers with not more than 70 mol % of vinyl monomers copolymerizable with the acrylic monomers. Examples of the suitable acrylic monomers may include acrylic acid, methacrylic acid, alkyl acrylates, alkyl methacrylates, hydroxyalkyl acrylates, hydroxyalkyl methacrylates, acryl amides, acrylonitrile or the like. Specific examples of alkyl groups contained in the alkyl acrylates or the alkyl methacrylates, may include a methyl group, an n-propyl group, an isopropyl group, an n-butyl group, a 2-ethylhexyl group, a lauryl group, a stearyl group, a cyclohexyl group or the like.

The vinyl monomers copolymerizable with the afore-mentioned acrylic monomers may be preferably those having appropriate functional groups. Examples of the preferred functional groups contained in the vinyl monomers may include a carboxylic group or salts thereof, an acid anhydride group, a sulfonic group or salts thereof, an amide group, an alkylolated amide group, a substituted or unsubstituted amino group, an alkylolated amino group or salts thereof, a hydroxyl group, an epoxy group or the like.

The polyamide-based resins used for the undercoat may include polycondensates prepared from lactams having 3 or more-membered ring, polymerizable ω-amino acid, diamines and dicarboxylic acids which are raw materials of polyamide resins.

Specific examples of the lactams having 3 or more-membered ring may include ε-caprolactam, enanthlactam, α-pyrrolidone, α-piperidone or the like. Specific examples of the polymerizable ω-amino acids may include 6-amino-hexanoic acid, 7-amino-heptanoic acid, 11-amino-undecanoic acid, 9-amino-nonanoic acid or the like. Examples of the diamines may include hexamethylene diamine, nonamethylene diamine, undecamethylene diamine, dodecamethylene diamine, m-xylylene diamine or the like. Examples of the dicarboxylic acids may include terephthalic acid, isophthalic acid, adipic acid, sebacic acid, dodecane-dioic acid, glutaric acid or the like.

Specific examples of the afore-mentioned polyamide-based resins used for the undercoat may include various nylons such as nylon 4, nylon 6, nylon 7, nylon 8, nylon 11, nylon 12, nylon 6 • 6, nylon 6 • 10, nylon 6 • 11, nylon 6 • 12, nylon 6T, nylon 6/6 • 6, nylon 6/6T, nylon 6I/6T and the like.

The urethane resins used for the undercoat may be polymer compounds having urethane bonds, and may be prepared from polyol, polyisocyanate, a chain-lengthening agent, a cross-linking agent and the like. Examples of the suitable polyols are polyehters such as polyoxyethylene glycol; polyoxypropylene glycol or polyoxytetramethylene glycol, polyesters prepared by the dehydration reaction of glycol and dicarboxylic acid, such as polyethylene adipate, polyethylene-buthylene adipate or polycaprolactone; polycarbonates having carbonate bonds; acrylic polyols; castor oil; or the like.

Examples of the suitable polyisocyanates are tolylene-di-isocyanate, phenylene-di-isocyanate, 4, 4'-diphenyl methane-di-isocyanate, hexamethylene-di-isocyanate, xylylene-di-isocyanate, 4, 4'-dicyclohexyl methane-di-isocyanate, isophorone-di-isocyanate, or the like.

Specific examples of the afore-mentioned chain-lengthening agents or the cross-linking agents may include ethylene glycol, propylene glycol, butane-diol, hexane-diol, diethylene glycol, trimethylol propane, hydrazine, ethylene diamine, diethylene triamine, 4, 4'-diamino-dicyclohexyl methane, diehtanol amine, water or the like.

As the vinylidene fluoride copolymer-based resins, copolymers prepared by reacting vinylidene fluoride and monomers having other polar groups copolymerizable therewith may be exemplified. The monomers having other polar groups copolymerizable with vinylidene fluoride may include, for example, acrylic acid, vinyl acetate, maleic anhydride, maleic acid-monoethyl ester, or the like. The vinylidene fluoride copolymer-based resins may contain vinylidene fluoride unit therein in an amount of usually not less than 70 mol %, preferably not less than 80 mol %.

Methods of coating the resin for the undercoat and the silicone-based resin for the coating layer on a surface of the fiber are not particularly restricted. For example, the fiber may be either immersed in respective coating solutions containing these resins or sprayed with the coating solutions and then dried to form the undercoat and the coating layer thereon. Especially, in the formulation of the undercoat and the coating layer, a coating apparatus comprising a bath containing each of the afore-mentioned coating solutions, and a coating roller rotatably supported therein and arranged such that a part of a surface of the roller is dipped in the coating solution is used. In a coating method, the fiber is allowed to pass above and across the rotatable coating roller, so that the coating solution is automatically coated onto the surface of the fiber and then dried. When the amount of the coating solution applied does not reach the aimed value, the afore-mentioned procedure is repeated appropriate times. The coating solution applied onto the surface of the fiber is dried at a temperature of usually 20°C to 100°C, preferably 40°C to 80°C. The concentration of the coating solution can be optionally selected, but usually in the range of 0.1 to 15 % by weight, preferably 0.5 to 10 % by weight.

The coating solution for the undercoat may be used in the form of an organic solution prepared by dissolving the afore-mentioned resin used for the undercoat in an organic solvent such as ethylene dichloride, hexane, toluene, benzene, carbon tetrachloride, acetone, methyl ethyl ketone, 1, 1, 1-trichloroethane or perchloroethane; an aqueous solution of the said resins used for the undercoat; an aqueous emulsion of the said resins used for the undercoat or an aqueous dispersion of the said resins used for the undercoat.

Also, the silicone-based resin solution for the coating layer may be used in the form of an appropriate coating solution depending upon kinds of the silicone-based resin used. For example, as the coating solution, an organic solution prepared by dissolving the silicone-based resin in an organic solvent such as ethylene dichloride, hexane, toluene, benzene, carbon tetrachloride, acetone, methyl ethyl ketone, 1, 1, 1-trichloroethane or perchloroethane; an aqueous emulsion of the silicone-based resin used or an aqueous dispersion of the silicone-based resin used may be exemplified.

The core fiber is preferably surface-treated by a corona-discharge, an ultraviolet-light irradiation or the like to enhance an affinity of the core fiber with the undercoat or the coating layer.

The surface treatment of the core fiber by the corona discharge is carried out such that the core fiber is allowed to pass above and across an electrode roller opposed on its upper side to a needle-like metal counter electrode, while generating corona discharge between both the electrodes. In this case, it is preferred that the surface treatment by corona discharge may be conducted at a temperature of, for example, 80°C to 100°C.

The ultraviolet-light irradiation may be conducted by using an ultraviolet light classified into UV-C having a wavelength of 100 to 400 nm. The amount of ultraviolet light irradiated is usually in the range of 50 to 10,000 mW • sec/cm^2, preferably 100 to 5,000 mW • sec/cm^2. When the amount of ultraviolet light irradiated is less than 50 mW • sec/cm^2, the effects by the surface treatment may not be sufficiently exhibited. On the other hand, even if the amount of ultraviolet light irradiated is more than 10,000 mW • sec/cm^2, any remarkable increase in the effect by the surface treatment may not be expected.

The musical instrument string according to the present invention can be applied to stringed instruments such as guitars, violin, viola or the like.

The use of the musical instrument string comprising the core fiber composed of the vinylidene fluoride-based resin and the coating layer comprising a the silicone-based resin formed on the surface of the core fiber, results in such advantages that a smooth continuity of harmonics can be produced while maintaining a clear and tightened tone quality, and production of harsh metallic sounds can be prevented by reducing high-pitched harmonics, whereby a gentle and soft tone quality can be produced. Further, a good lubricating property can be obtained due to the inherent characteristic of the silicone-based resin contained in the coating layer, whereby rendering the musical instrument comfortable to play and reducing a sense of fatigue after playing.

Examples:

The present invention is described in more detail below by way of examples, but these examples are only illustrative and therefore not intended to limit the present invention.

The measurement of harmonics-spectrum (frequency analysis) was conducted under the following conditions.

Equipments used:

Recorder: MD recorder MZ-1 (manufactured by Sony Corp.)
Microphone: ECM-737 (manufactured by Sony Corp.)
Guitar: G-33 (manufactured by Kawai Gakki Co., Ltd.)
Analyzer: FET analyzer CF-350 (manufactured by Ono Sokki Co., Ltd.)

Further, the measurement of the harmonics-spectrum was conducted while the first string (E string) remained open. Incidentally, the harmonics to be measured represents tones having frequencies obtained by multiplying the frequency (325 Hz) of a fundamental tone by integers.

Example 1:

Musical instrument strings composed of a vinylidene fluoride-based resin (the first to third guitar strings "ALLIANCE" produced by SABARES Co., Ltd.) were immersed in a 15 weight % aqueous solution of a silicone-based resin (aqueous emulsion-type fiber-coating agent composed of silicone: "BY22-826" produced by TORAY DOW-CORNING SILICONE Co., Ltd.). After being drawn up from the solution, the strings were dried at room temperature of 23°C for 60 minutes. The coating layer having a thickness of 3 μm was formed over a surface of each of the thus-treated strings in an amount of 1.4 % by weight based on the weight of each coated string. The silicone-coated strings prepared above were installed onto the guitar and tightened at given tensions. The guitar was played by 10 players to comparatively evaluate various characteristics of the strings. The results are shown in Table 1 in which the numbers appearing in the table represents the number of the players. Further, the first string (E string) was subjected to the harmonics-spectrum measurement. The results are shown in Fig. 1.

Example 2:

A musical instrument string composed of a vinylidene fluoride-based resin (the first guitar string "ALLIANCE" produced by SABARES Co., Ltd.) was immersed in a 5 weight % aqueous solution of a silicone-based resin (aqueous emulsion-type fiber-coating agent composed of dimethyl polysiloxane-based silicone; "SH7036" produced by TORAY DOW-CORNING SILICONE Co., Ltd.). After being drawn up from the solution, the string was dried at room temperature of 23°C for 60 minutes. The coating layer was formed over a surface of the thus-treated string in an amount of 0.8 % by weight based on the total weight of the coated string. The silicone-coated string prepared above was subjected to the measurement of the harmonics-spectrum in the same manner as defined in Example 1. The results are shown in Fig. 2.

Example 3:

A musical instrument string composed of a vinylidene fluoride-based resin (the first guitar string "ALLIANCE" produced by SABARES Co., Ltd.) was immersed in a 10 weight % aqueous solution of a silicone-based resin (two-liquid system aqueous emulsion-type epoxy-modified silicone; "FZ4685" produced by NIPPON UNIKER Co., Ltd.). After being drawn up from the solution, the string was dried at room temperature of 23°C for 60 minutes. The coating layer was formed over a surface of the thus-treated string in an amount of 0.9 % by weight based on the total weight of the coated string. The silicone-coated string prepared above was subjected to the measurement of the harmonics-spectrum in the same manner as defined in Example 1. The results are shown in Fig. 3.

Comparative Example 1:

The same measurements as defined in Example 1 were conducted except that no coating layer composed of a silicone-based resin was formed on the surfaces of the guitar strings composed of a vinylidene fluoride-based resin. The results of the playing comparisons and the harmonics-spectrum measurements are shown in Table 1 and Fig. 4, respectively.

Table 1

	Playing comparison					
	Tone quality				Playing	
	Softness		Clear tone	Tightened tone	Ease in playing	Ease in tuning
	Soft tone	Metallic tone				
Example 1	8	2	8	9	9	8
Comparative Example 1	3	7	8	9	6	7

As will be seen from Table 1, when the fiber composed of the vinylidene fluoride-based resin, which was coated with the silicone-based resin, was used as the musical instrument string, production of harsh metallic sounds could be prevented while maintaining a clear and tightened tone quality of the string, whereby a round and soft tone quality could be obtained. Also, a good lubricating property was exhibited due to the inherent characteristic of the silicone-based resin contained in the coating layer, which not only rendered the musical instrument comfortable to play but also reduced a sense of fatigue after playing.

Furthermore, as will be seen from Figs. 1 to 3, when the fiber composed of the vinylidene fluoride-based resin, which was coated with the silicone-based resin, was used as the musical instrument string, sounds with a smooth continuity of harmonics could be produced, and production of harsh metallic sounds could be prevented due to reduction in high-pitched harmonics, whereby a smooth tone quality could be obtained. On the other hand, as will be seen from Fig. 4, when the fiber composed of the vinylidene fluoride-based resin but having no coating layer composed of the silicone-based resin was used as the musical instrument string, harmonics were generated only in an intermittent manner, and high-pitched tones were extremely frequently produced, thereby producing harsh metallic sounds.

Example 4:

A musical instrument string composed of a vinylidene fluoride-based resin (the first guitar string "ALLIANCE" produced by SABARES Co., Ltd.) was surface-treated by corona discharge. The surface treatment by corona discharge was conducted by using a high-voltage D.C. supply source (WITHSTAND VOLTAGE TESTER manufactured by Tokyo Seiden Co., Ltd.) in such a manner that a distance between the string and an electrode was held 10 mm, and the corona discharge was carried out at 80°C for one minute while applying a voltage of 5.5 kV to the electrode. The thus-obtained string was coated with the silicone-based resin used in Example 2 (the 5 weight % aqueous solution of dimethyl polysiloxane-based silicone "SH7036" produced by TORAY DOW-CORNING SILICONE Co., Ltd.) in the same manner as defined in Example 1. An entire portion of the coated string was then rubbed against a round rod 50 times while applying a load of 0.02 kg/cm^2 thereto. The string was subjected to the harmonics-spectrum measurement. The results are shown in Fig. 5.

As will be seen from Fig. 5, when the fiber composed of the vinylidene fluoride-based resin, which was surface-treated by corona discharge and then coated with the silicone-based resin, was used as the musical instrument string, it was found that effects due to the coating, such as a smooth continuity of harmonics and reduction of high pitched harmonics, became more enhanced. This indicated that the surface treatment by the corona discharge strengthened an affinity between the silicone-based resin and the vinylidene fluoride-based resin.

Claims

1. A string for a musical instrument, comprising:

   a fiber as a core fiber comprising a vinylidene fluoride-based resin; and
   a coating layer comprising a silicone-based resin formed over a surface of said fiber.

2. A string according to claim 1, wherein said fiber is in the form of a monofilament or multi-filament.

3. A string according to claim 1, wherein the amount of said silicone-based resin coated is in the range of 0.1 to 10 % by weight based on the total weight of said fiber and said coating layer.

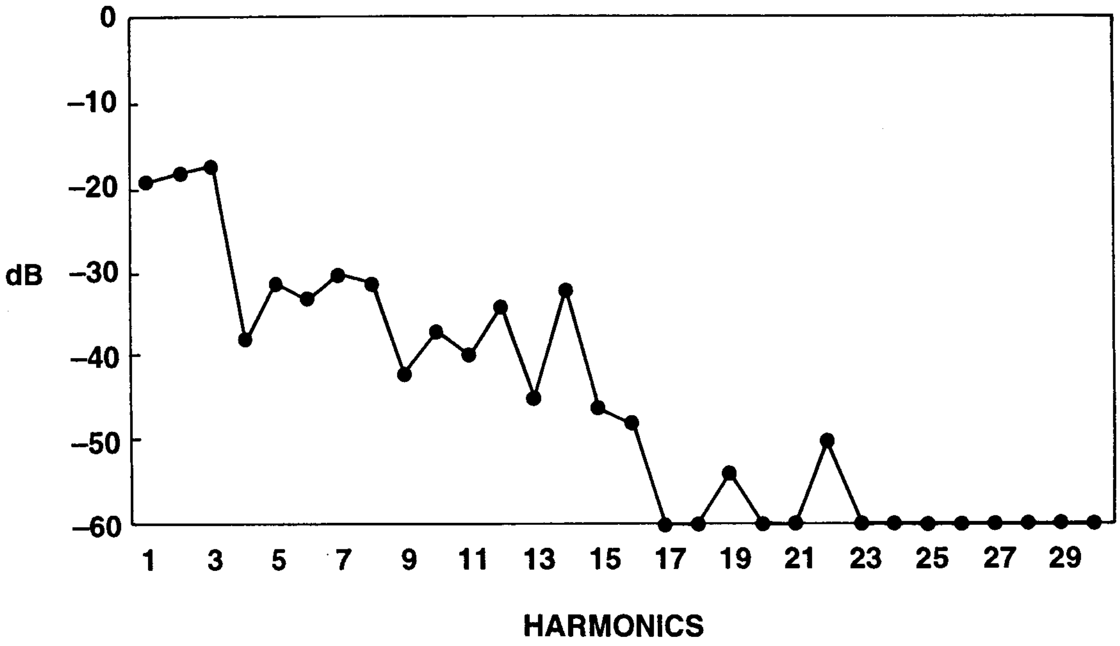
4. A string according to claim 1, wherein said vinylidene fluoride-based resin contains vinylidene fluoride in an amount of not less than 90 mol %.

5. A string according to claim 1, wherein said silicone-based resin is selected from the group consisting of dimethyl silicone resins, fatty acid (carbon numbers: not less than 15)-modified silicone resins, amino-modified silicone resins, epoxy-modified silicone resins, glycol-modified silicone resins, methyl-hydrodiene-silicone resins, methyl phenyl silicone resins, polysiloxane-based silicone resins and organometal salt-based silicone resins.

6. A string according to claim 1, wherein said fiber as the core fiber comprising a vinylidene fluoride-based resin is coated on a surface thereof with a undercoat comprising polyester-based resins, acrylic-based resins, polyamide-based resins, urethane-based resins or vinylidene fluoride copolymer-based resins.

7. A string according to claim 6, wherein the amount of the undercoat is in the range of 0.01 to 5 % by weight based on the total weight of said fiber and said undercoat.

8. A string according to claim 1, wherein said fiber as the core fiber comprising a vinylidene fluoride-based resin is surface-treated by a corona discharge or an ultraviolet-light irradiation.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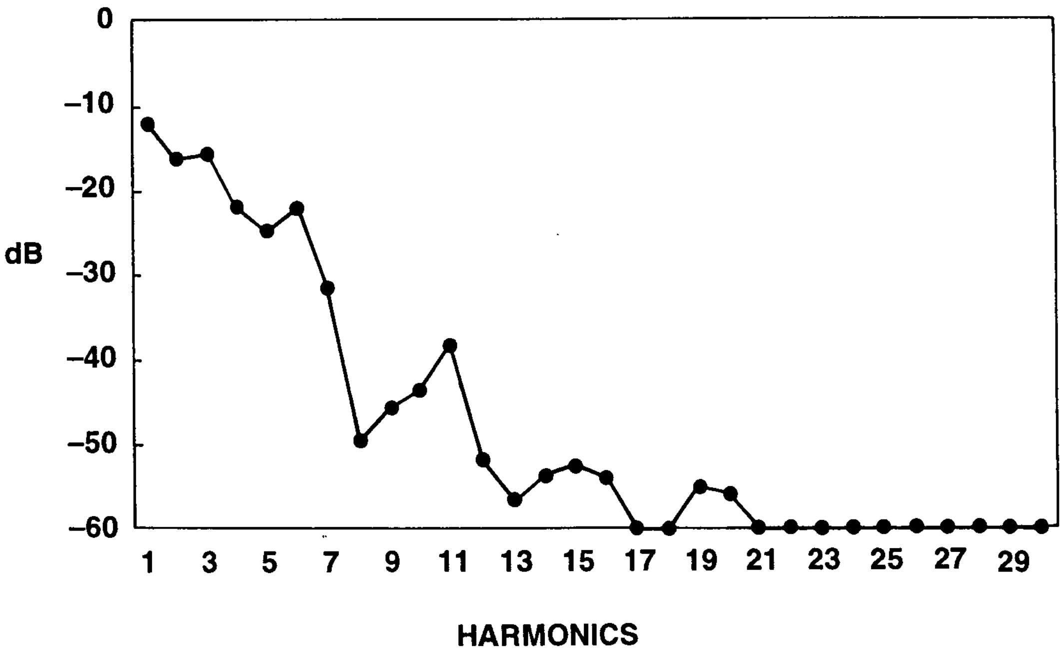
HARMONICS

FIG.1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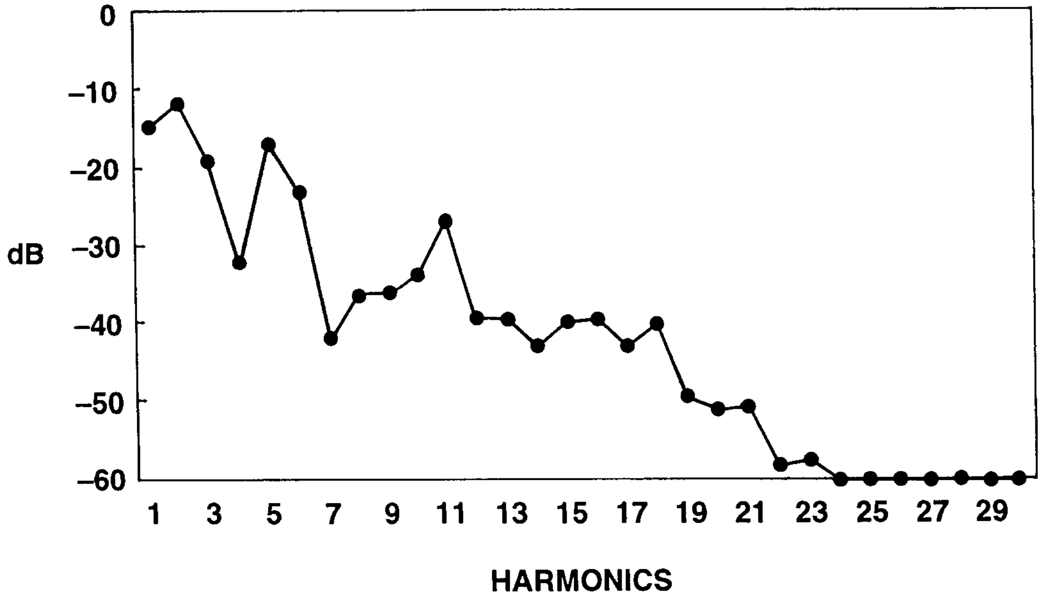
HARMONICS

FIG.2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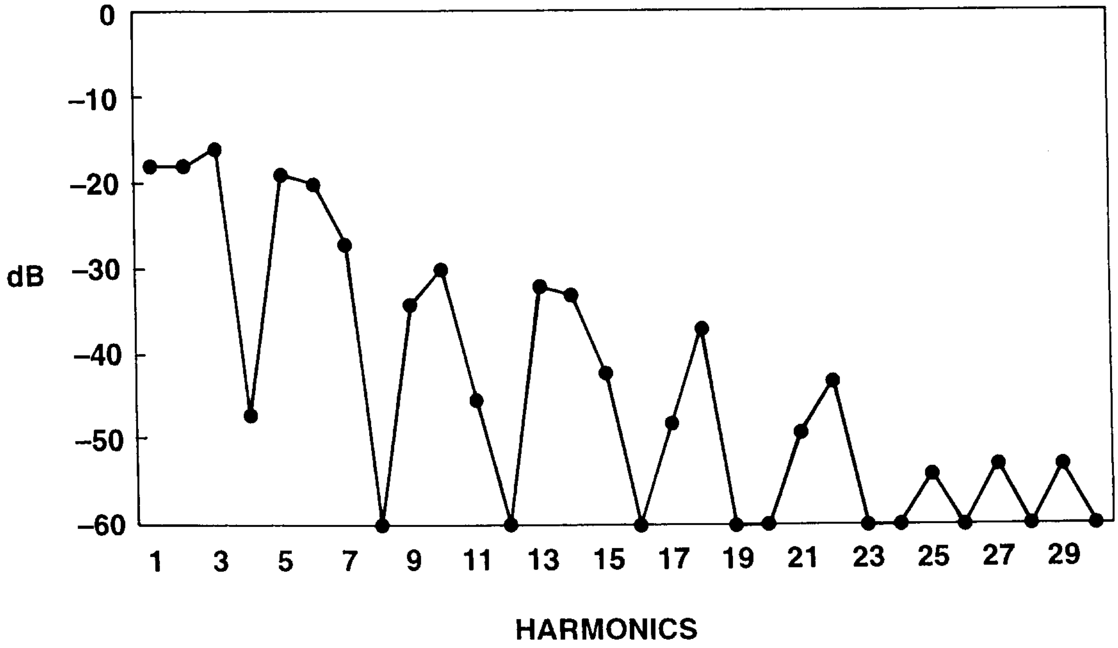
HARMONICS

FIG.3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HARMONICS

FIG.4

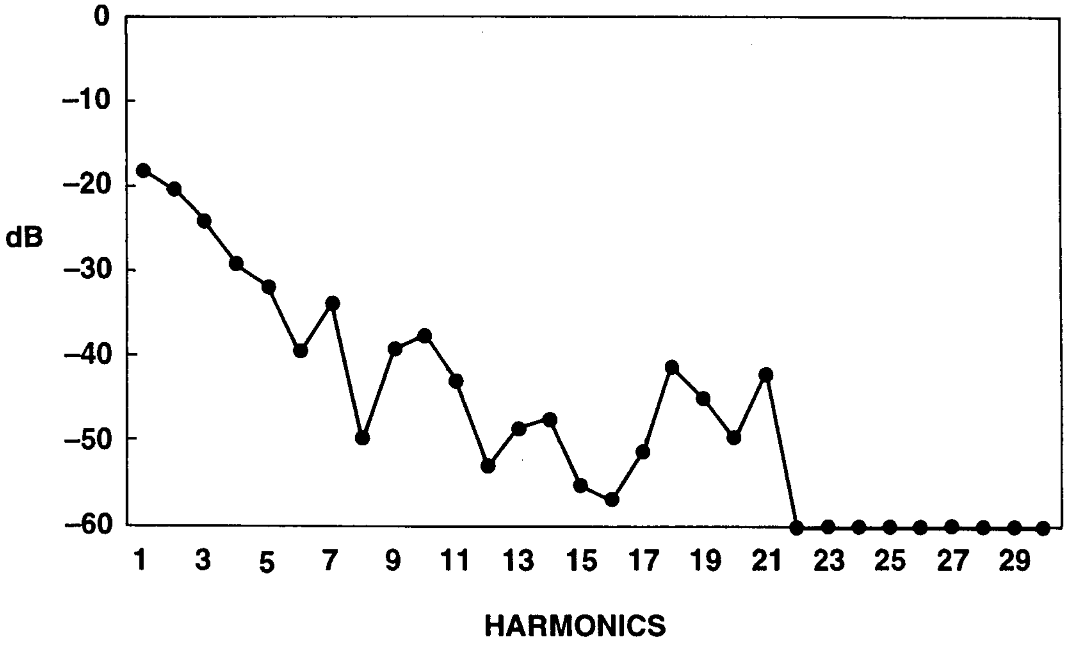

FIG.5