July 30, 1963 H. V. ALLBAUGH 3,099,595

METHOD OF MAKING COMPOSITE MUSICAL INSTRUMENT STRINGS

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Fig. 1.

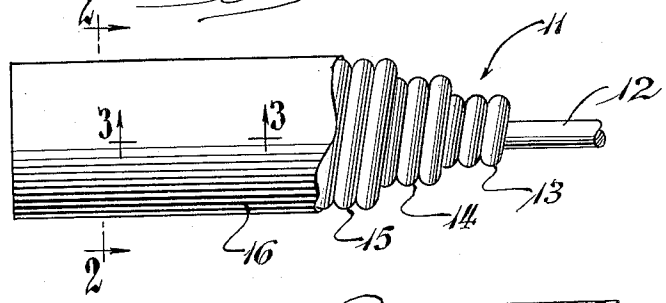


Fig. 2.

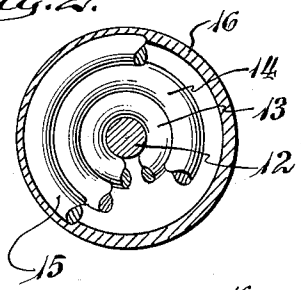


Fig. 3.

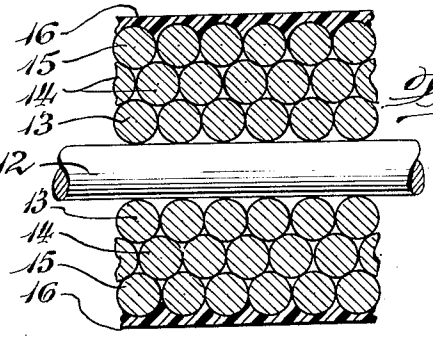


Fig. 4.

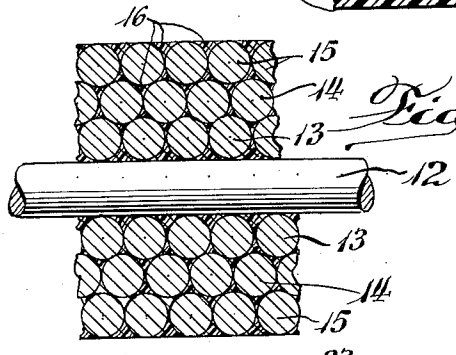
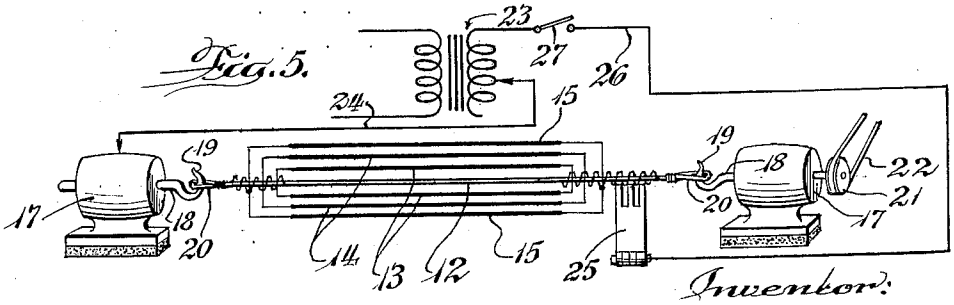


Fig. 5.



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METHOD OF MAKING COMPOSITE MUSICAL INSTRUMENT STRINGS

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This invention relates to musical instrument strings; to composite musical instrument strings; and more particularly to novel improvements in methods and apparatus for making such strings more effectively than previously disclosed and practiced in United States Letters Patents Nos. 2,241,282 and 2,241,283.

In the manufacture of musical instrument strings, it is common practice to prepare the strings compositely; that is, for example, with a central core covered over with a wrapping of metal wire. The central core may be made from gut, in which case, during tuning, its elasticity subjects it to elongation, reduction in cross-sectional area, and consequent loosening of the wire wrapper. In lieu of gut, a central metal core may be employed, covered with an intermediate silk or other soft material wrapping, and ultimately have an external wire wrapped thereover. Because of the soft nature of the intermediate wrapping, the latter external wire also eventually works loose. In each case, of course, the loose wire wrapping causes undesirous false tones.

To obviate loosening of the wire wrapping or wrappings, an intermediate resinous layer, or layers may be placed over the metal core and subjected to heat, which generally is accomplished by placing the metallic core in electrical continuity with an electrical circuit. With the electrical current on, the resistance of the wire causes the wire to heat and, in turn, heat the resin. While the resin still is warm, the external wrapping is applied thereto by conventional means. As hardening of the intermediate resinous layer occurs, the external wire wrapping becomes bonded firmly in place, as described in detail in the aforementioned U.S. Patent No. 2,241,283. Additional resinous layers and metallic wire wrappings are applied in much the same manner.

However, this latter method of making composite musical instrument strings also has proved at times to be unsatisfactory. In the manufacture of strings comprised of multiple wrappings of wire and resin, the method as disclosed in U.S. Patent No. 2,241,283, does not lend itself readily to modern and efficient mass production methods. After each layer of resin is applied, it is separately heated for receiving and binding the immediately succeeding wire wrapping to be applied thereto. Heat distribution often is uneven, resulting only in partial setting of the wire wrapping. Also, heat application for an outer wire often loosens an inner wire. Moreover, the work is tedious and time consuming; since, great care must be taken, when applying a wire wrapping over its respective layer of heated resin, to achieve proper wire setting and binding in place.

Accordingly, a principal object of the present invention is to provide an improved method for making composite musical instrument strings, which method overcomes the foregoing and other shortcomings found in prior art methods for producing such strings.

Another object of this invention is to provide an improved method whereby composite musical instrument strings, even those comprised of multiple wire wrappings, may be manufactured in a highly efficient manner.

Still another object of the present invention is the provision of an improved method whereby the wire elements of a composite musical instrument string are permanently bonded in position with binder compounds, such as heat setting or hardening materials. In carrying out this object it is a feature thereof that binder curing, and setting in place of all wrappings of wire by the binder employed, occurs contemporaneously, thereby greatly reducing the over all time required to manufacture a composite musical string as well as assuring that all wires are firmly and uniformly set in position.

Stated somewhat differently, it is an object of this invention, where composite musical instrument strings are concerned, to provide a novel method whereby a single heating of the resinous binder compound binds all wire wrappings in position.

A still further object of this invention is to provide a novel method whereby a single application of binder compound is sufficient to permanently set even multiple wire wrappings, convoluted one over the other, in position.

A corollary or related object is the provision of a novel method whereby the wire wrappings of a composite musical string may be wound in an uninterrupted sequence, and thereafter the binder is applied over the outer jacket wire.

A further feature of this invention resides in the provision of a method whereby, in the heat curing of composite musical strings, heat is applied thoroughly throughout the string structure and binder to achieve thereby a highly effective locking of the wire wrapping or wrappings in place.

A somewhat more specific object resides in the provision of a novel method whereby binder is applied only externally of the outermost wire wrapper or jacket and electric current is assuredly introduced to the jacket wire and thereafter to the inner wires, thereby insuring the introduction of heat to the binder at the closest proximity to the binder. In carrying out this object, it will be apparent that heating occurs from the outer jacket wire towards the core wire of the string structure.

Other object of this invention are to provide a simple and inexpensive method for manufacturing composite musical strings of superior quality, one which may be conveniently practiced without requiring expensive additional equipment, and one which otherwise is well adapted to produce a musical string capable of giving the service and tone required of it.

In carrying out the method disclosed herein, it is contemplated that the binder compound will be applied over the outer jacket wire of the wire wrappings, the wire wrappings including the core wire placed in electrical continuity, with electrical circuitry, and current sent through the wires, the resistance of which generates sufficient heat to disperse the binder compound throughout the string structure to set the wire wrappings firmly in position.

The foregoing objects, advantages and features will become more apparent upon a consideration of the following description together with the accompanying drawings.

In the drawings:

FIGURE 1 is an enlarged side view of a composite musical string in the process of being formed;

FIGURE 2 is an enlarged diametral cross-sectional view of the same, taken on line 2—2 in FIGURE 1;

FIGURE 3 is an enlarged longitudinal cross-sectional view, taken on line 3—3 in FIGURE 1, and showing the string structure prior to heat curing;

FIGURE 4 is a similar enlarged cross-sectional view subsequent to heat curing; and

FIGURE 5 is a diagrammatic view of one form of apparatus for carrying out the present invention, and includes a somewhat schematic diagram of the electrical circuitry involved.

The herein invention is exemplified by the following description of the structure and the function thereof as well as the steps for accomplishing the intended result. It is

to be understood, of course, that these are not intended to serve as a limitation upon the scope of the teachings of the invention, but instead are merely illustrative thereof. Thus, considerable variations and adaptations may be made within the dictates of commercial practice and without departing from the scope of the invention.

Referring to the drawings, the composite musical instrument string **11** includes a core **12** made from electrically resistant material, such as a metallic core wire which conducts electrical current and is covered with insulation stripped bare at its ends as diagrammatically shown in FIGURE 5 by the sinusoidal line indicators proximate to the looped portions **20** of the core **12**, extending the length of the string. Successive wrappings **13—14** of metallic wire and which are electrically characterized by being conductor-resistor wires, next are provided about the core **12**, and finally a stainless steel outer wire jacket wrapping **15** is provided. The number of wrappings and the metals from which they are made, of course, depends upon the type of musical string and tone desired. For example, wrapping **13** itself may be enamelled aluminum wire. And, wrapping **14** may be either enamelled aluminum or copper wire, or it may be eliminated completely. An outer skin or coating **16** of plasticized material, such as heat setting or hardening plastics like plastic phenolic resin compounds, next is applied about the outer wrapping **15**. The outer coating **16** is heat cured and rendered fluid to fill the interstices between the various wire wrappings, as explained more fully hereinafter. One preferred material for the coating **16** is Bakelite. It should be understood that the particular string constructions and materials enumerated hereinabove, however, are given by way of example only, and are not intended as limitations upon the present invention. Consequently, for the purpose of the herein disclosure, materials used for the outer coating **16** shall be referred to as "binder compound" and that which is used for the core and wrapping wires shall be referred to as "metallic wire."

Winding apparatus to make the composite musical string **11** may vary; however, for the purpose of illustration it may take the form such as shown in FIGURE 5. As shown, the apparatus comprises insulated spaced bearings **17—17**, each carrying a rotatable spindle **18** formed at its end with a hook **19**. Looped portions **20** of the core **12** are connected to each hook **19** so that the core is maintained extended and substantially taut between the bearings **17—17**. Each spindle **18** may be rotatably driven, or, as shown in the drawings, only one may carry a member for rotating the same, such as, for example, a pulley **21** having a belt **22** trained between it and a motor (not shown).

As the driven spindle **18**, or spindles, turns, it rotates its hook **19**, causing the core wire **12** to rotate. During rotation of the core wire, the wrappings are applied successively thereto from a lathe-like carriage (also not shown but familiar to those skilled in the art) to provide smooth and rounded wire wrappings.

The winding apparatus is arranged so that the core **12** and its wire wrappings may be placed in continuity with electrical circuitry. As seen in FIGURE 5, this is achieved and exemplified by connecting one bearing **17** to a variable transformer **23** by means of a conductor **24**. Adjacent the other end of the core **12** and near the other bearing, a hinged contact **25**, preferably of slotted construction, is provided and arranged to contact the string bare ends for electrical connection therewith, and particularly the outer jacket wire **15** at one end thereof where no binder compound is applied thereover. A conductor **26** connects contact **25** with the transformer **23**, and the metallic core and wrapping wires complete the electrical circuit through a switch **27** which normally is closed when the apparatus is in operation and through contact **25** the string wrappings **13—14—15** provide parallel circuits which electrically generate heat so that the resin

applied thereover between stripped or bare ends will flow between the interstices of the convolutions to the inner wires as will appear more fully hereinafter.

In preparing the musical string, the ends of all wires having one form or another are bared. With contact **25** hinged away from the work area, wires **13, 14** and **15** successively are wrapped or convoluted about core wire **12**. One bared end of each of the wrapping wires (the left hand end as seen in FIGURE 5) thus is connected to the transformer **23** through connector **24**. At their other bared ends the wires are connected together and with core **12** in readiness to complete the circuitry to transformer **23** through hinged contact **25**. As contact **25** is moved towards the musical string, it contacts the external or outermost wrapping which in this exemplification is the bared end of wire **15**. With such an arrangement the core and wire wrappings are in parallel with each other and in series with the electrical circuitry. Before hinged contact **25** is brought into contact with the outermost wire, however, the binder compound is applied over the outermost wire **15** between but not over its stripped ends.

After the coating **16** of unhardened or plastic binder compound is applied or wiped over the outer jacket wire **15**, as seen in FIGURE 3, switch **27** being closed, contact **25** is brought into contact with the bared end of the jacket wire, passing current through the various metallic wires, the resistance of which generates heat and causes the plastic binder compound to diffuse and interlay in the intervening spaces between the wires, as seen in FIGURE 4. As binder curing continues, the wire wrappings become bonded firmly in position.

By bringing contact **25** into position against the outermost jacket wire **15**, heating of the wire **15** is insured irrespective of comparative resistances in wires **13** and **14**, or that of core wire **12**. With the outermost wire **15** heated, the binder compound will flow between the interstices of the convolutions to the inner wires which will get some current and be heated also. The current flow, however, provides the outermost wire with the highest heat where it is necessary. The circuitry used generally is one of low voltage so that resistance is a factor to be considered. Should metal contact between the stripped ends of the wires be imperfect, then the inner and core wires receive lesser current flow; but so long as the outermost wire **15** has direct contact with contact **25** there is assurance of effective heating of the binder compound **16** and its flow inwardly regardless of the inner and core wires and the electrical characteristics and resistances thereof. It therefore is an important factor that the outermost wire be heated assuredly when binder compound is applied thereto.

Briefly, the herein invention involves the following steps for making composite musical strings: applying metallic wire wrappings on a metallic core wire, stripping the ends of the wire wrappings and the core wires for contact therebetween, applying an uncured binder compound over the exterior wire wrapping between the stripped ends thereof, diffusing the binder compound throughout the voids or interstices between the wire convolutions by passing current through the exterior wire wrapping and core wires to heat the binder compound and intersperse the same, curing the binder compound and thereby setting the wrappings firmly in place. In the case of wire wrappings having fibrous covers, the binder also impregnates the fibers to assure firm setting thereof.

The temperature of the binder compound should be consistent with that which is necessary to make it diffuse and bind the wires in place. Temperature control is achieved by suitably adjusting transformer **23**.

After the wires are set firmly in place, their ends may be cut and twirled to provide a loop, if desired, and the ends may be color codified to identify the different type strings.

It will be apparent from the foregoing that only a single layer of binder compound need be applied to the musical string, and that it is done only after the desired wire wrap-

pings are applied over the core wire in uninterrupted order. Further, the wires need be connected in the electrical circuitry only once to secure the desired binding of all wires in position. The elimination of the steps of applying multiple binder compound layers and passing current separately through the various wire wrappings, of course, appreciably cuts down the manufacturing time as well as the expense of the additional materials heretofore used. Further, the application of heat is from the outermost wire, where it does the most good, towards the core wire. That is, current is introduced first to the outermost wire, assuring adequate heating of the binder compound applied thereto; and, thereafter, current passes to the successive inner wires, which in the herein exemplification of the invention are in contact and parallel with the outermost wire to achieve inward heating as the binder compound disperses to the interstices between convolutions.

Although what has been shown and described are preferred embodiments of the invention, it should be understood that these are not intended to be exhaustive nor limiting the invention, but instead are given for the purpose of illustration so that the invention may be better understood, and that others skilled in the art may be able to modify and alter the invention without departing from the spirit thereof, the scope of which is defined in the appended claims.

What is claimed is:

1. The method of making composite musical strings which consists in suspending a metallic wire under tension between the ends thereof to define an innermost core wire, then convoluting insulated metallic wire around said core wire until an outermost convoluted uniform wrapping is formed in relation to said metallic innermost core wire, then solely applying a binder over the outermost convoluted uniform wrapping of insulated wire, and then electrically connecting the ends of the metallic core wire and the convoluted insulated wire to generate heat between the outermost convoluted wrapping and the innermost core wire to diffuse the binder and fill the interstices between the convoluted insulated wire and the core wire to provide a composite musical string after the binder has set.

2. The method of making composite musical strings which consists in suspending a metallic wire under tension between the ends thereof to define an innermost core wire, then convoluting separate superposed wrappings of electrical resistor wire around said metallic core and each successive superposed wrapping until the outermost convoluted uniform wrapping is formed, then solely applying a binder over the outermost convoluted uniform wrapping, and then electrically connecting the respective ends of the metallic core wire and each of the convoluted wrappings to generate heat therethrough to diffuse the externally applied binder and fill the interstices between the convoluted wrappings and the inntermost core wire to provide a composite musical string.

3. The method of making composite musical strings which consists in suspending a metallic resistor wire under tension between the ends thereof to define an innermost core wire, then convoluting separate superposed wrappings of electrically insulated resistor wire around said metallic innermost core wire and each successive superposed convoluted wrapping until the outermost convoluted uniform wrapping is formed, then removing the insulation from the ends of each convoluted superposed wrapping of insulated wire and from the ends of the core wire, then solely applying a binder in a fluid state over the outermost convoluted uniform wrapping, and then electrically connecting the respective bare ends of the metallic core wire and each of the convoluted wrappings to generate heat therethrough to diffuse the externally applied binder and fill the interstices between the convoluted wrappings and the innermost core wire to provide a composite musical string.

4. The method of making composite musical strings which consists in suspending a metallic resistor wire under tension between the ends thereof to define an innermost core wire, then convoluting separate superposed wrappings of electrically insulated resistor wires of different physical characteristics around said metallic innermost core wire and each successive superposed convoluted wrapping until the desired outermost convoluted uniform wrapping is formed, then skinning the insulation from the ends of the superposed insulated wrappings and core wire, then solely applying a binder in its fluid state over the outermost convoluted uniform wrapping, and then electrically connecting the respective bare ends of the metallic core wire and each of the convoluted wrappings to generate heat therethrough to diffuse the externally applied binder and fill the interstices between the convoluted wrappings and the innermost core wire and effect the setting of the binder for providing a composite musical string.

5. The method of making composite musical strings which consists in suspending a metallic resistor wire under tension between the ends thereof to define an innermost core wire, then convolutely winding separate wrappings of electrically insulated wires around said innermost core wire and each successive superposed convoluted wrapping until the desired outermost convoluted uniform wrapping is formed, then skinning the insulation from the ends of the superposed insulated wrappings and core wire, then solely applying a thermosetting binder in its fluid state over the outermost convoluted wrapping, connecting all the wire ends in electrical continuity with electrical multiple circuitry, and passing current therethrough for heating the innermost core wire and each of the superposed wrappings of insulated wire to diffuse the binder and fill the interstices between the convolutions and the core wire to provide a composite musical string.

6. The method of making composite musical strings which consists in suspending a metallic resistor wire under tension between the ends thereof to define an innermost core wire, then convolutely winding separate wrappings of electrically insulated wires around said innermost core wire and each successive superposed convoluted wrapping until the desired outermost convoluted uniform wrapping is formed, then skinning the insulation from the ends of the superposed insulated wrappings and core wire, then solely applying a thermosetting binder in its fluid state over the outermost convoluted wrapping, passing an electric current simultaneously through the innermost core wire and the convoluted wrapping wires to diffuse the binder anad fill the interstices between the convolutions and the superposed wrappings in relation to the core wire, and continuing the electrical current to continue the heating of the wires until the binder is cured and the thermosetting thereof takes place to provide a composite musical string.

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