MUSICAL INSTRUMENT STRING

Filed Sept. 21, 1933

Fig. 1.

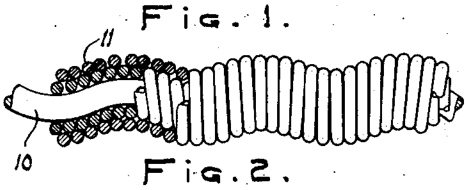


Fig. 2.

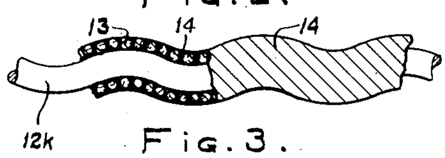


Fig. 3.

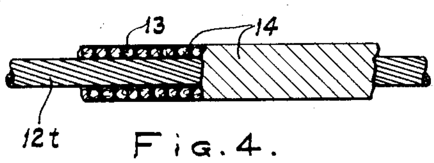


Fig. 4.

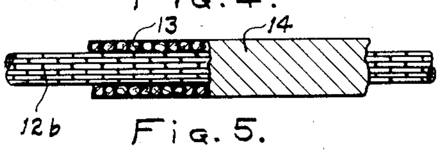
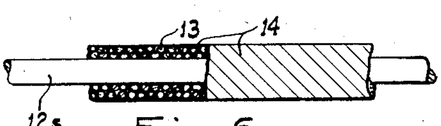


Fig. 5.



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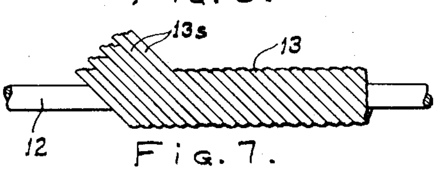
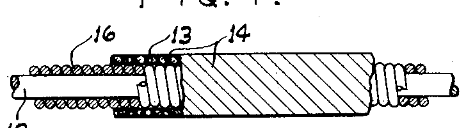


Fig. 7.



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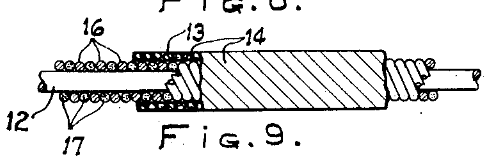


Fig. 9.

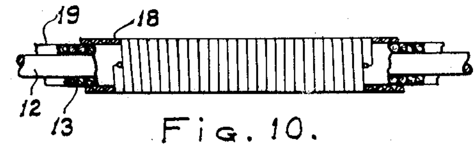


Fig. 10.

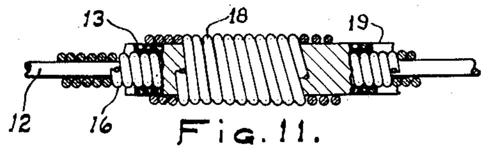


Fig. 11.

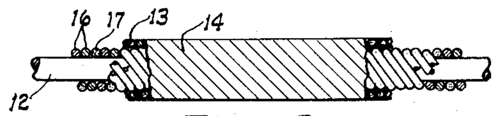
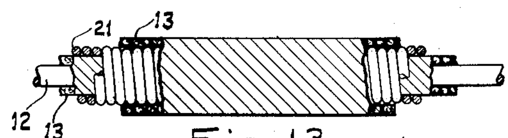


Fig. 12.



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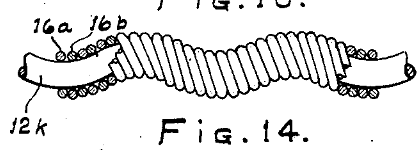

Fig. 14.

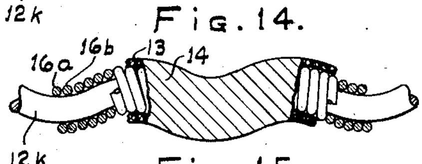

Fig. 15.

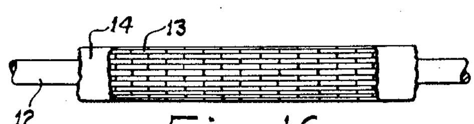

Fig. 16.

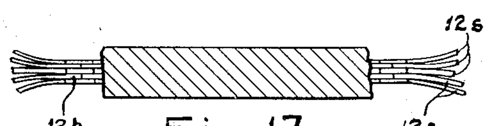

Fig. 17.

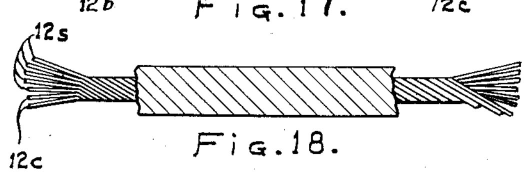

Fig. 18.

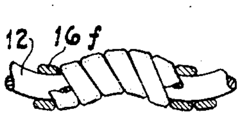

Fig. 20.

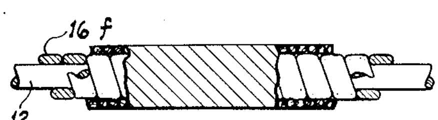

Fig. 19.

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2,049,769

MUSICAL INSTRUMENT STRING

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Application September 21, 1933, Serial No. 690,455

11 Claims. (Cl. 84—199)

My invention relates to musical instrument strings.

In accordance with my invention, I provide an improved musical instrument string which is capable of being more readily tuned and which maintains the tuned condition for relatively long periods, these results being effected due to the physical capability of the wire to give longitudinally. Preferably, this capability is imparted by slightly kinking or crimping the wire constituting the string, whereby the wire acquires longitudinal springiness. This quality may also be given to multiple strand wire by braiding or twisting the strands. The kinked or crimped wire may constitute the completed string or it may be used as a metallic core or reinforcing element of my improved composite string.

Kinking, crimping or corrugating of the wire is done only to a small extent, that is, insufficient to interfere with the normal use of the string as a musical instrument string but sufficient to afford ample give or longitudinal springiness to facilitate tuning and maintenance of the tuned condition. A straight wire, for example, a violin E string, is quite sensitive or sharp to tuning because there is very little give. The same thing is true of guitar and other musical instrument strings. On account of the very small motion required for tuning straight wire strings, reduction gearing is frequently employed in order to convert a relatively large manual adjustment into a small tightening or stretching movement applied to the string. On the other hand, where the wire is kinked, nearly double the stretching or tensioning movement of the string may be required because of the give or springiness due to the kinking with the result that the string is less critically sensitive, tuning is therefore easier, and tuning is maintained for longer periods. Where the kinked string or wire is applied to a piano, and assuming that it has been tuned to the pitch point, greater expansion and contraction of the frame may occur without throwing the instrument out of tune. With straight wire, the expansion of the frame may be sufficient to elongate the wire so that the latter acquires permanent set with the result that, with subsequent frame contraction, the strings are thrown out of tune. This difficulty is greatly reduced, if not avoided altogether, by the kinked wire, for its give or longitudinal springiness is due to the kinked formation rather than to internal structural deformation such as reduction in section incident to elongation below the elastic limit.

The kinked form of wire may be used alone or it may be loaded in ways well known in the art. There are other situations where it may be incorporated as reinforcement in a composite string; and a second feature of my invention is involved in this connection. The composite string embodies a metallic core or reinforcement covered with fabric and solidified with the latter by a suitable resonant substance, such as insulating varnish, the fabric being so arranged that it carries part of the tension load. Since the pitch and tone are dependent on the loading and the string diameter, and not on the metallic reinforcement or core diameter, a variety of strings may be constructed with the same size core or reinforcement wire. While a straight wire may be incorporated as the metallic core or reinforcement element, I prefer to use one which is inherently longitudinally springy; and this capacity may be readily afforded, as heretofore pointed out, by using a reinforcing wire which is kinked or one which is made up of braided or twisted strands.

Capability of the fabric wrapping to carry part of the tension load is due to the way in which the wrapping is done. This result may be achieved, for example, by braiding the fabric about the reinforcing wire or by wrapping the latter with fabric strands at a large helix angle, which may be effected by arranging a plurality of strands side-by-side or in ribbon formation and wrapping them together about the metallic reinforcement. Where the helix angle is sufficiently large, when the string is stretched, the fabric convolutions bind together sidewise, grip the central reinforcement, and carry part of the tension load. Furthermore, where the helix angle of the convolutions is large, the convolutions do not spread apart when the string is bent to a small radius. Thus it will be apparent that, whether the fabric be wrapped at a large helix angle or braided about the reinforcement, the fabric strands are largely effective in an axial direction to carry part of the tension load; and it is on this account that the wire itself does not determine the tuning but the wire in combination with the fabric, the latter being arranged to carry tension load, and the wire or reinforcement and the fabric being joined together as a unitary structure by the resinous or varnish-like material.

My improved composite string involves a process of manufacture which is conducive to a uniform cross-sectional area, which is important from a physical and musical point of view. Instead of impregnating the fabric and then wrapping or braiding the latter about the metallic reinforcement, I first wrap or braid the fabric about the metallic reinforcement and then impregnate the structure with the resinous or varnish material in consequence of which the resulting structure is more uniform, the varnish adhering to the core or reinforcement, filling all voids and interstices and incorporating the fabric material so as to provide a solidified and unitary string structure, and lumps and high spots are largely avoided. Next, the impregnated structure is dried and then it is treated, as by buffing, abrading, rolling or pressing, to secure uniformity of cross section.

The composite type of string my be loaded either by interior or exterior metallic wrapping. As the hard, tough, elastic and resonant resinous binder is non-hygroscopic, the composite string may be loaded with external metallic wrapping without fear of wire looseness, the latter difficulty being experienced with gut strings because of expansion and contraction of the latter incident to absorption and giving up of moisture.

Accordingly, therefore, it is an object of my invention to provide a musical instrument string with longitudinal give or springiness and one which is not affected by changing atmospheric conditions, the string being constituted by a kinked steel wire used along, loaded, or incorporated in a composite string structure.

A further object of my invention is to provide a composite string consisting of a central metallic core or reinforcing element wrapped with fabric and the fabric being impregnated by and joined to the reinforcement by a varnish-like compound to constitute a unitary resonant string structure wherein the fabric is constructed and arranged, as by wrapping at a large helix angle or by braiding, to carry part of the tension load.

A further object of my invention is to provide a moisture-proof musical instrument string and one affected to a minimum by atmospheric and temperature changes.

A further object of my invention is to provide a non-hygroscopic string body wrapped externally with metallic loading wire.

A further object of my invention is to provide a composite string of the type referred to which is loaded in any suitable manner, or as hereinafter more particularly described.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawing, in which:

Fig. 1 is a side elevational view of a short section of kinked wire, the wire being enlarged and the kinking being exaggerated to facilitate an understanding of the invention;

Fig. 2 shows a kinked wire with loading wire wrapped therearound;

Fig. 3 is a detail view, partly in section, showing the kinked form of wire incorporated as reinforcement in a composite string;

Figs. 4, 5, and 6 are views similar to Fig. 3, but showing modified forms of metallic reinforcement, Figs. 4 and 5 showing twisted and braided metallic strands and Fig. 6 showing a single straight metallic strand;

Fig. 7 is a detail view showing a multiple thread wrapping to secure a large helix angle of the threads;

Fig. 8 shows a composite string with inside loading;

Fig. 9 is a view similar to Fig. 8 except that the convolutions of the metallic loading wire are spaced;

Fig. 10 shows the composite string with outside loading;

Fig. 11 is a detail view showing both inside and outside loading;

Fig. 12 is a view showing inside loading consisting of a double metallic wrapping with a spacing thread;

Fig. 13 shows a composite string with a loading wire incorporated between layers of fabric wrapping;

Figs. 14 and 15 show loading wrappings of different weight metals, Fig. 14 being an all-metal wire or string and Fig. 15 being of the composite type;

Fig. 16 shows a composite type of string wherein the fabric is braided about the metallic reinforcement;

Figs. 17 and 18 show multiple strand metallic reinforcements, that of Fig. 17 being stranded and that of Fig. 18 being twisted; and

Figs. 19 and 20 show further modified forms embodying a flattened loading wire.

In Figs. 1 and 2, I show metallic wires or strings 10 which are kinked or corrugated, Fig. 2 also showing loading wire 11. The kinking or corrugating is shown greatly exaggerated in these, as well as other, views in order to facilitate an understanding of the invention. The kinked or corrugated condition may be produced in any suitable manner, as by passing straight wire between toothed or fluted rolls or wheels, it being understood that the kinking is very slight, that is, only to the extent necessary to provide the required amount of give or springiness to make tuning easier and to maintain the tuned condition or pitch of the string longer than a straight wire or string. When the ordinary straight steel string is compared to a gut string it will be observed that, in tuning, the steel string will rise and fall in pitch much quicker, the straight steel string usually requiring special tuning arrangements. The reason for this is that the gut string possesses endwise elasticity which the straight wire string does not have; however, when the straight wire string is kinked or corrugated, I obtain endwise elasticity similar to the gut type. I have compared the tuning of violin E strings, straight and kinked, and find that nearly twice the travel is necessary to tune the kinked type. This extra travel not only makes tuning easier but the pitch of the string will be maintained longer because more contraction and expansion is necessary to change the pitch. When the kinked string is drawn tighter, the pitch does not jump suddenly; and, if tension is released the pitch does not drop suddenly. The very small deformations or kinks are adequate to give increased tuning movement, to maintain better the tuned condition and to give easier vibration even though the kinks or deformations are so small as to be hardly perceptible. It is characteristic of my improved kinked wire string, under all conditions, that the axis thereof is well within the wire structure and does not intersect the surface of the latter at any point, it being understood that the string axis is the longitudinal median axis of the deformed or kinked wire as distinguished from the wire axis which conforms to the kinks or deformations.

The kinked type of wire or string may be used on various musical instruments. It is advantageous for a piano, whether of the loaded or unloaded type because of ease of tuning and longer maintenance of pitch. When a straight wire is placed under proper tension on the metal frame of a piano, and if the frame should expand due to rise in temperature, the wire or string may be elongated or stretched to such an extent that, with contraction of the frame, the strings will be thrown out of tune. On the other hand, if the kinked wire or string is used, it has sufficient spring tension or give to provide the necessary contraction and expansion to stay in tune.

In Figs. 3, 4, 5, and 6, I show a composite type of string, the strings in these views being identical except for the specific types of metallic reinforcement, Fig. 3 showing the kinked wire type of metallic reinforcement **12*k***, Fig. 4 shows the twisted strand type **12*t***, Fig. 5 shows the braided type **12*b***, and Fig. 6 shows the straight wire type **12*s***. Wherever the reference character **12** is used hereinafter, it is intended that the reinforcement may be of any of these types. The central core member or reinforcement is surrounded by fabric **13** impregnated with suitable varnish-like material diagrammatically indicated at **14**, the resonant varnish-like material joining the fabric to the reinforcement, filling all voids and interstices and embodying the fabric to produce a unitary string body. This composite type of string owes its resonance and musical properties to the structure as a whole and does not depend upon modification or muting of the reinforcement by the covering.

In Fig. 7, I show the preferred mode of encompassing the reinforcement **12** with fabric **13**, the latter being wrapped on helically as a ribbon of multiple strands **13*s***. When the fabric material is wrapped in this way, the helix angle is large and consequently the ability of the fabric to act in tension and carry part of the string load is increased. Since the fabric carries a substantial part of the string tension, it will be apparent that the reinforcement **12** may be made quite small to provide for maximum string flexibility and a variety of strings may be manufactured with the same size reinforcement. If a single thread is wrapped helically about a wire, it would not afford any additional tensile strength but the convolutions would merely spread apart with stretching of the string; however, with increase in the helix angle, incident to multiple or parallel strand helical wrapping, the added tensile strength increases, the convolutions tending to squeeze together sidewise and tightly grip the reinforcement and the strands having a large component effective in an axial direction. Where the helix angle of the fabric wrapping is large, there is no possibility of the fabric becoming separated under bending and tension use. Furthermore, the ribbon or multiple strand wrapping may be effected more rapidly.

After the body structure has been built up to the desired size, that is, by providing one or more fabric wrappings, the lint is preferably removed and then the fabric is saturated with a resonating compound, which will cement and solidify the fabric and the reinforcing wire into a solid structure. Saturation after wrapping of the fabric about the reinforcing wire, instead of saturating the fabric before wrapping, has the advantage of producing a more uniform structure and one which is free of heavy spots. The fabric takes up what it will absorb and there are no open spaces such as would be caused by lumps of varnish or resonating compound if saturation occurred before wrapping. Aside from these physical advantages, saturation after wrapping makes is possible to wrap in any suitable and desired manner.

Any suitable compound or binder may be used to combine the fabric and the reinforcement into a unitary string body so long as it possesses the necessary physical properties. First of all, it should be resonant, it should be elastic and retain its elasticity, it should be moisture and oil proof, and it should be resistant to chemical and physical changes such as might be occasioned due to use and storage. Hence, the term "varnish-like material" is used generally to indicate substances having these desired physical properties. I have found insulating varnish of the baking type, such as is used with windings or coils of electric motors, to be satisfactory.

After the wrapped reinforcement is saturated or impregnated, it is dried or baked to the desired hardness and then it is processed to remove surplus resonating compound and to provide a cylindrical string body of uniform cross-sectional area. The processing may consist in rolling, pressing, die-drawing, or abrading, abrading being particularly desirable where there is any tendency toward high spots. Thereafter, the string body is preferably buffed or rubbed to get the desired surface finish, and, if a smoother surface is desired, an additional and thin coat of the resonating compound may be applied followed by polishing.

As already pointed out, the pitch and the tone are dependent on the loading and diameter of the string body and not upon the diameter of the core wire, which serves as a reinforcement. Therefore, with the same size of core wire, a variety of strings may be constructed. Loading may be effected in various ways: the specific gravity of the resonating compound may be varied, for example, by the incorporation of a metal oxide; and preferably the string body is loaded by wrapping with metallic material. The metallic wrapping may be wound directly about the reinforcement, about the string body, or both, and then again it may be incorporated between layers of the fabric where multiple fabric wrappings are employed. Wrapping or loading wire of different specific gravities, for example, aluminum, copper, or silver, may be used, either separately or in combination dependent on the loading desired.

In Fig. 8, I show a loading wire **16** wrapped about the reinforcement **12** (of any of the types heretofore described), the convolutions of the loading wire being close together. Fabric wrapping **13** consisting of one or more layers applied in either of the ways heretofore described encompasses the loading wire and resonating compound cements the structure together to produce a unitary string body.

Fig. 9 is similar to Fig. 8 except that the metallic convolutions **16** are spaced apart, a spacing thread **17** preferably being interposed between the loading wire convolutions.

In Fig. 10, I show a string body having an outside loading wire **18** wrapped thereabout. Preferably a thin silk wrapping **19** is arranged between the solidified body and the loading **18** to separate the hard surfaces and thus avoid the production of harsh tones. This type of string is preferable in several respects over the wrapped gut string. A gut string will absorb and give up moisture dependent on changing climatic conditions, and this induces wire looseness because of the unavoidable expansion and contraction of the gut due to absorption of moisture and drying. In the manufacture of the gut string, careful attention has to be paid to temperature and humidity conditions to reduce spoilage or rejects, but, with the present type of string, since the solidified body is non-hydroscopic and acid and oil proof, temperature and humidity conditions may be disregarded incident to loading. As compared to the gut string, I secure greater uniformity. Before wrapping a gut string, it is the practice to stretch it until it holds a certain pitch, and then it is ready for wrapping; on the other hand, with my string body, it is merely necessary to stretch and wrap it.

In Fig. 11, I show a string provided with inner loading 16 and outer loading 18.

As already pointed out, a wide range of loading is possible with strings of the same outside diameter or without going to excessive diameters. A string may be loaded by wrapping the reinforcement, by external wrapping, or both, with metallic wire of suitable specific gravity; and the range may be further extended by mechanical arrangement. Spacing of the convolutions of the wrapping has already been described, and a modification of this is shown in Fig. 12, where two wires 16 are wrapped about the reinforcement 12 with pairs of adjacent convolutions spaced by a thread 17, this arrangement being advantageous in that a string may be heavily loaded and wrapped with sufficient fabric without attaining excessive outside diameter. Furthermore, wire of different specific gravities may be used. Obviously, if it was attempted to give the same loading with a single wire, the outside diameter would be larger.

In Fig. 13, I show a variation in the loading where the loading wire 21 is arranged between layers of fabric.

Figs. 14 and 15 show adjacent convolutions consisting of wires 16a and 16b of different materials. For example, the wire 16a may be copper and the wire 16b aluminum. In Fig. 15, the loading wires 16a and 16b are wrapped with fabric 13 and impregnated with the resonating compound 14 to produce a unitary string body.

Fig. 16 shows the fabric 13 braided instead of being wrapped, the advantage for this being the somewhat greater tensile strength due to braiding.

Figs. 17 and 18 show further modifications of the reinforcement. In Fig. 17, the reinforcement 12 is braided from small wire of suitable material or materials; for example, the reference character 12s indicates steel wire and 12c copper wire used in such ratio as to secure variation in loading. Fig. 18 shows the component wires 12s and 12c twisted instead of braided. The advantage of the twisted or braided reinforcement is that for heavy strings it is not too stiff. For example, with a cello or bass violin, I prefer to use the braided or twisted reinforcement in order to obtain a highly flexible composite string. As already pointed out, loading may be varied by the incorporation of strands of suitable specific gravity, for example, strands of copper, the steel strands being relied upon to give tension resistance.

In Figs. 19 and 20, I show a loading wire 16f which is flattened, the advantage for this construction being that the wire section gives greater side resistance for the same cross-sectional area and the string may be more heavily loaded without going to excessive diameters. Fig. 19 shows the loading covered with fabric and the whole solidified into a unitary string body, as heretofore described, while Fig. 20 shows a central wire with flattened metallic reinforcement only.

From the foregoing, it will be apparent that I have provided a composite, unitary, resonant string body, which is superior to a metal string in that tuning is easier. It has the advantage of a gut string so far as tuning and quality of tone are concerned, but, unlike the gut string, it is not affected by temperature and moisture conditions. The composite type of string makes possible a variety of loadings to get desired vibration properties and to suit the requirements of various instruments. The central wire or reinforcement and the fabric wrapping both act in tension, with the result that such wire or reinforcement may be made quite small and the same size of wire may be used for different types of strings. The metallic reinforcement may be stranded, braided, straight or kinked; and the kinked structure is in itself, or with suitable loading, susceptible of constituting a musical instrument string or wire.

The kinked structure has its spring action increased due to the kinking. An ordinary straight metallic string is elastic within the elastic limit, but springiness on this account is added to by that of the kinked formation. The kinked wire may be plucked or vibrated more easily, harshness is reduced, and the tone is mellower or easier. Purity of tone is increased by the freedom of vibration. Due to the crimped or kinked structure, less resistance is encountered to lateral movement of the string, and, therefore, an easier and freer tone and movement are produced for any given pitch. Greater movement is required to affect the pitch of a crimped string as compared to a straight string, with the result that an instrument may be maintained in tune more easily and for longer periods. In other words, the critical tuning point is spread, as in a gut string, so that tuning is easier and the tuned condition is held better because the kinked string has greater travel than a straight string incident to tuning and departure from the tuned condition. The term "kink", as used herein is understood to mean deformation of wire in any suitable manner to secure the purposes herein pointed out.

The helically wrapped loading wire may be disposed in a variety of ways. It may be incorporated within the composite covering, either within the structure of the latter or bearing directly upon the core wire. Also, the loading wire may be wrapped helically about the cylindrical covering. The claims hereof calling for loading wire specify that such wire shall be incorporated within the covering, either with or without additional loading wire wrapped about the covering. In my application, Serial No. 45,254, filed January 16, 1936, I disclose and claim a covering with helical loading wire wrapped thereabout, but which covering does not incorporate loading wire.

As the unitary string comprises an inner metallic core which is wrapped with fabric before it is given a coating of varnish, the varnish saturating the fiber, adhering to the latter and to the core, it will be apparent that the coating will fill all spaces and interstices so that it is in effect a cylindrical tube adhering to the core and incorporating the fabric material, thereby promoting substantial uniformity of string section.

From the foregoing, it will be seen that I have provided a metallic musical instrument string element, which in itself is susceptible of use as a string or which may be loaded in various ways, loading being effected by either or both impregnated fabric and wire wrapping and the impregnated fabric also serving as an essential part of the unitary, resonant string body.

What I claim is:

1. A musical instrument string comprising an inner metallic reinforcing core and an outer tubular and cylindrical covering adhering to the core, said covering including a body of tough, flexible and moisture-proof coating medium incorporating fabric material encompassing the core and including strands or fibers extending longitudinally of the string to an extent sufficient to carry part of the string tension, said body saturating the fabric material and adhering to the latter and to the core and filling all voids and interstices to secure uniformity of string section and cooperating with the fabric material and with the core to provide a unitary and composite resonant string.

2. The combination as claimed in claim 1 wherein the fabric material is comprised by one or more helical layers each including multiple or parallel strands arranged side-by-side to provide a large helix angle of wrapping.

3. The combination as claimed in claim 1 wherein the coating medium is a varnish of the baking insulating type.

4. The combination as claimed in claim 1 wherein the metallic core is kinked or crimped to increase the longitudinal springiness of the string.

5. The combination as claimed in claim 1 wherein the metallic core is kinked or crimped at successive intervals and wherein the crimps or kinks are so small that the string may be used with instruments of the bowed type.

6. A musical instrument string comprising a metallic wire having the portion thereof which is subjected to force to induce vibration thereof provided with a succession of kinks or crimps, the kinks or crimps being so small that the string is generally sufficiently straight that it may be vibrated in normal use by means of a bow.

7. A musical instrument string comprising an inner metallic reinforcing core and an outer tubular covering structure adhering to the core; said covering structure incorporating loading wire wrapped helically about the core axis, one or more layers of fabric material encompassing the core axis and including fibers or strands extending sufficiently longitudinally of the string to carry part of the string tension, a body of tough, flexible and moisture-proof coating medium incorporating and saturating the fabric material, adhering to the core and filling all voids and interstices to provide for uniformity of string cross-section and cooperating with the fabric material, the core and the loading to provide a unitary and resonant composite string.

8. The combination as claimed in claim 7 wherein the loading wire contacts directly with the core and the coating medium body fills the spaces between convolutions thereof and adheres thereto.

9. The combination as claimed in claim 7 wherein a plurality of layers of fabric material are employed and the loading wire wrapping is arranged between adjacent layers.

10. The combination as claimed in claim 7 with additional loading wire wrapped helically about the covering structure.

11. A musical instrument string comprising a metallic wire formed for substantially its entire length with a succession of small kinks to provide endwise elasticity for the string, the kinks being formed by deflections of the wire which are so slight that the axis of the string is under all conditions entirely within the structure of the wire.

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