May 24, 1932. N. CRANE 1,859,553

MEANS FOR MODIFYING VIBRATIONS OF STRINGS

Original Filed June 8, 1925

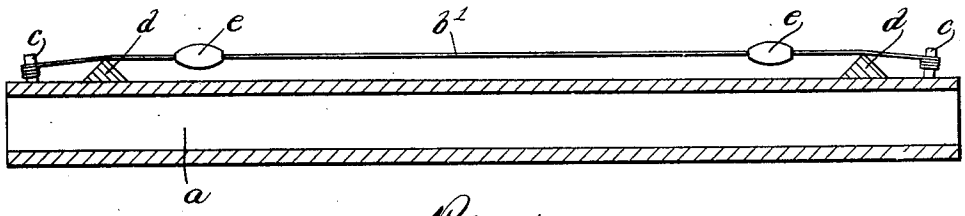


Fig. 1

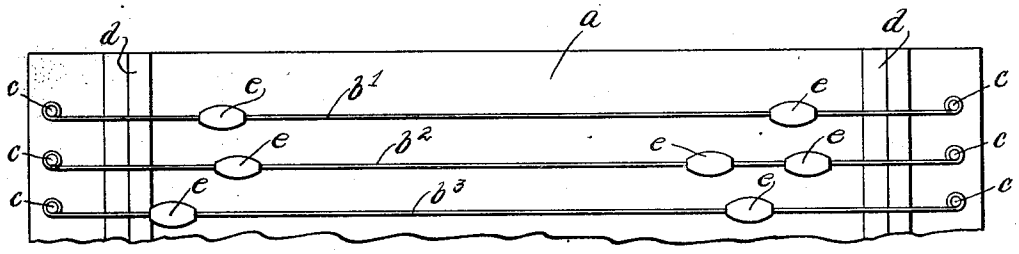


Fig. 2

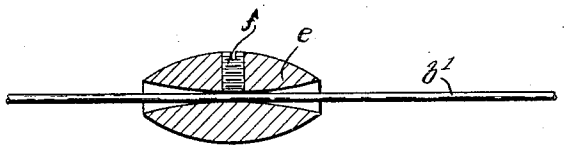


Fig. 3

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Patented May 24, 1932 1,859,553

UNITED STATES PATENT OFFICE

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MEANS FOR MODIFYING VIBRATIONS OF STRINGS

Application filed June 8, 1925, Serial No. 35,584. Renewed August 19, 1931.

This invention relates to musical instruments in which the tones are produced by the vibration of strings stretched between fixed points. The invention is applicable generally to all musical instruments having strings which are susceptible of being loaded in the manner and according to the principles hereinafter explained, but is particularly adapted and intended for pianos. In the following specification, therefore, by way of illustration, but not of limitation, I will treat the invention with particular reference to its use with piano strings.

The principal objects of the invention, stated generally, are to control and modify the pitch of a note produced by the string, by means other than, and supplemental to the length, tension, mass and size of the vibrating string as a whole; and also to control, modify, and improve the timbre of the string. This, briefly stated, is accomplished by loading the string at a desired point, or at a plurality of more or less widely separated points between the extremities of the vibrating length of the string, with a load or loads of concentrated force. Such loading is preferably effected by applying a weight or weights of concentrated mass to the string at such desired point or points; although the application of force to the string at such points, by other means capable of acting to the same effect as such weights, and in an equivalent manner, is within the scope of the protection which I claim.

Vibrating strings give harmonics or overtones in addition to the fundamental tone. Such harmonics or overtones are produced by secondary independent vibrations of various fractional lengths of the string between different nodes. The combination of these overtones with the fundamental tone of any string is what makes the so-called timbre of the string. The method now used in pianos for producing lower tones, without making the strings of excessive length, is to overwind a bare wire with another wire, in a close helix extending through substantially the whole vibratory length of the string and heavy enough to reduce the rate of vibration of the composite string to the pitch of the required note when the string is under proper tension. Strings thus overwound are also used in other instruments than pianos for the same and other purposes. Such strings when vibrated produce harmonics of exactly the same character as those of the bare string. The usual piano string, whether a bare string or one that is overwound, never gives a pure tone and frequently gives a dissonant tone because of interference between various overtones and/or, between the fundamental tone and certain overtones.

I have discovered that by combining with the string so as to vibrate with it a weight or weights of concentrated mass located at appropriate points, it is possible not only to control and vary the pitch of the fundamental note, but also to produce a tone of greater purity with a timbre of greater beauty than has heretofore been obtainable. This, I believe, is due to the fact that a concentrated weight or weights of suitable mass and volume and of restricted length in proportion to the vibrating length of the string, located at suitable points on the string, so control and modify the normal secondary vibrations of the string, as well as the fundamental vibrations, that certain overtones will be suppressed or wholly eliminated, at least so far as the human ear is able to detect, while other overtones will remain unaffected or be relatively emphasized. By placing the weights in various positions on the strings, increasing or reducing the number of the weights on the same string, and varying the mass or volume, or both, of the weights, a great variety of surprising results is attained in the quality of the tones produced; and, by appropriate selection and placement of the weights, those conditions can be secured which produce the desired pitch and eliminate or subordinate the dissonant or disagreeable overtones, or bring out more prominently certain desired overtones, and so enhance the beauty of the timbre and produce new qualities of timbre.

The principles of the invention, together with the characteristics of certain specific embodiments thereof, and the results secured by such embodiments, are further explained in the following specification.

In the drawings:

Figure 1 is a sectional view illustrating a sound box with a string mounted thereon and loaded with weights in accordance with these principles;

Fig. 2 is a plan view of part of the sound box showing three strings mounted over the same and carrying different numbers of weight in different illustrative locations;

Fig. 3 is a sectional view on an enlarged scale showing one of the weights in position on a string.

Like reference characters designate the same parts in all the figures.

The drawings above identified do not represent any specific musical instrument, but simply illustrate the principles of the invention in connection with strings suitably mounted under tension to emit musical tones when struck or otherwise put in vibration.

a represents a sound box of any suitable construction, b', b^2 and b^3 represent strings fastened at their ends to tuning pegs *c*, *c*, set in the top of the sound box, *d*, *d* represent bridges across which the strings are stretched and which rest against a wall of the sound box and *e*, *e* represent metal weights mounted on the strings between the bridges. The strings may be of steel wire or rods, of suitable dimensions to obtain the effects desired when put under tension, or any other material suitable for the strings of musical instruments and adapted to have weights affixed or applied to them, or be otherwise loaded in an equivalent manner. The weights are preferably circular in cross section and circular or elliptical in longitudinal section, or at least made of symmetrical form without sharp edges or corners and with concentration of their mass. The desideratum is maximum mass in minimum volume; from which departure is made for the practical purpose of allowing the strings to be placed as near to one another as may be desired, without bringing the weights into contact with adjacent strings or with the weights on such strings. A symmetrical and smoothly rounded convex external configuration is preferably given to the weight in order to minimize air resistance and disturbance when the weight vibrates. The weights may be mounted on the strings by being perforated centrally lengthwise so as to be passed over the string, and may be secured in desired position by a set screw *f*, as shown in Figure 3. The bore or passage through a weight so perforated is of varying diameter, being smallest in that part where the set screw is located, which is preferably the longitudinal middle, and flaring thence toward either end, in order to limit the length of contact with the string to the minimum. Other means of mounting the weight may however be employed and I therefore do not limit my protection to this detail.

By selecting weights of proper specific gravity, mass, and volume, and placing them in desired numbers at desired locations on the strings, I am able to get remarkable results in the control of the pitch and tone quality of the string, including much greater purity and beauty of tone than has been obtained heretofore. For instance, taking a piano string of a standard diameter (bare wire) and of a given length between bridges and under a given tension, it is possible by placing certain weights at certain places on the string vastly to reduce the frequency of the vibrations of the string and thereby lower the pitch. And these weights can be so placed that certain harmonics are suppressed while others are preserved or emphasized.

A string allowed to vibrate naturally, vibrates as a whole, producing the fundamental note, and also divides itself into fractional vibrating parts with intermediate nodes; each of the fractional parts giving secondary vibrations which produce the harmonics. At least twenty harmonics have been detected, corresponding to the vibrations of all the fractional parts of the string from halves to twentieths. All of these harmonics are given off at some time during vibration when the string is allowed to vibrate uncontrolled. Many of them are dissonant, and so far as the dissonant harmonics are audible they introduce a harsh and unpleasant quality in the timbre of the string. But when weights, containing concentrated mass are placed on the string at certain points, in accordance with the present invention, such weights are vibrated by and with the string, and their momentum prolongs the duration of the vibrations of those parts of the string on which they are placed; augmenting the tendency of the string to divide into the vibrating fractions which the weights dominate, and suppressing or opposing its tendency to divide into other vibrating fractions. One, two, three or more weights may be thus placed on any string.

In Figure 2 I have shown illustrative arrangements of weights—two or more—on one string. On the string b' there are two weights placed equal distances from the bridges and, for illustrative purposes, near the positions in which they cause the overtones based on the subdivision of the string into thirds to predominate over other harmonics. Again there are shown on the string b^2 three weights placed to bring out the overtones on the thirds and fifths of the string, with the fundamental note strong. And, likewise in the same manner, there are shown on the string b^3 two weights, one of which is placed close to one of the bridges, but without touching it, while the second weight is at some distance from the other bridge, this arrangement bringing out the octaves; in other words causing the spring to vibrate in halves, fourths, eights, etc. These illustra-

tions do not purport to show all the possible numbers and settings of weights which may be used with any string, but simply to emphasize the principle of this invention and the fact that by the application of these principles radically new results, all the same in kind but having many specific variations, may be secured. The basic new principle of this invention, common to all variations thereof, is the loading of musical strings and other vibratory members with weights of concentrated mass, or equivalent concentrated application of force, at given points in the vibrating length of the string or member, in such manner as to control the vibrations thereof in a desired way, but without impeding the free vibration of the member as a whole between its points of support, whereby the rate or quality of vibration of the string or member is controlled without altering its vibrating length.

The weights used may be of various materials differing from one another in specific gravity. For instance, certain weights may be made of copper of a certain size, and others of aluminum of the same size. The difference in results from using weights of these different gravities upon two strings of the same length and under the same tension is that the string having the copper weight will be much lower in pitch than that having the aluminum weight. But weights of different volumes or sizes may be used upon strings tuned to different pitches; or upon the same string. As the weights themselves vibrate, the volume of the weight impinging on the air has a modifying effect on the sound. This fact furnishes one reason for making the weights with smoothly rounded surfaces and symmetrical form, for the weights thus shaped give the air smooth vibrations, whereas those with flattened surfaces and with edges or corners may give rise to false tones. The formation of the passages, within the weights, through which the string passes, so that the contact of the weight with the string will be limited to an area of minimum length, leaves the string unconfined and free to vibrate as it will, modified only by the mass and volume of the weight. Thus the weight does not change the effective or vibratory length of the string, or damp its vibrations at either side of the point where the weight is applied.

The use of weights according to this invention not only alters profoundly the quality of tone production from strings, thus making a new art from the standpoint of the musician, but it also creates a new art in the realm of the manufacturer of musical instruments, as well as having other advantages.

In this specification the use of the word "string" does not imply any limitation as to the material of the strings. Those used in pianos and loaded according to this invention are preferably made of the same materials as heretofore used for bare strings and the cores of overwound strings for pianos.

The musical string thus described is one type or species of vibratory member, applied and used for the primary purpose of producing musical tones, but not differing in essential characteristics from other members which are subject to vibration according to the same laws, although different in proportions or dimensions and applied to different uses in other structures and environments. And the principles of this invention, consisting in the application of concentrated forces for the purpose of changing the rate or frequency of fundamental vibration, or modifying harmonic vibrations, may equally well be applied to such other vibratory members in substantially the manner hereinbefore explained, or in equivalent ways. Hence, since I have disclosed in this specification one species of a generic fundamental invention, I desire to claim herein such invention in a scope commensurate with its basic character.

This invention is adapted without change of principle or departure from the foregoing disclosure, to the production of a carillon or chime. In such application the sound box is made of metal preferably of rectangular section and equal transverse dimensions. Loaded strings or equivalent members, such as described herein, are mounted across bridges on opposite sides of the sound box or, if desired, on all of the sides. The several strings may be tuned to have the same fundamental note, or to different octaves of a fundamental, and the sound box itself is tuned, by being given an appropriate length, so as to respond resonantly to the same fundamental note, or to the note of the lowest in pitch of the several strings. A series of such assemblages of sound boxes and strings tuned separately to the notes of the musical scale provide a carillon; and when different strings on each sound box are tuned to intervals an octave apart, a series of such units equal in number to the notes of the scale in one octave will serve for producing notes through a range of two or more octaves, depending on which ones of the various strings are set into vibration. It is understood of course that the concentrated weights of the preceding description are applied to the strings thus assembled, and that thereby tones of widely ranging pitches are obtainable with approximate equalization of the stress applied to opposite sides of the sound box due to the tension of the strings mounted thereon. Thus the sound boxes may be given a natural tendency to remain straight without being made excessively massive and heavy.

I claim:—

1. The combination with a vibratory string supported at two separated points, of a weight of concentrated mass and a substantially circular cross section and smoothly

curved convex longitudinal section connected rigidly with said string at a given point thereon between said points of support.

2. The combination of a musical string supported to vibrate between separated points and a weight of concentrated mass formed with a substantially circular cross section and smoothly rounded convex longitudinal section and with an axial bore through which the string passes, said weight being fixed to the string between said points so as to vibrate with the string.

3. The combination of a musical string supported to vibrate between separated points and a weight of concentrated mass formed with a substantially circular cross section and smoothly rounded convex longitudinal section and with an axial bore through which the string passes, said weight being fixed to the string between said points and the bore of said weight being enlarged toward either end from the point of engagement with the string sufficiently to limit the contact between the string and the weight to said point of engagement, and being there made fast to the string.

4. A vibratory member, separated supporting means on which said member is supported and between which it is adapted to vibrate as a whole, and means for modifying the harmonic vibrations thereof comprising a concentrated load applied to the member at a point unequally distant from the respective supports and adapted to vibrate with the member; the member being unloaded as to its major part.

5. A tension member supported between separated points to vibrate as a whole, and a weight secured to said member at a point unequally distant from the respective supported points of the member, whereby it vibrates with the member as a whole and modifies the secondary vibrations of said member; the member being clear of weights as to its major part.

6. A tension member supported at separated points to vibrate freely between said points, and a plurality of weights secured to said member at separated points between the supported points to vibrate therewith, said weights being few in number and located where they suppress undesired secondary vibrations of the member, leaving the major part of the vibratory length of the member free of attached weights.

7. A musical string stretched between two supports, and means for applying a concentrated load to said string at a point intermediate said fixed points and at a relatively great distance from any other loaded point on the string, said load being coupled with the string to vibrate with it and permit vibration of the string as a whole while modifying secondary vibrations of the string.

8. A musical string supported under tension between fixed points, combined with a weight rigidly affixed to said string between such points to vibrate therewith and located at such distances from the fixed points as to modify the secondary vibrations of the string.

9. A musical string supported under tension between fixed points, and a weight affixed to said string so as to vibrate therewith at a point spaced apart from each of said fixed points and so located as to modify both the pitch of the string and the secondary vibrations thereof.

10. A tension member, separated supporting means for said member between which the member is adapted to vibrate as a whole, and a weight secured to said member so as to vibrate in unison therewith at a point between said supports, so located as to modify secondary vibrations of the member.

11. A musical unit comprising a sound box, a tensioned vibratory member applied to said sound box and spaced apart therefrom by bridges which bear on the wall thereof and means for applying a concentrated load to said vibratory member at a point between the middle and the supported points of the member.

12. A musical unit as set forth in claim 11 comprising loading masses applied to the vibratory member at points such as to cause over tones based on the subdivision of the vibrating member into thirds to predominate over other harmonics.

13. A musical unit as set forth in claim 11 in which three weights are placed on the string, two of them adjacent to one of the bridges and a third adjacent to the other bridge in position to emphasize the over tones on the thirds and fifths of the vibratory member.

14. A musical unit as set forth in claim 11 comprising a concentrated weight located on the string close to, but out of contact with, one of the bridges, and another weight mounted on the member adjacent to, but at a greater distance from, the other bridge, whereby to emphasize the octave harmonics of the vibratory member.

15. The method of controlling and modifying the pitch and timbre of a musical tone produced by a vibrating string, which consists in the application at one or more points on the string of a force adapted to alter both the normal foundamental vibrations and the normal secondary vibrations of the string.

In testimony whereof I have affixed my signature.

NEWTON CRANE.