(No Model.)

C. S. WEBER.

STRINGING PIANOS.

No. 510,944. Patented Dec. 19, 1893.

Fig. 1.

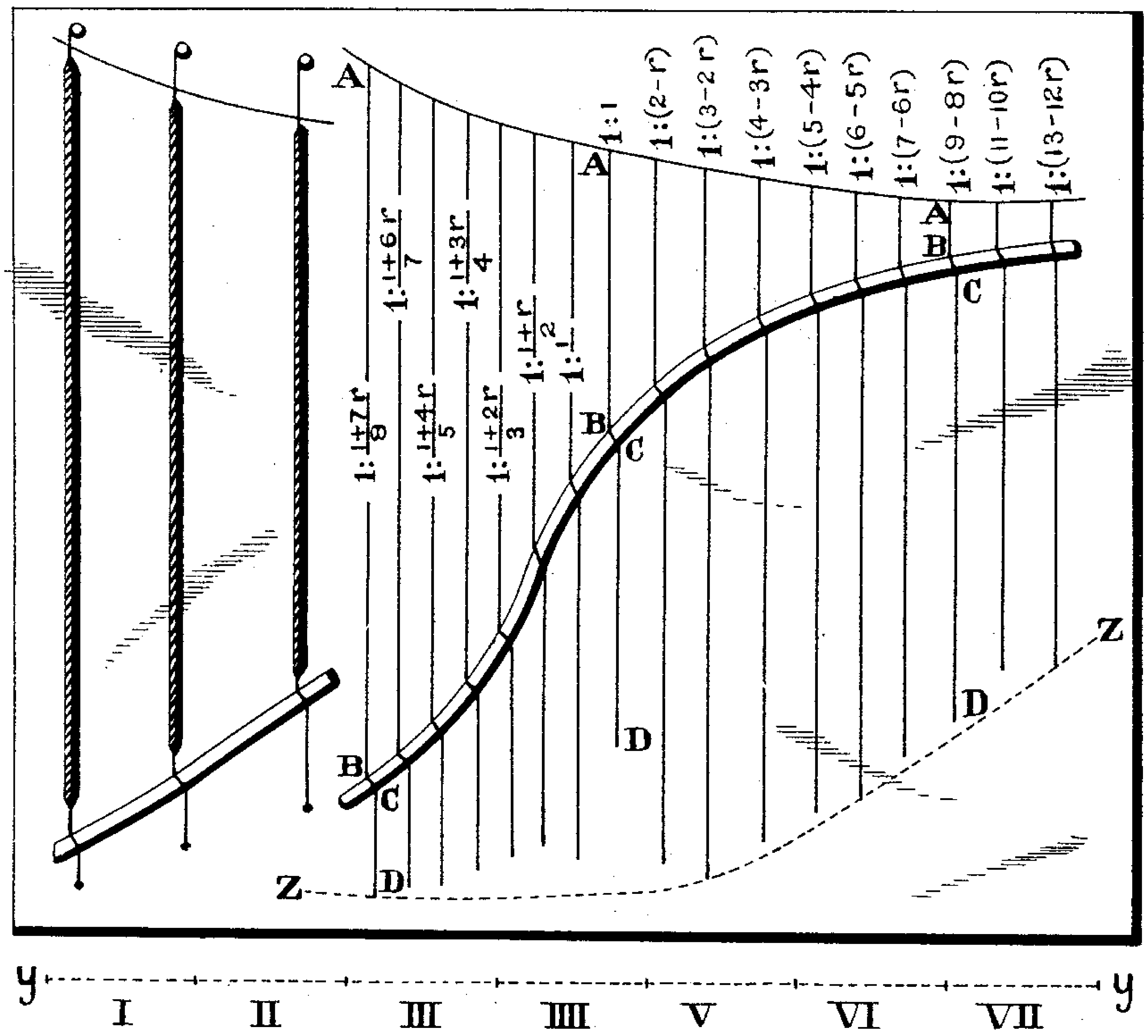


Fig. 2.

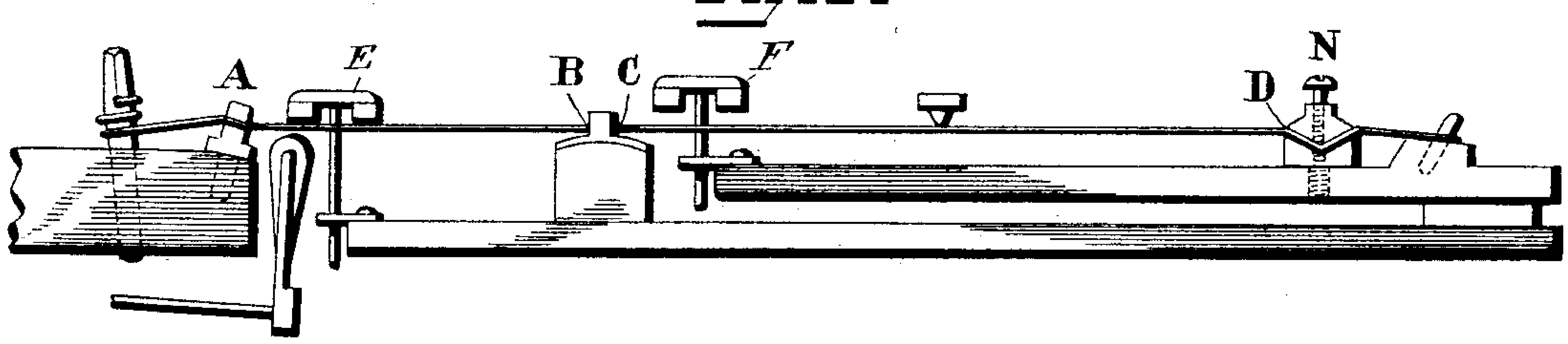
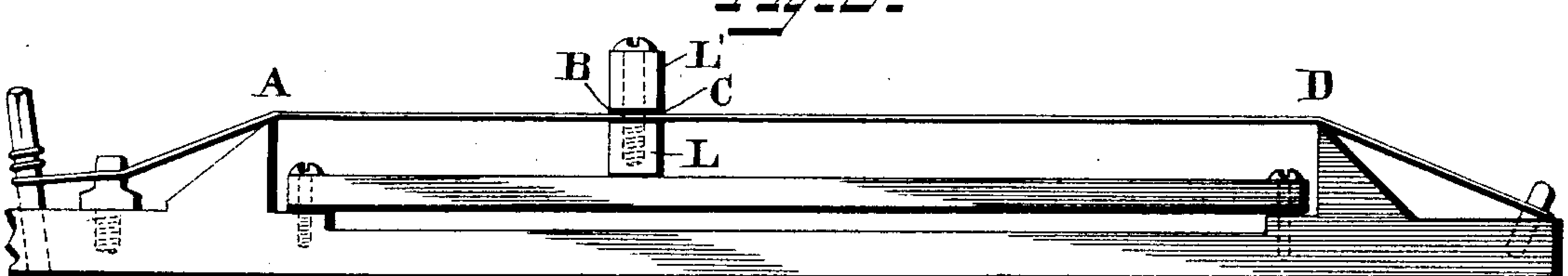


Fig. 3.



Witnesses

Albert Speiden

Van Buren Hillyard.

Inventor

Charles S. Weber.

By Attorneys. R. S. & A. P. Lacey

UNITED STATES PATENT OFFICE.

CHARLES S. WEBER, OF SAN JOSÉ, CALIFORNIA.

STRINGING PIANOS.

SPECIFICATION forming part of Letters Patent No. 510,944, dated December 19, 1893.

Application filed November 5, 1892. Serial No. 451,071. (No model.)

To all whom it may concern:

Be it known that I, CHARLES S. WEBER, a citizen of the United States, residing at San José, in the county of Santa Clara, State of California, have invented certain new and useful Improvements in Stringing Musical Instruments; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

Figure 1 is a front view of the sound board and stringing frame of an upright piano showing the application of my invention. Fig. 2 is a detail side view showing the relative arrangement of the string, the frame, sound board, dampers and (tone refiner) equalizer agraffe. Fig. 3 is a side view of a testing apparatus for showing the application and proving the theory of the invention.

This invention relates to stringing musical instruments, especially pianos of that class in which certain proportions of length are established between the two sections of string lying next to—but on opposite sides of—the bridge over the sound-board.

The object of this invention is to gain vibratory power in the instrument and so regulating those proportions, that in the said two sections of every string the maximum intensity of sympathetic influence should appear at the point where the tension is equal in both sections. To attain this end two seemingly insignificant factors are here considered which heretofore have not been accorded any influence in determining the proper relation of those sections. The factors referred to are the diameter of the string and the rigidity of the material in the same. To ascertain the value of these factors I use the following device which admits of great accuracy without requiring elaborate preparation. The string is stretched between two metal bridges, shaped as shown under A and D in Fig. 3 to allow an exact measurement of the clear length between them. Six or eight feet of this admits of correct results being obtained. At the point of contact with a bridge the string is deflected as shown before it reaches its point of fastening. The distance of the string from a parallel soundboard is one-half inch. A steel rod L one half inch square and about six inches long is placed crosswise to the string between this and the soundboard. A duplicate L′ of the first bar is placed above the string. Being set with the edges perfectly even and connected by means of screws the two bars L and L′ form a clamp by the aid of which the string can be held at any distance between the bridges and divided into two sections of equal tension. By dint of trial the point is now ascertained at which one section sounds exactly the octave of the other. Were the rule correct that serves for calculating the proportional lengths in inventions of this class, then said point would be where one section has exactly double the length of the other. This, however, is not the case in any string having a uniform thickness. By subtracting the length of the prime C D from double the length of the octave A B there remains a difference which augments with the diameter of the string and with the rigidity of the material of which the string is composed. This difference in length will be called here the "equivalent of rigidity." In the various sizes of ordinary piano wire (steel) I found it so nearly equal to five diameters of the string that no appreciable error will be committed by taking the equivalent of rigidity equal to five diameters in all calculations relating to lengths in the ordinary piano wire.

To simplify the following explanation, that section of string which in a piano receives the blow of the hammer is called here the "tone section," its prolongation beyond the bridge of the soundboard being named the "hitch section." A B in Figs. 1 and 2 shows the former; C D the latter. The lengths of the tone section remain in this improved construction the same as those used in ordinary pianos. The difference is in the hitch section. To find the proper length of this for a given note of the piano, the equivalent of rigidity (in the proper string) is first subtracted from the length of the tone section.

This diminished length is then multiplied by a number from the common series (1, 2, 3 or 4 &c.), whichever gives for product the greatest length which when added to the equivalent of rigidity will not exceed the limit of space available for stringing the hitch section. Should a unit as a multiplier result in an excessive length of hitch section, then division is resorted to under identical conditions, that is, a number is selected as a divisor which will produce as a quotient a length which being added to and the equivalent of rigidity will result in the greatest length possible for the available space in which to string the hitch section. The following examples will serve to illustrate this rule:

Supposing we find in a piano dimensions as follows: limit for the combined length of both sections, forty-eight inches; length of tone section, thirty-two inches; diameter of string, 0.04 inch, making the equivalent of rigidity (in common piano wire) 0.2 inch. If we should choose 2 as a divisor in calculating the length of the hitch section, the result would exceed the limit by 0.1 inch. Thus 3 must be the divisor to exactly conform to the rules, making the length of the hitch section 10.8 inches.

In a second example we put the length of the tone section at 12.1 inches, the other data being unchanged. If we now should choose 2 as a multiplier, we would not obtain the greatest length admissible for the hitch section, as there is exactly room for a length resulting from 3 as a multiplier, giving the hitch section 35.9 inches.

If these rules be applied to all the plain strings of a piano, the following series of proportions will reslt in the lengths of the two sections:

$1:1$		$1:1$
$1:(2-1r)$		$1:\frac{1+r}{2}$
$1:(3-2r)$		$1:\frac{1+2r}{3}$
$1:(4-3r)$	and	$1:\frac{1+3r}{4}$
$1:(5-4r)$		$1:\frac{1+4r}{5}$
$1:(6-5r)$		$1:\frac{1+5r}{6}$
$1:(n-(n-1)r)$		$1:\frac{1+(n-1)r}{n}$

The length of the tone section is taken as the unit of measure (equal to one) in every string. r stands for equivalent of rigidity. Both series start with those notes in which the two sections are of equal length. The first series gives the proportional lengths encountered in ascending from the middle to the highest notes, the second those encountered in descending from the middle notes until the covered (low bass) strings are reached which by reason of variations in their diameter cannot form similar proportions.

Above proportional lengths correspond in exactly the same order to the following proportional numbers of vibration:

1:1	1:1
2:1	1:2
3:1	1:3
4:1	1:4
5:1	1:5
6:1	1:6
n:1	1:n

The number of vibrations corresponding to the tone section precedes the sign (:) in every proportion. The correctness of this relation between lengths and numbers of vibration can be proven by means of the apparatus used to ascertain the equivalent of rigidity. Similar proportions are shown in Fig. 2 the equivalent of rigidity being taken as 0.1 inch in the drawings.

A B show the tone section decreasing from the lower to the highest notes as usual in all constructions.

C D show the varying lengths of the hitch section, sometimes touching the line of extreme limit Z Z at other times somewhat off from this.

Below the square representing the outside dimensions of the piano is a line $y\,y$ divided into seven parts, each of which shows how far a certain octave extends in the instrument.

It will be seen that, with the exception of those notes where both sections are equal, the proportion of exact multiples as to length does not exist in the two sections of any string, yet that very proportion is presented in the corresponding number of vibrations by the two sections of every string. This relation between lengths and vibrations constitutes an important feature of this invention and in part distinguishes it from others in which proportional lengths are shown bearing an inverse relation to their corresponding numbers of vibration.

In sounding a note regulated according to the rules here laid down not only the tone section but the corresponding hitch section also will vibrate; the latter moved by the sympathetic influence of the former, if the tension be equal in both sections; but the slightest difference in tension will cause a marked diminution in the intensity of sympathetic vibrations. This circumstance I take advantage of for ascertaining the point at which the tension is equal in both sections. This equality is always disturbed by the frictional resistance which the string encounters in being drawn across the bridge of the soundboard. To correct this I provide the hitch section with the "equalizer agraffe" and an extra set of dampers. The first will be fully described and claimed in a subsequent application for Letters Patent as a device admitting of a very delicate graduation in the tension of a string. The graduation is effected by the turns of the regulator screw N in Fig. 2. As for the extra dampers they are combined with a mechanism allowing them to act either in concert with or independently of the ordinary dampers pertaining to the tone section.

To equalize the tension in any string I first set its extra damper so it remains open after the stroke of the hammer as shown in F, Fig. 2, while the ordinary damper closes as shown in E to leave only the sympathetic vibrations. By repeatedly striking the proper key and turning gently at the corresponding regulator screw a gradual increase is perceived in the intensity of the sympathetic vibrations if the turns be in the right direction. Stopping at the point of maximum intensity, perfect equality is obtained in the tension of both sections even without the aid of a specially trained ear. To rectify any possible mistake both dampers are now set to act in concert, and are kept open long enough after each stroke to ascertain the nature of the tone interval formed in the two sections. This must be the prime in every string where the tone section is the shortest, the same where both sections are of equal length. Where the hitch section is the shortest its vibrations must form a certain overtone, the distance of which from the prime of the tone section is determined by the proportions of length prevailing between the two sections. Whatever be that distance the correctness of the interval is readily recognized by a trained ear even when its upper note does not belong to any scale of the piano, as is the case where the proportion of vibrations is one to seven or one to eleven. Having thus obtained equality of tension coincident with the maximum intensity of sympathetic influence the object of this invention is accomplished. The following comparison will show that this result could not be obtained by means of proportional lengths in which the diameter of the string is not a factor. Taking the following dimensions: limit for the combined length of the two sections, forty-two inches; length of tone section, thirty-two inches; thickness of string (piano wire), 0.04 inch, the equivalent of rigidity being 0.2 inch; the length of the hitch section will be 8.15 inches according to rules of this improvement, while the ordinary calculation would assign eight inches to the same section which by equal tension with the tone section would sound a note one-third of a semi tone above the fifteenth (second octave) of the tone section, an interval which will prevent all sympathy between the two sections. If on the other hand we establish sympathy by so reducing the tension of the hitch section that notwithstanding its insufficient length it will sound the fifteenth to the prime of the tone section, than we have destroyed the equality of tension, throwing thus a certain pressure on the bridge of the sound-board. In the example here given that pressure would not be less than three pounds which may be accepted as a low average for all plain strings except those in which both sections are equal. Thus in an upright piano of ordinary size not less than thirty strings below and about one hundred strings above the middle notes would throw considerable pressure on the bridge; the bass strings upward and the treble strings downward. To prevent the bridge thus being displaced it would have to be made even stronger than where only a short length is left beyond the bridge, just sufficient for fastening the string as in the ordinary construction, while in this improved construction where the bridge is perfectly balanced all the attention hitherto paid to its solidity can be henceforth turned to its vibratory quality.

Another advantage which this improvement possesses over similar constructions is that it applies the law of sympathy to all the plain strings of the piano, combining in the same instrument the brilliancy derivable from overtones with the surprising length and fullness of tone obtained where two or more lengths in the prolongation sound the prime to the main string. To prevent an under tone being formed in this case I place the point of nodal damper against the hitch section at a distance from either end equal to the length of the tone section diminished by half the equivalent of rigidity.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. A pianoforte or other stringed musical instrument having a bridge, strung by having the musical string extended on opposite sides of said bridge to form a tone and a hitch section, the latter sounding by sympathetic action, and varying from a proportional length of the tone section by a length corresponding with about five times the diameter of the said string, substantially as described.

2. A pianoforte or other musical instrument having a bridge, strung by having the musical string extended on opposite sides of the said bridge to form a tone and a hitch section, the latter sounding by sympathetic action, and varying from a proportional length of the tone section by about five times the diameter of the said string, and having the said tone and hitch sections of equal or like tension, substantially as and for the purpose described.

3. A stringed musical instrument having a

musical string divided into a tone and a hitch section, and having a tuning device applied to the said hitch section to vary the tension thereof without altering the tension of the tone section, substantially as described.

4. The combination with a musical string composing a musical hitch and a tone section of proper proportional length, of separate and independent dampers for the two sections of the said string, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES S. WEBER.

Witnesses:
WM. E. BOON,
O. J. BROODDIES.