

March 9, 1937.

W. NERNST

2,073,071

INSTRUMENT PRODUCING MUSIC

Filed Jan. 3, 1934

2 Sheets-Sheet 1

Fig. 1

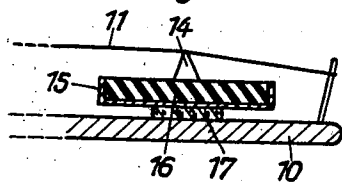


Fig. 3a.

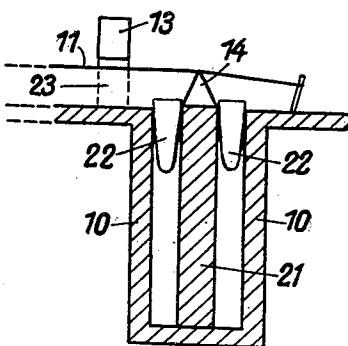


Fig. 2

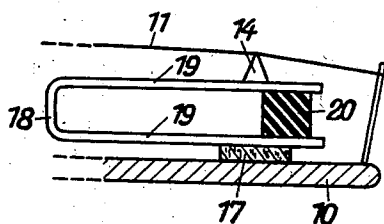


Fig. 4

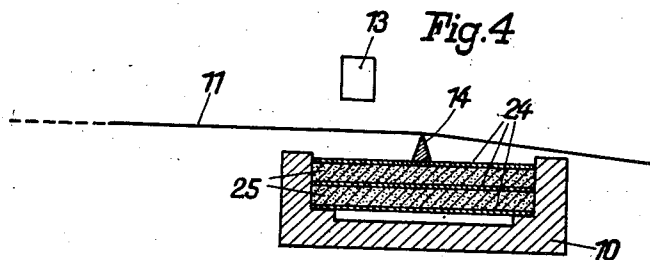
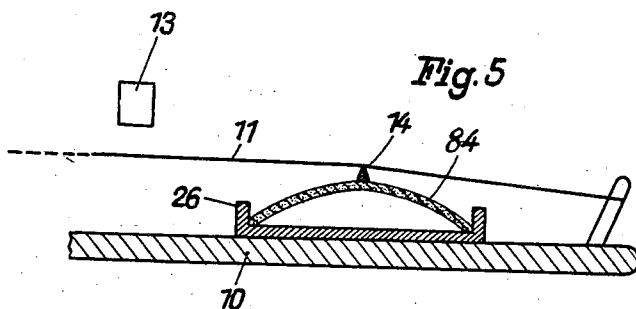


Fig. 5



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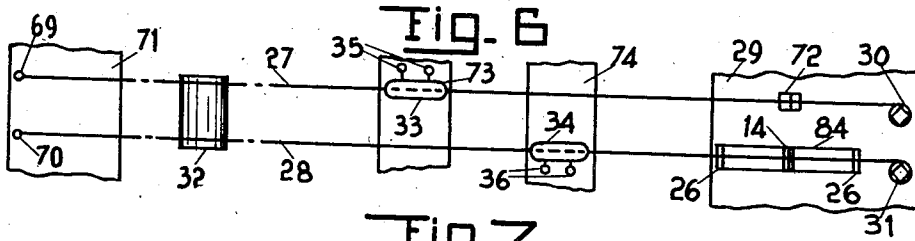
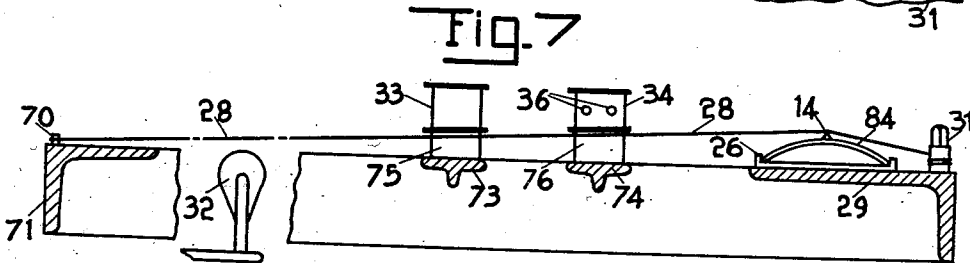
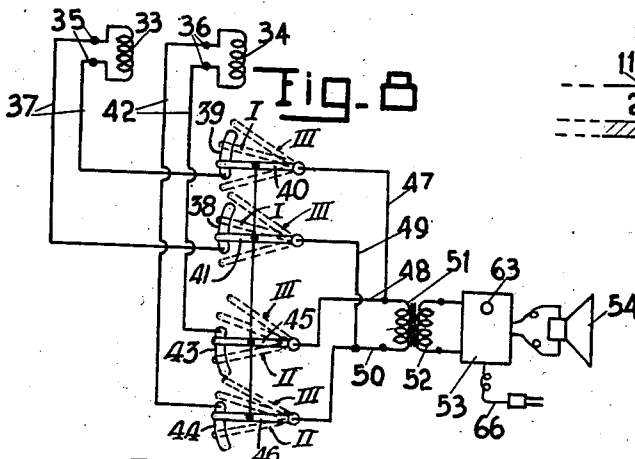
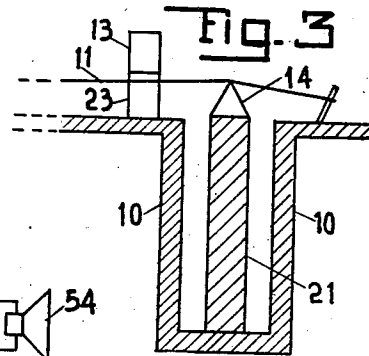
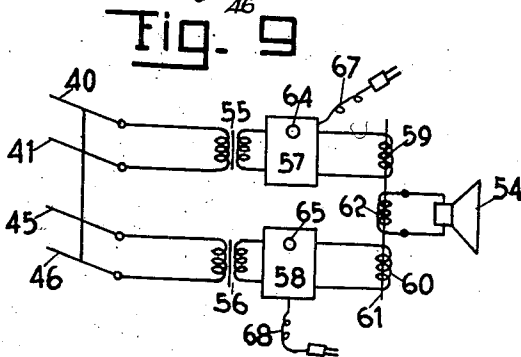
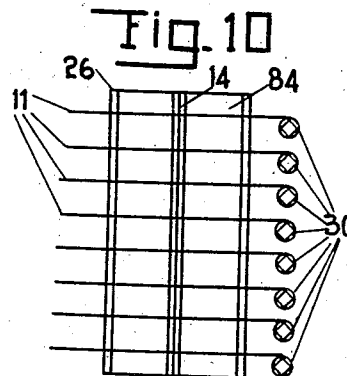
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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

2,073,071

## INSTRUMENT PRODUCING MUSIC

Walther Nernst, Berlin, Germany

Application January 3, 1934, Serial No. 705,047  
In Germany January 4, 1933

12 Claims. (Cl. 84-1)

This invention concerns a stringed musical instrument as described in previous applications of mine still pending. Such an instrument comprises a solid frame of any suitable material like iron, brass, wood, or the like, to which the strings are fastened in a preferably adjustable way. The strings are caused to vibrate by any suitable means. If a piano is concerned, the regular keyboard is used, actuating hammers striking upon the strings. If a violin is concerned, the strings are actuated by the bow. The vibrations, however, are not transferred to any resonant body, but the vibrating strings are electrically influencing coils or other suitable means into which corresponding electrical vibrations are being induced by the vibrating strings. The electrical currents thus induced, may be in a magnetic, may be in an electrostatic way, are then amplified by means of well-known amplifiers as, for example, thermionic amplifiers and the currents thus amplified are then operating loudspeakers. One may also distribute the amplified currents over wires or by wireless and then conduct the currents or electrical impulses received, after having them amplified once more or not, to loudspeakers or any other acoustic reproducers.

In such instruments, the vibrations of the strings are only slightly damped, while in regular pianos relatively strong damping takes place because of the resonant body absorbing mechanical energy to a high degree. Consequently, the sound reproduced by my arrangement differs somewhat from the regular sound of a piano. Especially the harmonic upper tones are of very long duration in my instrument, compared to normal pianos, since the relatively small energy of such harmonics is first absorbed by the resonant body of a regular piano and thereby is suppressed very quickly, while the other tones still continue.

It has been suggested, therefore to apply electrical means in order to absorb such harmonics quickly, and to assimilate in such way the sound reproduced to those of regular instruments. But it is necessary to use for such purposes electric condensers properly adjusted in the electrical connections between the coils to be electrically influenced and the acoustic reproducers.

It is one object of my invention to assimilate the sounds reproduced to those of corresponding regular instruments by other than electrical means, as condensers.

It is a further object of my invention to provide mechanical means absorbing to a sufficient

extent undesired harmonics as quick as regular resonant bodies would do.

It is a further object of my invention to provide very simple and efficient mechanical means for damping the harmonics contained in the vibrations of the strings.

According to this invention, the intermediate chevalets over which the strings run, are connected with the frame or any other holding means for the strings in both a resilient or elastic way in an energy-absorbing manner. In other words, such support is not directly or solidly connected with the frame or the like, but there is interposed a cushion of elastic and damping properties.

According to the invention, such interposed means are of such dimensions as to be capable of absorbing the relatively small energy of harmonics without, however, agitating the surrounding air in a way similar to that of a resonant body. In other words, the undesired harmonics will be suppressed without being rendered audible.

According to my experience, only elastic or only absorbing means would not be sufficient in every case for the purpose of my invention. But it is not necessary to provide elastic and absorbing means separately. It is possible, however, to choose a material or a structure, combining both properties.

Further objects of my invention may be described by means of the drawings in which examples of possible performances of my invention are shown without limiting, however, my invention thereby in any way.

In the drawings various features of the invention are shown. Figs. 1, 2, 3, 3a, 4, 5 show in a more diagrammatic way, in cross section and with parts broken away, various embodiments of the invention pertaining to the bridge supporting strings of a musical instrument, while Figs. 6, 7, 8, 9 show the general arrangement of strings, microphones, amplifiers and loudspeakers to be used with any arrangement of strings suiting the invention, but in particular application to a piano, of which only one pair of strings and part of the frame, and only one hammer are conveniently shown. Fig. 10 shows a plurality of strings of such an instrument, but only that part to which one end of the strings is fastened, and the bridge. Thus, any man skilled in the art is in a position to apply the invention to any known stringed musical instrument.

In the drawings, Figure 1 shows in cross section, with parts broken away, a bridge supported

according to this invention; Figure 2 shows in the same way another support of the bridge; Figure 3 shows in the same way another support of the bridge; Figure 4 shows another such support for a piano in cross section, other parts being broken away, while Figure 5 shows in cross section another feature of such support.

In Figure 1, 14 is a bridge consisting of wood in a violin, or of metal in a piano; it is supported by means of a resilient and elastic case 15 which may consist of wood, metal, or the like, stuffed inside at 16 with a porous or soft material as felt, cork, rubber, or the like. This case is mounted on the frame 10, but preferably indirectly. For this purpose a piece 17 of cork or other resilient material is interposed which, at the same time, insulates the case a little more acoustically against the frame 10 of wood or metal. As far as other details of performance are concerned, I refer to my co-pending applications, Serial No. 516,480 and Serial No. 577,082.

In the feature shown in Figure 2, the bridge 14 is supported by a U-shaped elastic intermediate body 18, which may consist of wood, metal, or the like. Between the legs 19 of the device 18, a soft or porous piece 20 is placed for the purpose of damping the vibrations of the legs 19 under the influence of the bridge 14. Its function is adequate to that of the stuffing 16, used in Figure 1. Piece 17 serves the same purpose as in Figure 1. Own oscillations of the body 18, if any, lie in any case outside the range of audible frequency.

The performance of the feature in Figure 3 shows a combination of both elastic and damping properties in one piece. The bridge 14 is positioned upon a support 21, consisting of wood, cork, or another preferably porous or soft material. Piece 21 has an oblong shape which presents sufficient elasticity in itself, while the material, because of its porosity and its softness, provides for the necessary damping. The frame 10, supporting bridge 14, and the support 21, respectively, have preferably a U-shaped cross section in order to receive properly the oblong piece 21. 13 shows more schematically an electromagnetic pick-up device, according to my co-pending applications 516,480 and 577,082, which is connected with the frame 10 by a rigid support 23.

In all these performances of the invention, by properly choosing the damping material and properly determining the dimensions of the pieces used, any wanted damping of harmonics can be obtained, without the use of any further means for filtering electrically, or otherwise, the sounds produced.

In case one wants to eliminate the effect of the intermediate pieces 15, 16, 20, 21, respectively, there exists a possibility of interposing tapered pieces between the bridge and the frame, as shown in the cross section of Figure 3a, at 22, for the purpose of directly connecting the bridge with the frame, and preventing any independent movement (vibration) of the bridge 14. Such pieces 22 can be inserted by hand, or in any other suitable way. If arresting the bridge in such way, the original sound is reproduced with its harmonics.

It is obvious that beside of the invention, any other means can be used for obtaining other and additional effects, as for instance adjustable condensers, connected in parallel to the electromagnetic microphones, solidly fastened to the frame 10. According to the example of Figure 4, the frame 10 of the U-shaped cross-section

receives a support for the bridge 14, consisting of two or more sheets 24 of steel, or another elastic material, which are separated one from the other by means of sheets 25 of leather or any other resilient and soft and, consequently, damping material. Such structure allows to use sheets of steel of different thickness and different dimensions, and intermediate layers of leather of different thickness and dimensions. In other words, any wanted elasticity afforded by the sheets of steel, and any wanted damping given by the layers of leather, can easily and cheaply be obtained. Any wanted timbre of the sound to be produced can be achieved thereby. 13 is a pick-up of the same character as pointed out hereinbefore in connection with the description of Fig. 3.

In Figs. 6, 7, 8 and 9 the arrangement of two strings 27, 28, side by side, for creating the same sound is shown. The strings are fixed at one end, 69, 70 to a part 71 of a non-resonant frame and at their other ends by means of keys 30, 31 to another part 29 of the non-resonant frame. One of the strings 27 is supported by a rigid bridge 72, while the other string 28 is supported according to this invention by means of a both elastic and damping support 84, 14. The tension of the strings may be adjusted by means of the keys 30, 31 which are being provided with e. g. square heads. A hammer 32 is provided in the way well known for pianos and adapted to strike both strings 27, 28 simultaneously so that they oscillate at the same height of tone. While the string 27 may freely oscillate, due to its rigid support 72, the string 28 will oscillate in a different way due to its elastic and damping support 84, 14. The tone created by string 27 will therefore be organ-like, while that of the string 28 will be piano-like due to the action of the elastic and damping support, thereby selectively acting upon the harmonics of the tone produced, as described above.

Electro-magnetic microphones 33, 34 are arranged close to the strings 27, 28, respectively, and rigidly connected to crossbars 73, 74, respectively, by means of arm 75, 76. Thereby these electro-magnetic microphones are supported in a non-resonant way, as being described in my co-pending application which resulted in Patent 1,988,564. The microphones are provided with terminals 35, 36 adapted to be connected with amplifiers. The terminals 35 of the microphone 33 are connected by means of conductors 37 to contacts 38, 39 of a switch 40, 41; the terminals 36 of the microphone 34 are connected by conductors 42 to the contacts 43, 44 of the switch 45, 46. The switch members 40, 45, are connected by conductors 47, 48 to one terminal of the primary 51 of a transformer and the switch members 41, 46 are connected by conductors 49, 50 to the other terminal of the primary 51. The secondary 52 of the transformer is connected to the input circuit of an amplifying means diagrammed in the casing 53 and fed by any suitable source of current by means of the conductor 66. The degree of amplification may be suitably adjusted by handle 63. The amplified currents are supplied to the loudspeaker 54. In operation, the switch members 40, 41, 45, 46 being in the position shown, the oscillations produced by both strings 27, 28 are directly inducing electro-magnetic impulses in the microphones 33, 34 and, thereby, correspondingly varying currents which are fed in parallel to the transformer 51, 52 and suitably amplified and rendered audible in the loudspeaker. In this case, a mixture of piano-

like and organ-like sounds will be reproduced. If putting the switch members in the position I (shown only for the members 40, 41) then, due to the length of the contacts 38, 39, the microphone 33 will still be connected with the primary of the transformer, while the microphone 34 will be disconnected. Therefore the loudspeaker will produce solely organ-like sounds. If moving the switch member in position II (shown only for the members 45, 46), then only the microphone 34 will be connected to the primary 51 of the transformer and the loudspeaker will produce therefore solely piano-like sounds. The switch members being moved in position III, all microphones are disconnected and no reproduction occurs. In such way, one can choose to have reproduced both kinds, or only one kind of the vibrations of the strings.

In Fig. 9 a somewhat different arrangement of transformers and amplifiers is shown in a connection otherwise similar to Fig. 8. Instead of a common amplifier 53 for both microphones, separate amplifiers 57, 58 are provided, each of which may be regulated by a handle 64, 65 and be supplied with current from a suitable source by means of the conductors 67, 68. In this case, the switch members 40, 41 are connected to separate transformers 55, 56 co-ordinated to the amplifiers 57, 58. The output coils 59, 60 of the amplifiers may be arranged on a common core 61 on which the secondary 62 is arranged connected to the loudspeaker 54. By suitably adjusting the amplifiers 57, 58 by means of the handles 64, 65 either equal or different amplifications of the vibrations of the two strings may be obtained and, thereby, any desired combination of both timbres, piano and organ, provided the switch members are positioned corresponding to that shown in full lines in Fig. 8.

It is understood that instead of leather, any other soft and resilient substance can be used for the layers 25.

In the feature according to Figure 5, the sheet 84 of steel, or other elastic material, is not flat but curved for the purpose of producing in it a wanted elastic tension. Between the sheet 84 and the frame 10 a support 26 is arranged in the U-shaped cross section in order to receive the sheet 84. The piece 26 may be of wood, brass, or any other material.

The sheet 84 may be curved in any other suitable form than is shown in Figure 5, and may include a flat middle portion. By suitably adjusting the tension required and suitably choosing the dimensions and also the elasticity of it, one can obtain any wanted elastic and nevertheless damping support, such damping being due to the inner friction in the sheet while under tension. Of course, it is possible to combine three or more such sheets, as is known to be done in the case of regular springs.

It is to be understood that according to the invention the support (bridge) may either be arranged separately for each of the strings present, as shown in Figs. 1 to 5, or for a pair of strings present, as shown in Figs. 6, 7, or for a plurality of strings, as shown in Fig. 10 where the ends of a multitude of strings 11 are fastened to keys 30 and supported by a bridge 84, 26, 14 in accordance with the invention. If co-ordinating a plurality of supports to a plurality of strings, the supports may be equal among themselves or differ from each other insofar as elasticity and damping action is concerned by correspondingly dimension-

ing the co-ordinating parts and choosing the material thereof.

What I claim is:

1. In a system for reproducing sounds, comprising a stringed musical non-resonant instrument, the strings of which are stretched between their ends over a support carried by a non-resonant frame and capable of being mechanically actuated to vibrate; electrical means arranged close to said strings adapted to be electrically influenced directly by said strings themselves on vibrating; amplifying means of the so directly induced electrical impulses and means for acoustically reproducing the so amplified impulses—the novel feature of a support for said strings, said support capable of vibrating at selected frequencies within the audible frequency range of vibrations of said strings, thereby damping said selected vibrations of said strings.

2. In a system for reproducing sounds, comprising a stringed musical non-resonant instrument, the strings of which are stretched between their ends over a support carried by a non-resonant frame and capable of being mechanically actuated to vibrate; electrical means arranged close to said strings adapted to be electrically influenced directly by said strings themselves on vibrating; amplifying means of the so directly induced electrical impulses and means for acoustically reproducing the so amplified impulses—the novel feature of an elastic and resilient support for said strings, said support due to its elasticity capable of vibrating at selected frequencies of vibrations within the audible frequency range of vibrations of said strings, thereby damping said selected vibrations, while resiliently supporting said strings when vibrating at other frequencies without substantially damping said last mentioned vibrations.

3. In a system according to claim 2, said novel support being adapted to quicker damp harmonics contained in the vibrations of said strings than the basic vibrations.

4. In a system according to claim 2, said novel support being adapted to absorb the relatively small energy of harmonics contained in the vibrations of said strings.

5. In a system according to claim 2, said novel support comprising an elastic case stuffed with damping material.

6. In a system according to claim 2, said novel support consisting of elastic and damping material.

7. In a system according to claim 2, said novel support consisting of at least two sheets of steel and at least one layer of damping material.

8. In a system according to claim 2, said novel support comprising at least two sheets of elastic material, at least one layer of damping material and means adapted to keep said sheets under tension.

9. In a system according to claim 2, said novel support comprising at least one layer of damping material, at least two sheets of metal and means for keeping said sheet in a bent state, creating thereby elastic tensions within said sheets.

10. In a system for reproducing sounds, comprising a stringed musical non-resonant instrument, the strings of which are stretched between their ends over a support carried by a non-resonant frame and capable of being mechanically actuated to vibrate; electrical means arranged close to said strings adapted to be electrically influenced directly by said strings themselves on vibrating; amplifying means of the so directly

induced electrical impulses and means for acoustically reproducing the so amplified impulses—the novel feature of at least two strings being provided for producing the same sound; a rigid support for one and an elastic and resilient support for another of said strings.

11. In a system according to claim 10, separate electromagnetic means arranged close to each of said differently supported strings.

10 12. In a system for reproducing sounds, comprising a stringed musical non-resonant instrument, the strings of which are stretched between their ends over a support carried by a non-resonant frame and capable of being mechanical-

ly actuated to vibrate; electrical means arranged close to said strings adapted to be electrically influenced directly by said strings themselves on vibrating; amplifying means of the so directly induced electrical impulses and means for acoustically reproducing the so amplified impulses— 5 the novel feature of resilient supports for said strings, said supports adapted to vibrate at selected frequencies of vibrations within the audible frequency range of said strings, thereby damping 10 the selected vibrations of said strings, the frequencies at which said supports are capable of vibrating being different for at least two supports.

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