June 9, 1942. O. KORNEI 2,286,178

PHONOGRAPH RECORDER

Filed Feb. 7, 1940 2 Sheets-Sheet 1

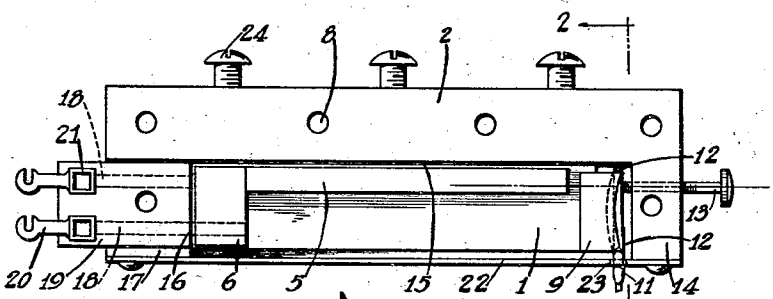


Fig. 1.

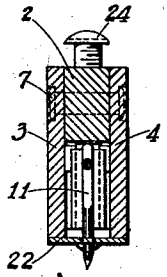


Fig. 2.

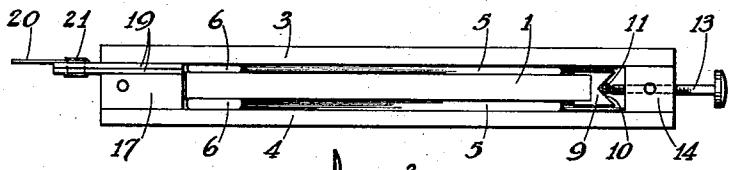


Fig. 3.

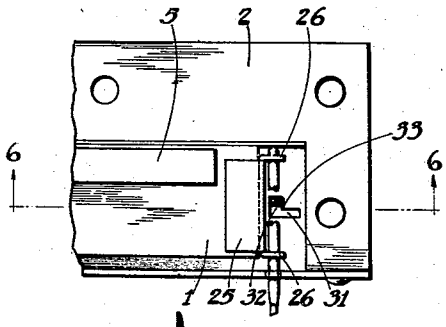


Fig. 5.

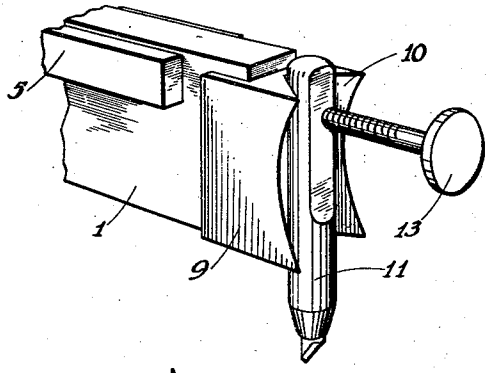


Fig. 4.

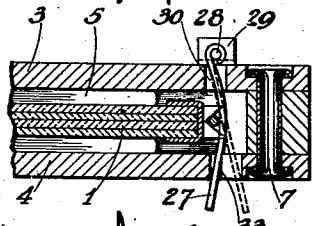


Fig. 6.

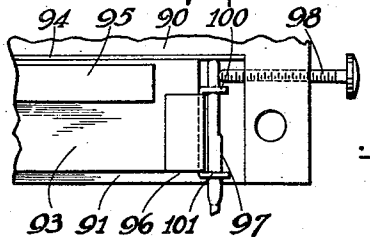


Fig. 13.

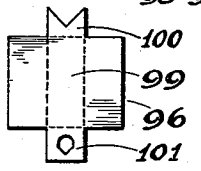


Fig. 14.

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PHONOGRAPH RECORDER

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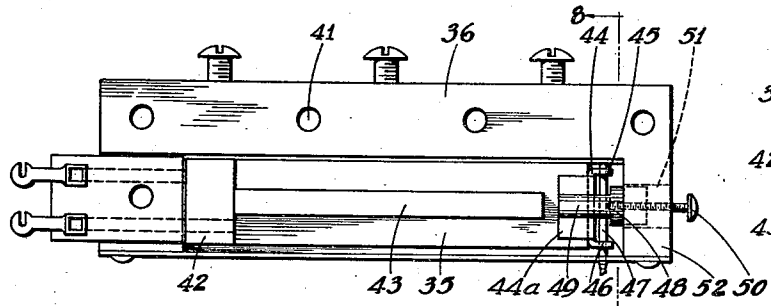


Fig. 7.

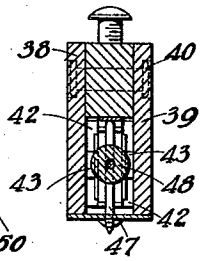


Fig. 8.

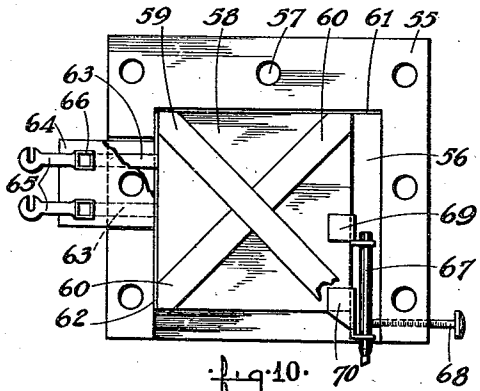


Fig. 10.

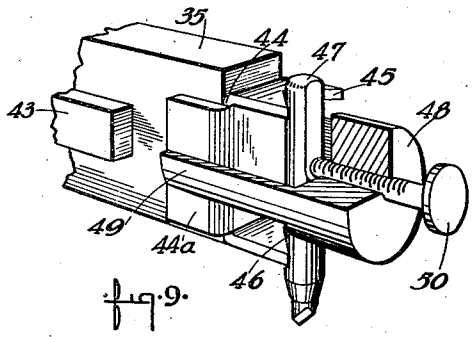


Fig. 9.

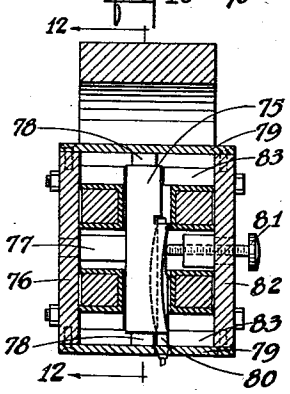


Fig. 11.

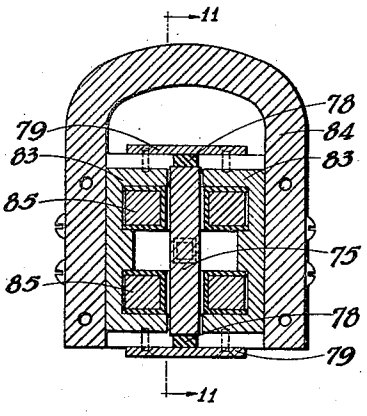


Fig. 12.

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2,286,178

UNITED STATES PATENT OFFICE

2,286,178

PHONOGRAPH RECORDER

Otto Kornei, Cleveland, Ohio, assignor to The Brush Development Company, Cleveland, Ohio, a corporation of Ohio

Application February 7, 1940, Serial No. 317,621

13 Claims. (Cl. 179—100.41)

This invention relates to record cutting mechanisms in general and relates more particularly to record cutters for making laterally cut phonograph records.

It has been found that the performance of record cutters available at the present time, particularly of lateral type cutters, is materially affected by the mechanical load on the cutting stylus. Both the frequency characteristic and the amount of harmonic distortion produced in the recording process are dependent on the record material, the depth of cut, and the amplitude of the recorded signal. This dependence of the performance on the stylus load may be due to any one or more of three factors: poor coupling between the cutting stylus and its holder, flexible coupling between the transducer element and the stylus holder, and insufficient available mechanical driving force in the transducer itself. When supported in the usual manner, the stylus bends somewhat while cutting the harder record materials. In fact, at the high frequencies the stylus may bend regardless of the type of record material being cut, and the stylus itself may resonate within the useful high frequency range. Also, an additional resonance may be present because of flexibility between the transducer element and the stylus holder even though the coupling between them appears to be rigid.

It is therefore the principal object of this invention to provide a lateral-type record cutter which has a smooth frequency characteristic and which is free from harmonic distortion when used to cut all usual record materials at usual depths of cut and recording amplitudes.

A more specific object of this invention is to provide a piezo-electric lateral-type record cutter having a smooth frequency characteristic and low amplitude distortion for all commonly used record materials, depths of cut, and recording amplitudes.

It is also an object of the invention to provide a lateral type record cutter in which the cutting stylus is rigidly supported and closely coupled to the vibratory transducer element so that the entire moving system behaves as a single vibratory system.

Another object of this invention is to reduce the amount of damping necessary in a record cutter.

Another object of this invention is to provide a lateral type record cutter in which the motion of the stylus is free from components in undesired directions.

Another object of this invention is to provide a structure which permits easy replacement of the cutting stylus.

Another object of this invention is to provide a record cutter having high efficiency.

Another object is to provide a record cutter that is simple in construction, that can be produced at low cost and that may be assembled easily.

Another object of the invention is to provide a piezo-electric record cutter in which there is no steady mechanical bias applied to the crystal element.

Still another object of the invention is to provide a piezo-electric record cutter in which the danger of breaking the crystal element is reduced to a minimum.

In its broadest aspect the invention consists of a record cutting mechanism in which the cutting stylus is rigidly supported upon and closely coupled to the vibratory transducer element so that there is effectively only one mechanically resonant system. By designing the cutter so that this resonance occurs at or above the highest frequency which it is desired to record, the amount of damping required may be reduced to a minimum since it will be understood that the damping embodied in most devices is used primarily to reduce resonant vibrations. Furthermore, by designing the cutter to have a resonant frequency at or above the highest frequency which it is desired to record a moderate rise in efficiency at high frequencies may be obtained. Also since it is a mechanical system having only one degree of freedom, it is only necessary to apply damping to one member of the system. The elimination of additional resonances at frequencies that are either in or above the useful range reduces the total amount of wave form distortion in the record because resonance in the cutting mechanism accentuates the harmonic distortion produced by both the recording amplifier and the cutter itself at frequencies that are submultiples of the resonant frequencies. The elimination of additional resonances not only minimizes the harmonic distortion and improves the frequency characteristics, but probably also reduces the amount of intermodulation distortion and the amplitude of undesired beat notes.

The objects of the invention have been achieved by employing a vibratory transducer element so designed and mounted that its amplitude of vibration is not materially affected by the mechanical load imposed on it during the cutting process, even when hard record material

is cut. Rigidly attached to the vibratory element is a small light-weight stylus holder that is arranged to support the cutting stylus at spaced points near its opposite ends. The stylus is securely clamped against the supports by suitable means adapted to contact it at a third point preferably but not necessarily intermediate the supports. The clamping engagement may be provided by a stylus clamping screw, a spring clip or like means. By using this type of stylus holder, it is possible to minimize vibratory bending of the stylus and to place the stylus resonance far above the useful frequency range. Furthermore, since the stylus is closely coupled to the vibratory element at two points near its ends, the element and stylus are effectively rigidly coupled together so that the stylus tip motion is completely controlled by the transducer element. This is made possible with a light-weight stylus holder because the transducer element is disposed in the same plane as the stylus so that a minimum of material is used in the stylus holder. Another object of the invention is achieved by mounting the piezo-electric unit edgewise. Since the unit is very stiff in its edgewise direction, the possibility of breaking it by shock or the like is greatly reduced.

In accordance with this invention, a stiff vibratory system having little mass is used in order to obtain the desired high resonant frequency. Although it is possible to design a magnetic type record cutter embodying a suitably stiff system, I prefer to use a piezo-electric transducer element such as a Rochelle salt bimorph unit. It will be understood that Rochelle salt crystal units, particularly units of a size suitable for use in record cutters, are extremely stiff and therefore, when properly mounted, inherently possess the desired characteristics.

The invention will be understood more fully through reference to the accompanying drawings taken in connection with the following descriptions. The drawings show selected embodiments of the invention which should be considered as illustrative rather than limiting.

In the drawings:

Fig. 1 is an enlarged elevational view showing a preferred form of the invention, a side cover plate and its fastenings having been removed from the device to expose the internal structure.

Fig. 2 is a sectional view of the device of Fig. 1 taken along line 2—2 thereof.

Fig. 3 is a plan view looking upwardly from the bottom of Fig. 1, the bottom cover plate having been removed from the device to expose the internal structure.

Fig. 4 is an enlarged schematic perspective view showing the constructional features of the stylus end of the vibratory member.

Fig. 5 is an enlarged fragmentary elevational view similar to Fig. 1 and shows a modified construction.

Fig. 6 is a fragmentary sectional view taken along line 6—6 of Fig. 5.

Fig. 7 is an enlarged elevational view of a modified construction, one side cover plate and its fastenings having been removed to show the internal construction.

Fig. 8 is a sectional view taken along line 8—8 of Fig. 7.

Fig. 9 is an enlarged fragmentary perspective view of the device of Figs. 7 and 8, showing the constructional features of the stylus end of the vibratory member.

Fig. 10 is an enlarged elevational view of a further embodiment of the invention, one side cover plate and its fastening having been removed to show the internal construction, additional portions having been broken away for the same purpose.

Fig. 11 is an enlarged sectional view showing a further embodiment of the invention.

Fig. 12 is a sectional view taken on line 12—12 of Fig. 11.

Fig. 13 is an enlarged fragmentary elevational view of a device embodying the invention and employing a modified form of stylus holder, one side cover plate having been removed to show the construction of the device.

Fig. 14 is a plan view of a metal plate which may be bent to form the stylus holder shown in Fig. 13.

Referring now to Figs. 1–4, which show a preferred form of the invention, it will be seen that the cutter consists of a bi-terminal torque type Rochelle salt bimorph unit 1 disposed in a frame or case 2, being clamped flatwise therein between opposite side walls or cover plates 3 and 4. The clamping is effected between pads 5, 5 and 6, 6 of resilient material extending along a side edge of the unit and along one end edge respectively. These pads are preferably made of material having damping properties, as for example the material sold under the trade name of "Koroseal." They not only support the unit, but due to their extended area of contact with the unit, provide the necessary damping. Rivets 7, 7, passing through holes 8, 8, secure the side walls 3 and 4 to the case 2. A stylus holder 9 is rigidly secured as by cementing, to the other end of the unit. It may be made of a suitable light-weight metal such as aluminum or magnesium, or of plastic materials, and preferably is recessed along one side edge thereof so as to firmly engage the end portion of the piezo-electric unit. The opposite side of the holder is preferably provided with a concave V-shaped groove 10. A suitable stylus 11 is disposed in this curved V groove and contacts the stylus holder at the extremities 12, 12 thereof. In order to insure proper engagement between the stylus and the upper extremity of the stylus holder, the holder is made somewhat shorter than the edge of the unit to which it is attached. The sylus is held in place in the holder by means of a stylus clamping screw 13 threaded through the adjacent end wall 14 of the case 2. A thin strip of resilient material 15 is disposed between the upper edge of the unit and the case 2, and extends beyond the end of the unit so as to also prevent rubbing contact between the case and the upper end of the stylus. A strip of insulating material 16 is disposed between the clamped end of the unit and the end wall 17 of the case and is provided for the purpose of insulating the case from terminal leads 18, 18 of the unit. The terminal leads extend through the end wall 17 of the case, being insulated therefrom by means of plates 19, 19 of insulating material which are clamped firmly between the cover plate 3 and the end wall 17. Suitable connecting lugs 20, 20 are mechanically and electrically connected to the terminal leads by means of rivets 21, 21. A bottom cover plate 22 is suitably secured to the case and substantially closes the assembly. An opening 23 is provided in it for clearance around the stylus. The cutter is provided with suitable fastening means such as screws 24, 24 for attaching it to a convenient support.

As pointed out above, the piezo-electric unit 1

is a multi-plate unit of the torque type. Such units are fully disclosed in U. S. Patent No. 2,105,011 and U. S. Reissue Patent No. 20,680, and reference should be made to those patents for a complete understanding of the operation of such units. A torque type unit is used because it makes the inertia of the stylus and its holder less effective. The cutter shown in Figs. 1 to 4 preferably employs a 4-ply unit which is quite long in comparison to its width. A multiplate unit is used to obtain a high voltage sensitivity. The length of the unit is so chosen that the mechanical resonance of the system occurs at the highest frequency within the desired frequency range. The width is made small compared with the length so that the other resonances occur above the useful frequency range. With the length and width of the crystal approximately equal, there would be, in most cases, two frequencies within or near the desired frequency range at which resonance occurs even though the stylus were closely coupled to the unit. When a long narrow unit is mounted in the manner shown, wave form distortion resulting from a bending motion of the unit is prevented. Furthermore, such type of mounting greatly simplifies the problem of rigidly supporting the cutting stylus, and makes it possible to achieve a high stiffness in the edgewise direction without the use of a stylus holder bearing. This reduces the possibility of distortion due to the presence of a steady mechanical bias on the unit and greatly reduces the possibility of breaking the unit. As pointed out above, the stylus holder is rigidly and firmly secured to the end of the unit, being so closely coupled therewith as to form a single vibrating system with it. By reason of this close coupling, and the absence of a stylus holder bearing, no damping is required either for the stylus holder or for the stylus. The elimination of all damping material except that used to support the crystal, the low mass of the stylus holder, the elimination of the stylus holder bearing and the close coupling between the crystal and stylus all contribute to the high sensitivity of this cutter.

It will be apparent that if an alternating potential is applied to the terminal lugs 20, 20, the stylus will move in a to and fro motion about an axis which is substantially in alignment with the axis of stylus clamping screw 13. It will be understood that the normal behavior of a torque type unit clamped at one end is to twist out of its original plane about a longitudinal axis which extends substantially midway between the side edges of the unit. It will be observed, however, in the construction shown in Figs. 1 to 4, the unit is constrained at one end and along the upper edge, with the result that the longitudinal axis of vibration is shifted upwardly an amount which is dependent upon the amount of restraint imposed by the clamping pads. This was done to obtain a lever effect providing greater motion of the stylus tip for a given angular displacement of the unit. By the use of suitably stiff damping material in the pads 5, 5 the axis may be shifted sufficiently so that it lies under the pads 5, 5. The position of the axis was determined by observing the pattern produced when some lycopodium powder was sprinkled onto the face of the unit when the unit was in operation. Alternatively, the axis could have been determined by probing the face of the unit with a light weight vibration pick-up or other suitable means. After the axis had been determined in this manner, the clamping screw 13 was positioned in the end wall of the case so as to be substantially in axial alignment with the neutral axis thereof. It will be understood that by reason of this construction the clamping screw engages the stylus substantially at its pivot point which is intermediate the extremities of the V groove in stylus holder 9. The clamping screw accordingly can be tightened upon the stylus sufficiently to clamp the latter firmly within the V notches. The three points of support for the stylus raise its natural resonant frequency well beyond the highest frequency which is to be recorded. Since the stress exerted upon the stylus and upon the unit 1 by the clamping screw is transmitted through the unit in directions parallel to its neutral axis, no biasing forces are created within the unit which might cause distortion.

It will be apparent that the construction of the stylus holder permits easy replacement of the stylus since the latter will be guided by the curved V groove from the lower extremity up to the upper extremity and will be properly aligned when it has been there inserted. The stylus clamping screw may then be tightened upon it with assurance that the stylus is properly seated and is rigidly supported, even though the stylus holder is hidden from view. It will also be noted that the clamping screw remains stationary and does not vibrate with the unit.

In view of the various features of the construction which have been mentioned above, it will be evident that the cutter shown in Figs. 1 to 4 involves a simple construction which permits of low production cost and which produces no more distortion than that which is inherent in the piezo-electric unit itself. Since the latter is very small, the wave form of signal recorded by this cutter is exceptionally good. Furthermore, the sensitivity versus frequency curve is substantially flat except for a slight peak at the high frequency end of the useful recording range.

Figs. 5 and 6 show a modified form of the device of Figs. 1 to 4 in which the clamping screw 13 has been replaced with a resilient clamping member such as a bent wire. The construction has been further modified by substituting a bent metal plate for the stylus holder shown in Figs. 1 to 4. Other parts of the assembly shown in Figs. 5 to 6 correspond with Figs. 1 to 4 and bear the same reference characters. In this modified construction, the stylus holder consists of a bent metal plate 25 which firmly engages the end of the unit 1. It is preferably cemented thereto. The plate is provided with two integral lugs 26, 26 which, as shown in Fig. 6, are bent outwardly therefrom and form two V-shaped guides. It will be apparent that this structure embodies the basic feature of the stylus holder shown in Figs. 1 to 4, but does not possess the advantage of the intermediate curved guiding portion of the latter. The stylus is held in place within the two V-shaped guides by means of a wire 27 which is hinged at 28 upon a lug 29 secured to the side wall 3 of the case. The wire extends through a clearance opening 30 in side wall 3 and through a latch opening in the other side wall 4. The latch opening is shown in Fig. 6, a portion of the stylus having been broken away to permit it to be seen. It consists of an elongated slot 31 disposed below a retaining notch 32. It will, of course, be apparent that in order to use this

structure to clamp the stylus within the stylus guides 26, 26 the wire is moved to a free position at the outermost end of slot 31. After the stylus has been properly positioned within the guides, the wire is then moved toward the opposite end of the slot, being bent around the stylus sufficiently to clear the shoulder 33. It is then raised upwardly and permitted to spring back into the retaining notch 32, where it is securely latched. It will be noted that the clamping wire 27 of Figs. 5 and 6 has been so placed that it does not engage the stylus at the pivot point. In view of this condition, it will be understood that when the device is in operation, the stylus is forced to slide back and forth under the clamping wire in its to and fro motion. This sliding action may be beneficial in that it provides a limited amount of damping action. It will be understood, of course, that the retaining wire may, if desired, be disposed to contact the stylus at its neutral point in which case the frictional force will be reduced to a small value. If the wire is moved up to the torsional axis, a further modification may be obtained by providing the wire with a hardened metal point to bear against the stylus to further reduce the friction. In all such constructions, it will again be noted that the clamping wire remains stationary and does not vibrate with the piezo-electric unit.

Another embodiment of the invention is shown in Figures 7, 8 and 9. In the device of these figures, a rather long and narow multiplate piezo-electric torque unit 35 is employed and is supported in a case comprising a frame portion 36 having side cover plates 38 and 39 secured thereto as by means of rivets 40, 40, disposed in holes 41, 41. As in the previous constructions, the unit is clamped between the side cover plates and clamping is effected by the end pads 42, 42 and longitudinal pads 43, 43, all of which are composed of resilient damping material. In this construction, the stylus holder 44 consists of a bent metal plate 44a provided with two V notches 45 and 46 for aligning the stylus 47. A U-shaped clamping screw body 48 is secured to the stylus holder plate 44a as by brazing or soldering the legs 49, 49 of the body thereto. A clamping screw 50 is threaded through the end of the body, being positioned therein so as to engage the stylus at any desired location between the V notches 45 and 46. Preferably, however, the clamping screw and clamping screw body are secured to the stylus holder so as to be symmetrically disposed in axial alignment with the neutral axis of rotation of the piezo-electric unit. An opening 51 is provided in end wall 52 of the frame 36, being large enough to prevent contact between the frame and any portion of the clamping screw body when the device is in operation. The balance of the structure will be understood from the description of Figures 1 to 4.

It will be observed that with a torque unit mounted as shown in these figures, the neutral axis of the unit extends longitudinally thereof and is substantially midway between the side edges. By disposing the stylus holder 44, clamping screw 50 and clamping screw body 48 symmetrically about the neutral axis, the assembly may be balanced for torsional rotation. Eccentric loading may thereby avoided. By suitably proportioning the stiffness of legs 49, 49 with regard to the mass of the clamping screw body and clamping screw, the natural resonant frequency of the stylus holder assembly may be designed to lie well above the highest frequency which the device is to record. A single vibratory system may thereby be obtained at least so far as its behavior within the recording frequency range is concerned. It will also be recognized that the sensitivity of the device is somewhat lower than that of the device of Figs. 1 to 4 as a result of the mounting arrangement employed here. Stylus holders of the types shown in the devices of Figs. 1 to 6 may be used here in place of the kind shown, or the structure here shown may be modified by extending the body 48 through the end wall 52 to provide a bearing for the stylus end of the unit. In such construction, a rubber bushing or sleeve preferably is disposed around the extended body to space it from the surrounding walls of the opening in the frame.

A further embodiment of the invention is shown in Fig. 10. This device is similar in construction to the devices described above, comprising a frame 55 having side cover plates 56, 56 (one plate is not shown) secured thereto as by means of rivets disposed in holes 57, 57. A multiplate bending type piezo-electric unit 58 is clamped between the cover plates, clamping being effected between the pads 59, 59 and 60, 60 of resilient damping material which are disposed along the diagonals of the square unit. Strips 61 and 62 of resilient material prevent contact between the frame and the two side edges of the unit, the strip 62 serving additionally to insulate the frame from the terminal leads 63, 63. The terminal leads pass through an opening provided in the frame, being clamped tightly between two insulating plates 64, 64 which in turn are clamped between the frame and one cover plate. Terminal lugs 65, 65 are mechanically secured to the two plates in electrical engagement with the leads by means of rivets 66, 66. A stylus 67 is secured to the unit by means of a stationary thumb screw 68 which clamps it against two V notch elements 69 and 70 which are cemented to the unit. The element 69 may be positioned any place along one edge of the unit between the adjacent corners, but preferably is positioned near the midpoint of the edge. The other element 70 is secured to an adjacent corner of the unit. In the construction shown here, the latter element is made so that its V notch lies somewhat beyond the point at which the stylus is intersected by that diagonal of the unit which passes through the corner to which the element is cemented. It will be understood, however, that its V notch may be positioned at any convenient distance from the V notch of element 69. The thumb screw is positioned in frame 55 so as to engage the stylus at a point which lies intermediate the two V notches and preferably at the nodal point of the assembly.

The operation of bender type bimorph units such as the one employed here is fully disclosed in U. S. Reissue Patent No. 20,213, but the operation will be described here briefly to aid in an understanding of the device. If an alternating potential is applied to the terminals, the unit will vibrate in such manner that points lying on its diagonals will remain stationary and will define a stationary plane. All other points of the unit will move out of that plane, opposite edge portions moving in the same direction out of the plane while adjacent edge portions move in opposite directions out of the plane, resulting in a saddle-shaped double curvature. In view of this action, it will be understood that the

stylus will be given a rocking or to and fro motion, the center of oscillation lying between elements 69 and 70.

The essential features of the invention are embodied in a magnetic type record cutter shown in Figs. 11 and 12. In this device, an armature 75 which also serves as the stylus holder is fastened rigidly to a back assembly plate 76 by means of a torsion shaft 77. The armature is clamped at its top and bottom by means of the damping pads 78, 78 and the clamping plates 79, 79. The armature is provided with a curved V-shaped groove, the extremities of which engage the cutting stylus 80 at points near its cutting end and near its top end. The mass of the armature and stylus, and the stiffness of the damping pads 78, 78 and the torsion shaft 77 are so chosen that the resonant frequency of the armature occurs at or above the highest frequency which it is desired to record. The stylus is clamped by means of the thumb screw 81 which is supported by the front assembly plate 82 and contacts the stylus substantially at its pivot point. The back and front assembly plates 76 and 82 also serve to maintain the pole pieces 83, 83 and the magnet 84 in their proper positions. The clamping plates 79, 79 are also fastened to the assembly plates. The armature is energized by means of the coils 85, 85.

It will be apparent from the above descriptions that this invention provides a record cutter in which rigid coupling is obtained between cutting stylus and transducer element, without the addition of excessive mass, and as a result, a smooth response free from undesired resonances is obtained. Several factors contribute to this result. The stylus is connected to the transducer element at two well defined and relatively widely spaced points, thus eliminating any uncertainty as to the actual point of contact and also eliminating any long, overhanging portion of the stylus which might introduce undesirable resonances. When the transducer element is a piezo-electric crystal element, it is disposed with its major faces parallel to the length of the stylus so that the two point connection can be achieved by use of a light weight stylus holder. If the unit were perpendicular to the stylus, a relatively large and heavy stylus holder would be necessary to insure rigid coupling between stylus and unit. The vertical position of the unit (vertical when the cutter is used to cut a record on a conventional turntable) has several other advantages. It is very stiff in the vertical direction so that it can support the stylus without bending or receiving a bending mechanical bias. With a horizontal unit, some additional support for the stylus, such as a conventional stylus holder bearing, would be desirable to prevent bending forces. Elimination of such bearings enhances the simplicity of the device and reduces the likelihood of spurious resonances being introduced by undesired modes of vibration. Another advantage of this construction is the reduction of harmonic distortion due to mechanical bias on the piezo-electric unit. This has not been completely verified but experiments indicate that the application of a mechanical bias to a piezo unit introduces a harmonic distortion. The device of this invention is designed to eliminate such bias. Supporting the stylus clamping means from the frame of the device rather than from the vibratory stylus holder as in conventional devices, as, in addition to simplicity, the advantage that the mass of the vibrating system is reduced by eliminating that part of the stylus holder required to support the clamping means.

To illustrate further how the mass of the stylus holder may be reduced as compared with holders of prior devices, Figs. 13 and 14 show a modified construction embodied in a piezo-electric cutter. The device of Fig. 13 comprises a case 90 and side cover plates 91, 91 (one cover plate is not shown) which define a cavity within which is positioned a torque-type piezo-electric unit 93 spaced from the frame by a resilient strip 94, and operatively retained in position between clamping pads 95, 95. This construction will be understood to correspond with the construction shown in the device of Figs. 1 to 4. A stylus holder 96 is secured to the end of the unit in a suitable manner, as by cementing. A stylus 97 is securely retained within the holder by means of a stationary clamping screw 98, preferably positioned substantially in axial alignment with the neutral axis of the piezo-electric unit. The construction of the stylus holder will be understood through reference to Fig. 14 which shows a flat metal plate which, when bent along the dot-and-dash lines, forms the holder 96 of Fig. 13. The holder will be seen to consist of a body portion 99 having two stylus contacting elements or lugs 100 and 101. Lug 100 is cut so as to provide an open V-notch, while lug 101 is provided with an opening having a V-notch which forms the outer portion of the opening. It will be understood that the two lugs 100 and 101 are bent upwardly out of the plane of the drawings to form the projections designated 100 and 101 respectively in Fig. 13, while the side portions of the body 99 are bent downwardly below the plane of the paper to form side plates which aid in retaining the holder in place on the piezo-electric unit. As shown in Fig. 13, the stylus holder is placed on the unit with the open V-notch 100 nearest the clamping screw 98, and with the enclosed V-notch 101 remote therefrom. When so positioned, a stylus 97 may be inserted through the closed V-notch 101 and firmly clamped in position against V-notch 100 by tightening clamping screw 98. Since the clamping screw preferably is positioned on the extended neutral axis of the piezo-electric unit, it contacts the stylus at its pivot point. It will be apparent, however, that clamping may be done at some point off the neutral axis, and that a stationary resilient member may be substituted for the screw. It will also be apparent that the stylus holder shown here may be used to replace the holders shown in the other figures of the drawings.

Although numerous modifications of the invention have been described in the above specification, many other constructions are possible without departing from the spirit and scope of the invention. For example, other types of small, light-weight stylus holders could be designed to engage the stylus near its cutting end and near its top end, and other methods of mounting the crystal unit could be used. Also, some other type of piezo-electric substance might be used in place of Rochelle salt, or the transducer element could be made of a magnetostrictive material. It will therefore be understood that the specification and the accompanying drawings are to be considered as illustrative; accordingly, the scope of the invention should be determined from the following claims.

What I claim is:

1. A piezoelectric record cutter having only one resonant frequency within its useful fre-

quency range, said cutter comprising the combination of: a plate-like piezoelectric unit clamped between strips of resilient material for edgewise operation and having, when in operation, an edge which includes a first portion which moves an appreciable amount out of the plane of said unit and an adjacent second portion which moves a negligible amount out of the plane of the unit; an elongated stylus; and means for securing said stylus lengthwise along said edge of the unit and for constraining said stylus to move with said first edge portion as a unitary part thereof in pivotal relationship to said second portion, said securing means comprising: a pair of spaced notch-like stylus seats adapted to engage said stylus near its opposite ends and secured inflexibly to said edge to couple said unit rigidly to said stylus when the latter is firmly seated in said seats; and stationary means for clamping said stylus firmly in said seats.

2. A piezoelectric record cutter as claimed in claim 1 wherein said piezoelectric unit is operatively clamped edgewise in a frame having a wall adjacent said end edge of the unit but spaced therefrom, and wherein said stationary clamping means consists of a screw threaded in said wall and engaging said stylus substantially at a point lying on said longitudinal torsional axis.

3. A piezoelectric record cutter as claimed in claim 1 wherein said piezoelectric unit is operatively clamped edgewise in a frame having a wall adjacent said end edge of the unit and wherein said stationary clamping means consists of a resilient member secured to said wall to engage said stylus resiliently.

4. A piezoelectric record cutter comprising: a frame; an elongated torque-type piezoelectric unit adapted for edgewise operation and secured in said frame between strips of resilient material which engage opposite faces of said piezoelectric unit along substantially all of the back end edge of the latter and along substantially all of the top edge, the front end edge of said unit being free to move torsionally about a longitudinal axis which lies in the plane of the unit and is substantially in register with the damping material which extends along the top edge; an elongated stylus; and means for securing said stylus lengthwise along said front edge and for constraining said stylus to oscillate with said front edge as a unitary part thereof in pivotal relationship to said longitudinal axis, said securing means comprising: a pair of spaced notch-like stylus seats inflexibly secured to said free end edge and adapted to engage said stylus near its opposite ends, and stationary means for clamping said stylus in said seats.

5. A piezoelectric record cutter comprising: a frame; an elongated torque-type piezoelectric unit adapted for edgewise operation and operatively supported edgewise within said frame between registering T-shaped bodies of damping material which engage opposite faces of the unit and extend along substantially all of the back end edge thereof and along substantially the entire length of said unit substantially midway between the top and bottom edges of the latter, the front end edge of said unit being free to oscillate torsionally about a longitudinal axis which lies in the plane of the unit and is substantially in register with the longitudinal portions of said T-shaped bodies of damping material; an elongated stylus; and means securing said stylus lengthwise along said front edge and constraining said stylus to oscillate torsionally with said edge, said front securing means comprising: a pair of notch-like stylus seats secured to said end edge in spaced relation to engage said stylus near its opposite ends and to couple said unit inflexibly to said stylus, when the latter is firmly seated in said seats; and means for clamping said stylus firmly in said seats.

6. A piezoelectric record cutter as claimed in claim 5 wherein said pair of notch-like stylus seats are disposed on opposite sides of said torsional axis and wherein said clamping means is a stationary member which engages said stylus substantially at a point lying on said torsional axis, but which does not oscillate with said stylus.

7. A piezoelectric record cutter comprising: a frame having a recess therein partially bounded by two intersecting walls of said frame; a flexing type plate-like piezoelectric unit adapted for edgewise operation relative to the record and clamped in said recess between strips of resilient material, the back end edge and top edge of the unit being buttressed against said intersecting walls of the frame, the front end edge having a first portion which moves an appreciable amount out of the plane of said unit, and an adjacent second portion which moves a negligible amount out of the plane of the unit; an elongated stylus; means for aligning said stylus lengthwise along said front end edge of the unit and for constraining said stylus to oscillate with said first portion as a unitary part thereof in pivotal relationship to said second portion, said aligning means comprising a pair of spaced notch-like stylus seats adapted to engage said stylus near its opposite ends and secured inflexibly to said front edge to couple said unit rigidly to said stylus, when the latter is seated firmly in said seats; and means for clamping said stylus firmly in said seats.

8. A record cutter as claimed in claim 7 wherein said piezoelectric unit is of the torque type and wherein said strips of resilient material engage the unit along said buttressed edges thereof.

9. A record cutter as claimed in claim 7 wherein said frame includes a wall lying adjacent the front edge of said unit and wherein said stylus clamping means are secured to said wall of the frame so as to remain stationary while the unit and stylus oscillate together as a single vibratory system.

10. A record cutter as claimed in claim 7 wherein said piezoelectric unit is of the torque type and wherein said strips of resilient material are T-shaped and engage the unit along the back end edge and along the length midway between the top and bottom edges.

11. A piezoelectric record cutter as claimed in claim 1 wherein said pair of notch-like seats lie at opposite ends of a concave V-shaped groove.

12. A piezoelectric record cutter comprising: a frame; an elongated torque-type piezoelectric unit adapted for edgewise operation and secured in said frame between strips of damping material which engage opposite faces of said piezoelectric unit along the back end edge of the latter and along the top edge, the front end edge of said unit being free to move torsionally about a longitudinal axis which lies in the plane of the unit; an elongated stylus; means for aligning said stylus lengthwise along said front edge and for constraining said stylus to oscillate as an inflexible part of said front edge in pivotal relationship to said longitudinal axis when the stylus is secured firmly to said aligning means, said align-

ing means comprising a member inflexibly secured to said front end edge and having a concave V-shaped groove formed therein, the extremities of said groove providing a pair of spaced notch-like stylus seats adapted to engage said stylus near its opposite ends; and means for clamping said stylus firmly in said seats.

13. A piezoelectric record cutter having only one resonant frequency within its useful frequency range, said cutter comprising the combination of: a plate-like piezoelectric unit clamped between strips of resilient material for edgewise operation and having, when in operation, an edge which includes a first portion which moves an appreciable amount out of the plane of said unit and an adjacent second portion which moves a negligible amount out of the plane of the unit; an elongated stylus; means for aligning said stylus lengthwise along the edge having said first and second portions and for constraining said stylus to oscillate as an inflexible part of said first portion in pivotal relationship to said second portion when the stylus is secured firmly to said aligning means, said aligning means comprising a spaced pair of notch-like stylus seats secured inflexibly to said edge and adapted to engage and support said stylus at substantially determinately spaced points lying near opposite ends of the stylus; and means for clamping said stylus firmly in said seats.

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