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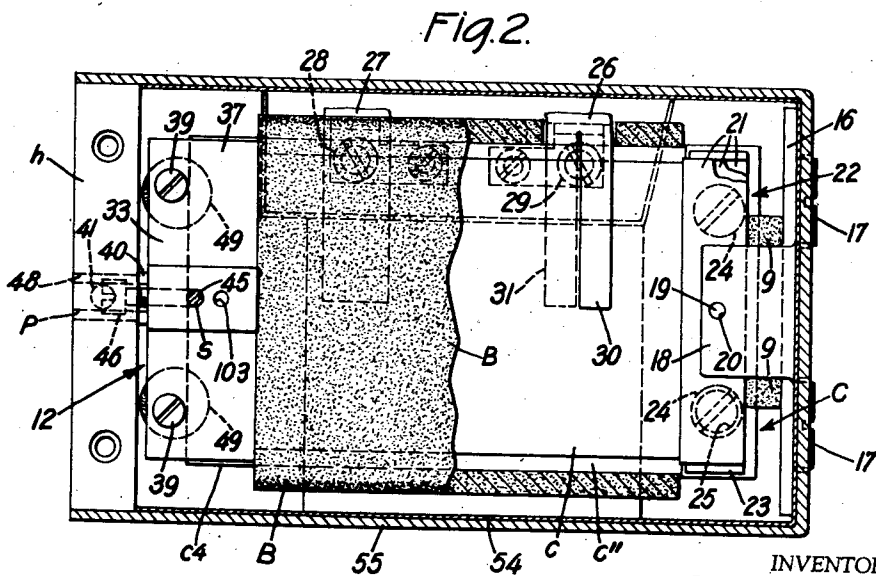
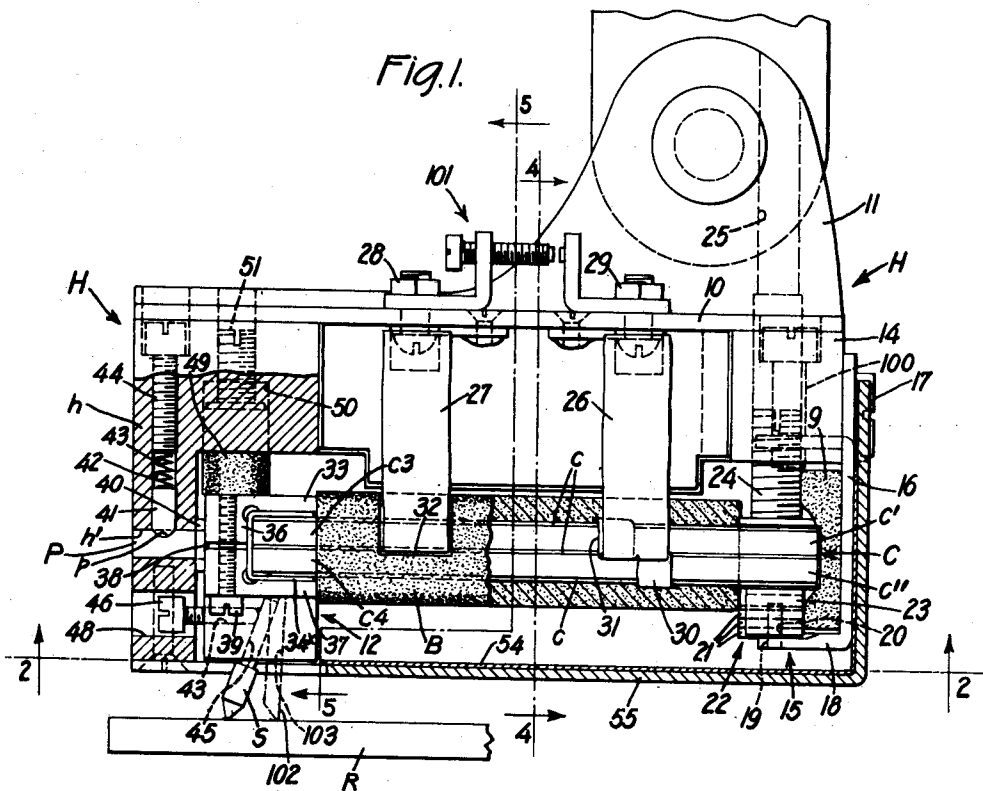
B. A. PROCTOR

2,133,333

SOUND RECORDING AND REPRODUCING MECHANISM

Filed March 26, 1936

2 Sheets-Sheet 1



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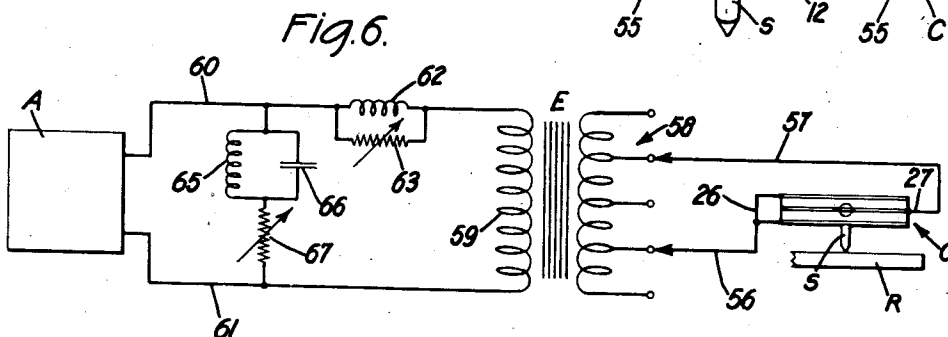
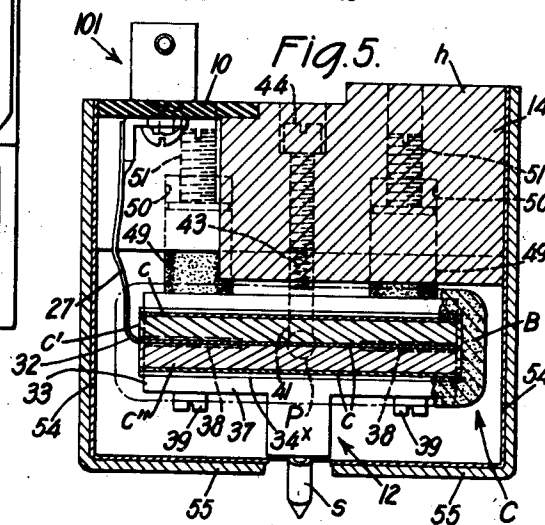
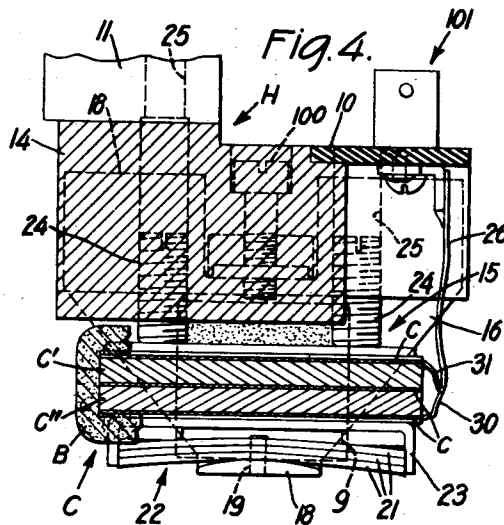
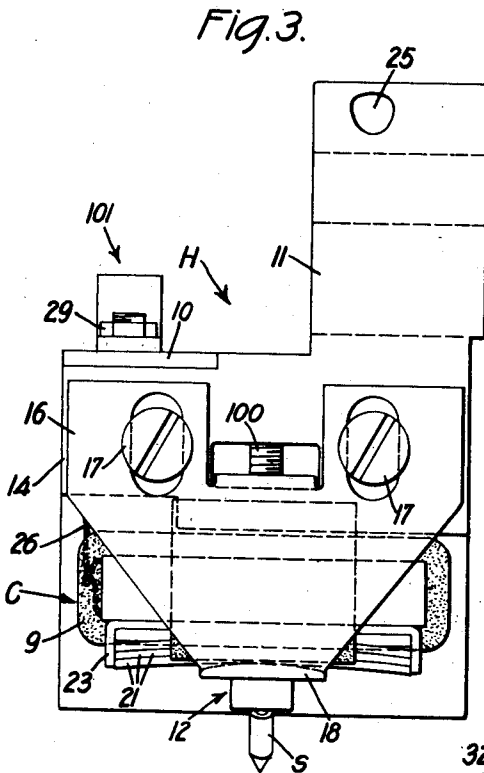
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SOUND RECORDING AND REPRODUCING MECHANISM

Filed March 26, 1936

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,133,333

SOUND RECORDING AND REPRODUCING
MECHANISMBarton A. Proctor, Larchmont, N. Y., assignor to
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Application March 26, 1936, Serial No. 70,962

21 Claims. (Cl. 179—100.41)

This invention relates to sound-recording and reproducing mechanism; especially to a head in which a stylus is adapted to be moved over the record for recording or for playing the record, and more particularly to a head of the so-called piezo-electric type in which movement of a crystal device responsive to torsional stresses set up therein by electrical current impulses or vibratory changes originating in an electrical circuit modulated by the sounds to be recorded are translated by the stylus into record track deformations the amplitude of which corresponds to the amplitude of the current impulses.

An important object of the invention is to provide a head of this type with crystal clamping means of such a novel character that when the crystal has been fully clamped and without any current on it, the crystal is at a position of no strain, so that when current is applied it will respond with maximum effect and to an equal degree in each direction.

Such equality cannot be secured in cases where the crystal is initially under stress when clamped without current on it. It is believed that many of the variations in response yielded by crystals used in conventional reproducers arise because the crystals are not clamped properly.

Another object of the invention is to provide means for holding a laminated crystal slab in such a head by means that exert thereon a yielding clamping pressure which may be regulated in an exact manner to permit the crystal to respond with maximum efficiency to the electric impulses passing through the crystal along its principal electrical axis, having regard both to the type of material to be deformed and the pressure it is necessary to exert thereon. The crystal is also permitted by the yielding clamp to expand and contract in response to temperature changes.

All told, three adjustments of the crystal are provided for by the present invention; the first being that described in the foregoing paragraph at one end of the crystal; another adjustment at the other end of the crystal; and a third adjustment which permits the differences of the two ends of the crystal to be adjusted to each other so that when the crystal is not subjected to current it will be firmly clamped at each end and there will be no strain internally.

In pursuance of the foregoing objects the invention includes means for improving the stylus holder and in general the parts associated with the free or active end of the crystal, such improved stylus-holding means comprising a split

magnesium clamping member embracing the free edge of the laminated crystal slab across its breadth, and provided with a pivot ring solidly embedded in the material of the clamp. A pair of screws enable the operator to apply pressure upon the crystal, of an order suitable to permit expansion, but sufficient to avoid lost motion.

A cognate object of the invention is to provide a metal head of more than ordinary weight so that by affording a substantial base to the stylus, the vibrations of the latter will be translated into the desired sound-track deformations and not dissipated in trepidation of the holder, and so absorbed uselessly.

A similar object is to provide exceptionally rigid, firm means to hold the stylus against any wobbling movements, and thus to obviate a source of defect in the fidelity of recording and reproduction which has characterized similar structures in the art.

An object of the invention is to provide a recorder head with a novel mounting for the crystal and stylus so constructed that the stylus may be used effectively to deform a material of high specific resistance to deformation, and consequently this resistance to formation of the sound track may be availed of to exert part of the damping effect requisite to change the natural vibration amplitude of the crystal device and its associated parts, eliminating it as a source of defects in the record.

Other provision against vibration takes the form of a spring-biased plunger engaged with the pivot of the crystal device; and damping plugs are engaged between the clamp of the stylus holder and the main holder of the recording head. Means are provided to vary the tension upon these plugs, which serve as auxiliary damping means to correct partially the frequency peaks that are caused by the mass and weight of the crystal device and its associated parts. It will be understood that the natural period is a function that has many variable factors such for example as the size and weight of the crystal and associated parts.

It is intended that as between damping by the plugs and by the record material the resistance of the record material to deformation shall be utilized to effect part of the requisite damping effect, in contradistinction to the virtually entire absence of damping effect when wax has been used for record material. The plugs may be relied upon for most or all of the remaining of the damping to be effected, where a resistant record material such as aluminum is used, but

if wax be used the plugs would have to be adjusted to effect the amount of damping required.

A further object of the invention is to provide electrical filter circuits to supplement the mechanical damping means in order to obtain the desired recording response.

Still another object is to provide an acoustic blanket for the crystal device adapted to shield the same against extraneous sound vibrations of an order capable of causing the crystal to vibrate on an undesired frequency; and as a means to further a similar object the faces of the metal casing may be loaded to render them non-resilient.

Other objects and features of the invention will appear as the description of the particular physical embodiment of the invention selected for illustration progresses.

In the accompanying drawings, like characters of reference are applied to corresponding parts throughout the several views comprised in the drawings, in which:

Fig. 1 is a view in vertical longitudinal section of a recording head in the construction of which the present invention has been embodied;

Fig. 2 is a view in horizontal sectional plan, taken on the line 2—2 of Fig. 1, looking upward;

Fig. 3 is a view in rear elevation, i. e., looking from right to left, of the main holder and associated parts shown in Fig. 1, with the casing omitted;

Fig. 4 is a fragmentary, detail view in vertical transverse section on the line 4—4 of Fig. 1;

Fig. 5 is a similar view on the line 5—5 of Fig. 1 looking in the opposite direction;

Fig. 6 is a diagrammatic view of a typical electrical circuit in which the crystal device of the present disclosure may be illustratively included; and a filter network is also shown.

In a now-preferred embodiment of the invention selected for illustration and description, the part designated by the reference character H is a body member which may be designated as the "main holder" of the recording head, as distinguished from the "stylus-holder" 12, in which a stylus S is mounted and caused to travel, by conventional or other suitable means, across a record blank R of suitable material which, in the present instance is preferably a metal such as aluminum or electrolytically deposited tin on a steel plate, or which may be cellulose acetate or wax.

The activating means for the stylus includes a crystal device of known or other suitable form, designated generally by the reference character C, and which is, in the instance illustrated, a laminated, slab-like structure comprising a pair of elements c' , c'' , made of compacted crystalline components such as Rochelle salts having metal foil coatings c over each outer face and between their adjacent faces, the elements being assembled in known broadside juxtaposition. While the present application shows such a laminated crystal of the twister type, it is to be noted that a single crystal may be used; also that the use of a bender type of crystal is contemplated, with suitable modifications, i. e., a crystal bending longitudinal axes, crystals of both of these types being known in this art.

The holder H is preferably made in part at least of metal of substantial weight, and comprises an upper part N from which extends upwardly a lug 11, shown as of a form conventional in the supporting arms for such recording heads; 10 is an insulating plate, and below the plate

extends a block 14 carrying a yielding clamping means 15 in which is fixed firmly, but with adjusted pressure, the adjacent end of the crystal device.

The clamping means comprises a member preferably made of sheet-metal or other suitably rigid material, having an upright 16 secured to the block 14, as by screws 17, and bent to form a stirrup 18 having a stud 19 fitted in orifices 20 in the elements 21 of a leaf-spring 22, this assembly being completed by an elongated top-plate 23 of inverted U-shape, which abuts against the inner margin of the lower face of the crystal device C (see Fig. 1).

In the mounting of the crystal the left hand end, Fig. 1, is first clamped in position. This causes the right end to assume a position at which the crystal is not under stress. Then the screws 24 are screwed down until they just touch the upper side of the crystal. Then the screw 100 is adjusted causing the entire clamp to come up and compress the crystal against the screws 24 through the intermediate agency of the leaf spring 22. The pressure on the crystal must not be too great because the efficiency of the crystal is diminished under too great a pressure. The proper pressure under which the crystal gives greatest response may be determined by the use of suitable known electrical measuring instruments.

A cushion 9, of felt or other elastic material, is interposed between the ends of the crystal elements c , c' and the upright 16.

Electrical terminals 26 and 27 are attached to the insulating upper plate 10, where they are provided with binding posts 28 and 29; the terminal 26 taking the form of a metal strap having fingers 30, 31 contacting respectively with the upper and lower foil facings c of the crystal element, while the strap 27 is inserted between the crystal elements and contacts with the metal foil c therebetween, as at 32.

The reference character B designates an acoustic blanket of rubber or other suitable sound-deadening material by which the crystal elements are enveloped, and which is effective against the propagation thereto of sound vibrations of undesired frequency, and to prevent the crystal from transmitting sound vibrations through the air and thus permitting feed back of the sound to the microphone and other instrumentalities. It serves also as a protection against moisture.

The free ends $c3$, $c4$, of the crystal elements, in pursuance of the invention, are embraced within a clamping member 33 preferably magnesium, occupying a medial slot 34 in the rear face of this clamp, which forms preferably an integral part of a one-piece device having the contour of a very broad T. A layer of paper 34x may desirably be provided between the crystals and the walls of slot 34, and the edges of the slot may be of arcuate shape to make it more resilient and to compensate for temperature changing effects of the clamp, and the crystal. The shank 12 of this member has already been referred to as constituting the holder for the stylus, and it will now be seen that the stylus is mounted within a socket 45 having a double bore, one axis 103 of which (see the dotted line position 102 of the stylus) is inclined at an angle of about 2° to 5° to the vertical. This position is used for cutting wax or other material, and for deforming records of aluminum or like materials the angle may be of the order of about 19°. The bore of socket 45 in which the stylus S is shown in full lines is pro-

vided to permit such disposition, the set screw 48 being effective against the stylus in each of the selected positions. This is about the same angle as that of the reproducing stylus employed in playing a record, and the disposition of the recording stylus at this angle makes possible a more faithful recording in the record, by reason of such correspondence to the playing position.

This disposition is a novel feature of the present invention, and is stressed at this point in the description for the reason that the resistance of the record material is overcome in the present instance by the exertion of unusual power supplied by the torsion of the crystal device C. The ability to deliver this requisite power with desirable elusivity to the modulations of sound to be recorded, is dependent in large degree upon the improvements now to be described in the mounting of the clamping member 33 intermediate the crystal and the point of pivot connection P in the front of the main holder.

For this purpose, each upper end part of the clamp 33, as 36, 37, is split, as at 38, and a pair of draft screws 39 serve to compress these split ends upon the crystal with adjusted firmness, designed to secure maximum efficiency in operation of the stylus. A pivot ring 40 is embedded in the material of the clamp and the pivot P extends through the pivot ring and through the contiguous wall h of the main holder H, which has an orifice h' to receive the pivot. In order to prevent any rattling of the pivot, a plunger 41 is provided in a bore 42 in the wall h in position to fit over the upper rounded side of the pivot, and a spring 43, urges the plunger 41 against the pivot. A screw 44 serves to maintain the tension on the spring.

At 46 I have shown a set screw, threaded into a bore 48 in the part 12 of the stylus-holder, and this screw may be set up by a screw driver inserted through the orifice 48' in the front wall h of main holder H.

Above the clamp portions 36, 37, a pair of elastic damping plugs 49 are interposed, being set in sockets 50, and set screws 51 are provided to regulate the pressure of these damping plugs 49 against the stylus-holder. As hereinbefore explained these plugs are designed to exert a damping effect which may be subsidiary when the material of the record to be deformed possesses suitable resistance; or if the recording head is working upon a low-resistance material such as wax, the plugs 49 may constitute the principal damping medium.

It is to be noted that there can be no sidewise wobbling of the stylus, in view of the firm character of all the elements entering into its support, so that the recording or playing is exceptionally faithful.

Preferably the recording head will be formed with a metal casing 55 surrounding four sides of the main holder leaving the front wall h exposed, while the top is covered by the plate insulating 10. This is a convenient mode of construction, and facilitates removal of the casing at will to expose the parts mounted on the main holder and associated with the crystal. The casing may desirably have a lining 54 of sound-absorbent material.

The typical circuit diagram illustrated in Fig. 6 will be understood readily by those skilled in the art of wiring piezo-electric crystal instrumentalities. In this figure the crystal device appears at C, and 26 is the terminal connected with the ex-

terior faces of the crystal, 27 designating the terminal connected with the medial axis thereof.

Conductors 56 and 57 lead respectively therefrom to movable points on the secondary 58 of an equalizing coupling device E whose primary 59 is energized by current supplied through conductors 60, 61 from an amplifier A. The latter derives current impulses through suitable connections (not shown) from a source thereof modulated by the sounds to be recorded.

The reference characters 62, 63, 64, 65, 66, 67 indicate elements of a filter net of well-known form designed preferably to dampen out effects caused by mechanical vibrations rather than by electrical constants of the circuit.

At 101 in Fig. 1, I have shown a spark-gap of known construction which bridges the terminals 28—29, and may be adjusted to protect the crystal from unusual surges of current or voltage which might tend to injure the crystal in the absence of such protection.

As an example of a modification which may be adopted without departing from the idea of means underlying the invention disclosed herein, a crystal device may be used for so-called "hill-and-dale" recording in which the crystal is secured at three of its corners in a manner conformable to the present invention, the stylus-holder being mounted at the free corner of the crystal.

I have described what I believe to be the best embodiments of my invention. I do not wish, however, to be confined to the embodiments shown, but what I desire to cover by Letters Patent is set forth in the appended claims.

I claim:

1. A crystal device and support therefor to cooperate with a stylus in the head of a mechanism of the class described, said crystal device comprising a crystal slab; means to impress thereon electrical currents modulated by the sounds to be transmitted so that said crystal device will respond to the torsional effects thereby caused, a pivoted stylus carrier clamped to the crystal and capable of determining a normal position for the crystal when the stylus is in a neutral position, and clamping means engaging and supporting the crystal at a distance from the stylus, comprising a rigid clamping member adjustable into engagement with one side of the crystal in said normal position, and a yielding clamping member adjustable against the opposite side of the crystal in opposition to the first clamping member, said clamping members being symmetrically disposed with reference to the pivot of the stylus carrier, the construction and arrangement being such when the crystal has been fully clamped and without any current on it, the crystal is at a position of no strain, and when current is applied the crystal will respond with maximum effect and to an equal degree in each direction.

2. In a recording head for a mechanism of the class described; a crystal device as claimed in claim 1, characterized by an extended crystal slab; and further characterized by means for supporting one end of said slab rigidly against current-induced torsion; means for clamping the other end of said slab with adjusted firmness to a stylus; and a means to compensate adjustively for differences of the two ends of the crystal, so that when the crystal is not subjected to current, it will be under no strain internally substantially as described.

3. A crystal device for operating a recording instrument in the recorder head of a sound-re-

cording mechanism of the class described, said
 crystal device comprising a set of crystal compo-
 nents, means clamping the crystal device cross-
 wise at one end, said clamping means compris-
 5 ing yielding and rigid clamping members for
 bearing, respectively, against opposite faces of
 the crystal device, and a stylus carrier clamped
 crosswise to the opposite end of the crystal de-
 vice and pivotally mounted to rock about an axis
 10 in substantial alignment with the axis of the crys-
 tal, the construction and arrangement being such
 that said recorder-head may be used effectively
 to deform a material of high specific resistance
 to deformation whereby said resistance may be
 15 availed of to exert a substantial portion of the
 damping effect requisite to dampen the natural
 vibration amplitude of the crystal device and its
 associated parts substantially as described.

4. A recording head for sound-recording mech-
 20 anism of the class described, comprising a crystal
 device including a slab composed of a compacted
 aggregate of crystalline components, having at
 one end means by which that end exclusively of
 the crystal device is clamped under compression
 25 with complete rigidity against current-induced
 torsion.

5. A recording head for sound-recording mech-
 anism of the class described, which includes a
 crystal device comprising a laminated slab com-
 30 posed of a compacted aggregate of crystalline
 components, having at one end means by which
 the crystal device can be yieldingly supported
 with adjusted rigidity and having a free end
 provided with means to clamp with adjusted
 35 firmness a stylus adapted to translate into record-
 track-deformation the movements of the crystal
 impressed upon the stylus as the crystal responds
 to torsional stresses set up therein by electrical
 current impulses or vibratory changes originating
 40 in an electrical circuit modulated by the sounds
 to be recorded.

6. A recorder head of the class described, in-
 cluding a crystal device provided at a free portion
 with a stylus-holder and a main holder support-
 45 ing a clamp in which said crystal device is fixed
 with complete rigidity against current-induced
 torsion at the end thereof remote from said
 stylus-holder, said clamp being characterized by
 a means, such as leaf-springs, for transmitting
 50 the clamping pressure to the crystal device in a
 manner responding only to temperature-and-
 moisture-induced expansion effects; also by
 means to control the tension of said springs.

7. A recording head for sound-recording mech-
 55 anism of the class described, comprising a crystal
 device having means to support one end with ad-
 justed firmness and having mounted on its other
 end a stylus-holder provided with a pivot, said
 head being further characterized by a main hold-
 60 er on which said adjustable holding means is
 mounted, and also by a pivot associated fixedly
 with said stylus holder and engaged pivotally in
 said main holder.

8. A recording head for sound-recording mech-
 65 anism of the class described, comprising a crystal
 device having means to support one end with ad-
 justed firmness and having mounted on its other
 end a stylus-holder provided with a pivot, said
 head being further characterized by a main hold-
 70 er on which said adjustable holding means is
 mounted, and also by a pivot associated fixedly
 with said stylus holder and engaged pivotally in
 said main holder, also by a spring-biased means
 carried by said main-holder and engaged yield-
 75 ingly with said pivot to prevent rattling thereof.

9. A recorder head of the class described, in-
 cluding a crystal device, a clamping means in
 which one end of said crystal device is held with
 complete rigidity against current-induced torsion,
 a stylus-holder on the remote end of said crystal,
 5 the latter being responsive freely to current-in-
 duced torsion, and a main holder for said crystal
 and its associated parts.

10. A recorder head of the class described com-
 prising the crystal device, clamping means, 10
 stylus-holder, and main holder elements, com-
 bined and cooperating as set forth in claim 6,
 and further characterized by means to change
 and dampen the natural period of vibration of
 the crystal and its associated parts, said damp- 15
 ing means arranged to bear against one side only
 of the crystal device including at least one resil-
 ient plug or buffer member interposed between
 said stylus-holder, or free part of the crystal and
 said main holder. 20

11. In an electrically operated recorder-head
 comprising a crystal device responsive to sound-
 initiated modulations in an electrical circuit, a
 filter circuit adapted to dampen out effects caused
 by mechanical vibrations rather than by electri- 25
 cal constants of the circuit.

12. In a recording head of the class described,
 a main holder, a crystal device supported rigidly
 against current-induced torsion exclusively at one
 end, by clamping means thereon, and an acoustic 30
 blanket enveloping said crystal device and effec-
 tive against the propagation thereto of sound
 vibrations of undesired frequency, and also
 against emission of sound from the crystal.

13. In a recording head of the class described, 35
 a main holder, a crystal device supported rigidly
 against current-induced torsion exclusively at one
 end, by clamping means thereon, and a metal cas-
 ing surrounding said main holder and crystal
 and having sheet metal faces loaded to quench 40
 sound vibrations.

14. A stylus-holder adapted to embrace one
 edge of a laminated crystal device, in a recording
 head of the piezo-electric type, said stylus-holder
 comprising a generally T-shaped body having a 45
 socket in which said stylus may be supported ad-
 justively at an angle of about 19° to the record
 upon which said stylus is to operate, and at an
 angle more nearly approaching the perpendicular.

15. A stylus-holder in a head of the class de-
 scribed, comprising a generally T-shaped body, 50
 and further characterized by having a slot ex-
 tending medially along the head of said T, and
 by having the end-portions of the T slotted to
 form spaced clamping means for the edge of a
 crystal lying in said medial slot, and tension bolts
 to apply said split portions to said crystal with
 55 adjusted pressure.

16. In a recording head of the class described,
 an assembly comprising a main holding means, 60
 a crystal device made of laminated components,
 and a metal clamping means at each end of said
 crystal device, each clamping means having at
 least one ply of sheet insulating material inter-
 mediate it and the crystal, means to hold said 65
 crystal at one end of said main holder by a piv-
 otal extension of said clamp at that end, and
 means to hold said clamping means fixedly with
 yielding firmness in the clamp at the other end of
 the crystal. 70

17. A recording head for sound-recording
 mechanism of the class described, in which a
 cutter-head is adapted to be moved transversely
 of the record, and which includes a crystal device
 comprising a (flexible slab or) mass composed of a 75

compacted aggregate of crystalline components, having at one end means by which the crystal device can be supported rigidly, and having a free end provided with means to support a stylus adapted to translate into record-track-deformation the twisting movements of the crystal impressed upon the stylus as the crystal responds to torsional stresses set up therein by electrical current impulses or vibratory changes originating in an electrical circuit modulated by the sounds to be recorded, said recording head being characterized by a conformation such that its principal electrical axis extends through the center of the crystal, also by electrical terminals so disposed as to supply electrical current to flow through the crystal from one face at right angles to the axis of the other face, so that the crystal, in response to such changing current impulses causes vibration of the stylus varying in amplitude according to the amplitude of the current impulses.

18. In a piezo-electric apparatus, the combination of a Rochelle salt multiple-plate piezo-electric unit adapted in operation to flex torsionally, a case enclosing the unit, means operatively supporting the unit in the case, and a rotatable spindle attached to the unit with the axis of the spindle in line with the torsional axis of the unit,

said spindle being mounted in a wall section of the case.

19. In a piezo-electric apparatus, in combination, a piezo-electric crystal unit adapted in operation to flex torsionally, means supporting one end of the unit in fixed position, a spindle connected with the crystal unit at the opposite end thereof, and means rotatably supporting the spindle in line with the torsional axis of the unit.

20. In a piezo-electric apparatus, in combination, a piezo-electric crystal unit adapted in operation to flex torsionally, means supporting one end of the unit in fixed position, a spindle connected with the crystal unit at the opposite end thereof, means rotatably supporting the spindle in line with the torsional axis of the unit, and a stylus carrier affixed to said spindle for oscillation in unison therewith.

21. In a piezo-electric apparatus, in combination, a piezo-electric crystal unit adapted in operation to flex torsionally, means supporting one end of the unit in fixed position, a spindle connected with the crystal unit at the opposite end thereof, means rotatably supporting the spindle in line with the torsional axis of the unit, and an oscillatory member affixed to said spindle for oscillation in unison therewith.

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