Feb. 27, 1951 W. H. HUTTER 2,543,497

PHONOGRAPH NEEDLE

Filed Sept. 22, 1945 2 Sheets-Sheet 1

Fig. 1.

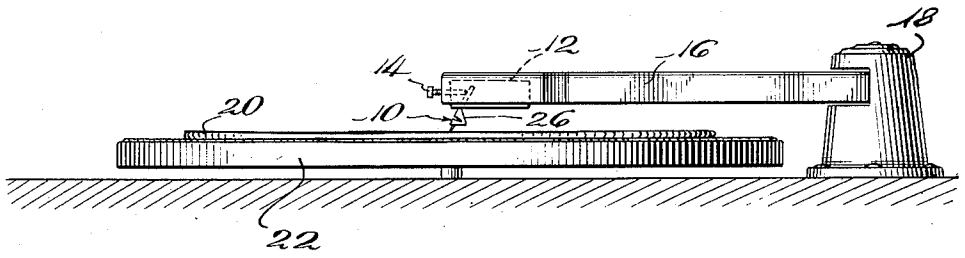


Fig. 2.

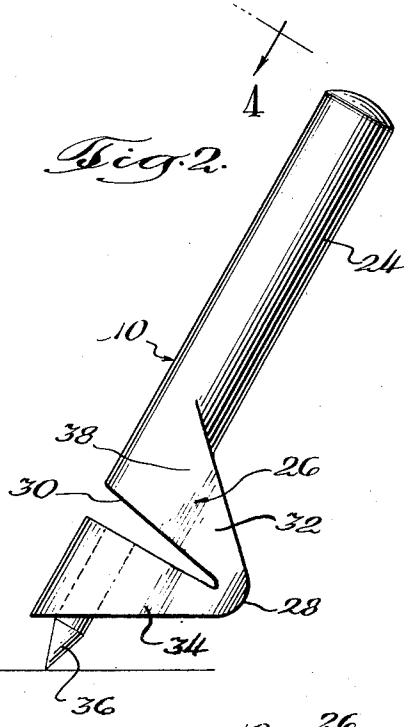


Fig. 3.

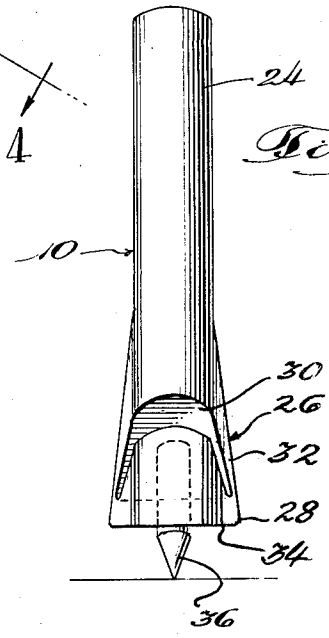
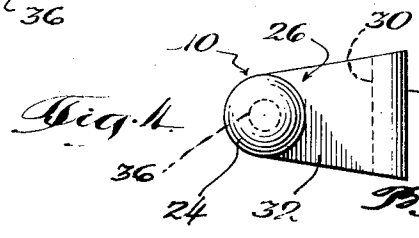


Fig. 4.



Inventor:
William H. Hutter
By Williams, Bradbury & Hulbert
Attorneys

Feb. 27, 1951 W. H. HUTTER 2,543,497

PHONOGRAPH NEEDLE

Filed Sept. 22, 1945 2 Sheets-Sheet 2

Fig. 6

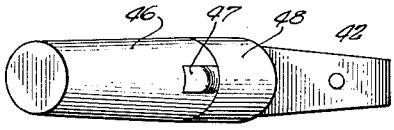


Fig. 11

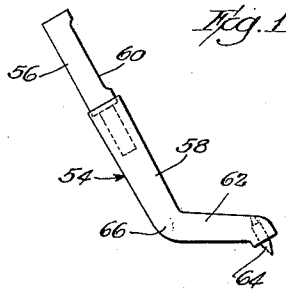


Fig. 5

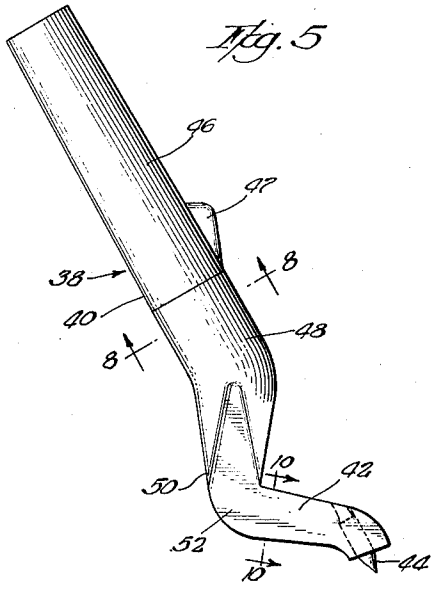


Fig. 7

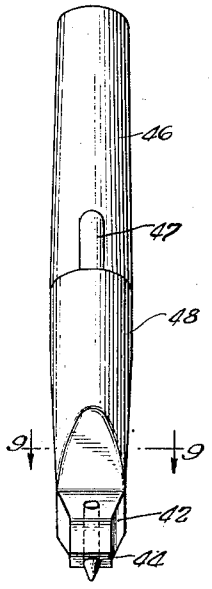


Fig. 8

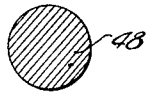


Fig. 9

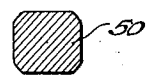
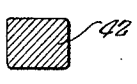


Fig. 10



INVENTOR.
William H. Hutter
BY
Zabel and Breitzkreutz
Attys.

Patented Feb. 27, 1951 2,543,497

UNITED STATES PATENT OFFICE

2,543,497

PHONOGRAPH NEEDLE

William H. Hutter, Chicago, Ill.

Application September 22, 1945, Serial No. 618,034

10 Claims. (Cl. 274—38)

1

This invention relates to improvements in phonograph needles and is a continuation in part of my copending application Serial No. 533,494, filed May 1, 1944, now abandoned.

The vibratory motion of a phonograph needle is not confined to the lateral vibrations imparted to it by the lateral undulations of the record grooves. The needle also vibrates in a vertical plane which is tangent to the record groove. The vertical vibrations may be imparted to the needle by variations in the effective width of the record groove, otherwise known as the "pinch effect." These variations in width are due to the method of cutting the groove and exert a camming action on the conically shaped record engaging point causing it to ride up and down as well as from side to side. Furthermore, certain abrasive constituents of the record material provide an uneven surface, and hence a variation in groove width.

The motion of the point itself in the aforesaid vertical plane includes not only that component which is perpendicular to the plane of the record, but may also include a forward and back, or horizontal component if the needle is at all compliant.

With a relatively stiff needle, the pinch effect will increase the needle point impedance, and hence the needle point wear and record wear, tremendously. This is due to the mass of the tone arm, which is added to the mass of the vibrating system, and reacts against the endwise thrust caused by the pinch effect. In an attempt to reduce or absorb the endwise thrust, the needle may be made somewhat flexible, or compliant. However, this not only cuts down the amplitude of the lateral vibrations which are transmitted to the pick-up, but it also increases the forward and back component. The latter causes a hammering or slapping of the point on the walls of the record groove which likewise causes rapid record and needle wear. Furthermore, the forward and back component not only of itself causes a variation in the velocity of the point with respect to the groove, but the backward movement takes place at a greater velocity than the forward movement, the lack of uniformity depending, for a given needle, upon the amplitude, frequency, and turning radius of the record groove.

This whipping of the needle contributes to poor output wave shape and poor tone.

It is an object of my invention to provide a novel phonograph needle which combines in an unusual degree, long life, low record wear, and fidelity of transmission.

Another object of this invention is the provision of a phonograph needle which has the ability to absorb the endwise thrusts imposed against the point.

Still another object is to provide a needle which is compliant to vertical vibrations, and which is

2

constructed in such a manner that the point of the needle has a minimum amount of forward and back component, thereby reducing record wear, and improving tone and fidelity.

The latter object is obtained by providing a needle in which the vertical compliance is localized at a point which is horizontally spaced from the record engaging point of the needle by a distance greater than the elevation of this point above the surface of the record. Thus the forward and backward component of the record engaging point will be less than the vertical component. In other words, the vertical vibrations of the record engaging point will be confined to motion in a direction which approaches as closely as possible a direction perpendicular to the plane of the record.

It is a still further object of my invention to provide a needle having a portion which is flexurally compliant to vertical vibrations, but not to lateral vibrations.

I have found that the desired vertical compliance may be introduced into the needle by providing a relatively abrupt bend, the abruptness of the bend having the effect of reducing the stiffness of the needle with respect to forces acting in the plane of the bent axis of the needle without reducing the stiffness of the needle to forces acting at right angles to said plane. Thus, the needle can be disposed with the plane of the bent axis perpendicular to the plane of the record to provide vertical, but not horizontal compliance. The vertical compliance provided by the bent portion serves as a filter, beyond which portion vertical vibrations are not transmitted to the remaining portion of the needle and to the pick-up. By virtue of the fact that the vertical compliance is localized, I confine the vertical vibrations to a portion of the needle which has a comparatively small mass. Thus, needle resonance, due to vertical vibrations, may be raised to a frequency beyond the effective range of the pick-up. I am also enabled to design the remainder of the needle so as to provide whatever amount and kind of horizontal compliance that may be desirable to provide the desired needle point impedance.

Experimentation on my part has indicated the desirability of regarding the elements of the vibration transmitting means, such as the needle, chuck, shank and coupling, together with the device such as a crystal, as a single vibrating system, and of achieving low needle point impedance and lack of resonance by maintaining low mass, and by providing distributed compliance throughout the system. The absolute values of the mass and compliance should be such that the output impedance of the vibration transmitting means matches the input impedance of the conversion device. Practically speaking, however, I have found that the needle point impedance of

practically all of the present day pick-ups is much too high for the best results. Therefore, in a well designed pick-up, due regard should be given to the mass and compliance of the needle, in order that the needle may cooperate properly with the associated parts of the pick-up to function as an integral part of the system as a whole. These considerations are of especial importance in the design of a needle with a hard, long wearing point for the reason that record wear is so much greater than with a soft point. By maintaining low needle point impedance, both horizontally and vertically, I am enabled to obtain the multiplay advantages of a hard point needle in combination with the record preserving qualities of a soft point needle, such as a fiber needle.

Whereas, my present invention is concerned primarily with the provision of means for reducing the vertical needle point impedance, the particular type of means herein disclosed enables me to provide a needle embodying the proper amount of horizontal compliance and mass. Thus low horizontal needle point impedance may be maintained in conjunction with the other parts of the pick-up, and separate needle resonances can be avoided.

Still another object of my invention is to provide a needle which provides both a vertically compliant portion and a lateral compliant portion, said portions being separate from one another so that in the design of the needle, both the vertical and lateral compliances can be regulated independently of each other. Furthermore, the practice of my invention provides a needle in which the lateral compliance is distributed throughout a considerable portion of the needle, thereby avoiding resonance, loose coupling and reflected vibrations.

To summarize, the objects of my invention are achieved by providing in a needle, an integral member which contains a relatively abrupt bend which brings the tip portion of the integral member into substantial horizontally disposed relationship. A hard, or long wearing record engaging point may be provided at the outer end of said horizontally disposed point portion. By means of this construction, a low radius angle is maintained, the term "radius angle" designating the angle between the plane of the record, and the radius drawn from the end of the record engaging point to the "hinge point," or vertically compliant portion. Thus, the relatively sharp bend, not only localizes the vertical compliance, but also localizes it in such a position with respect to the point, that the desired low radius angle is provided, thereby minimizing the forward and back component of the record engaging point.

The remaining portion of the needle may be designed to provide any desired amount of stiffness or compliance. Where a certain amount of lateral compliance is desired, a torsional compliance may be introduced in the upright portion of the integral member, the horizontally disposed tip serving as a lever arm. In other instances, I may desire to reduce the torsional stress on that part of the needle which is received within the chuck of the pick-up, and in such instances, the proper design would embody an arrangement in which the record engaging point is in substantial alignment with the portion which is received within the pick-up.

It is obvious that my invention is capable of numerous embodiments, and in the appended drawings, in which like reference numerals designate like parts, certain preferred embodiments are shown.

Fig. 1 is a view of the essential record reproducing portion of a phonograph and shows a needle of the type comprising the present invention associated with the phonograph record and tone arm;

Fig. 2 is a side elevational view, on a greatly enlarged scale, of the needle of the present invention;

Fig. 3 is a front elevational view of the needle illustrated in Fig. 2;

Fig. 4 is a plan view of the needle and may be considered as being taken on the line 4—4 of Fig. 2;

Fig. 5 is a side view of a phonograph needle embodying another form of my invention;

Fig. 6 is a top view of the needle shown in Fig. 5;

Fig. 7 is an end view of the needle shown in Fig. 5;

Figs. 8, 9 and 10 are sectional views taken at various points along the indicated lines of Figs. 5 and 7, in order to show the gradual reduction in cross section of the needle as one approaches the tip; and

Fig. 11 is an elevational view of still another form of my invention.

In Fig. 1 the numeral 10 designates, generally, my novel phonograph needle secured in the chuck of a pick-up 12 by set screw 14. The pick-up 12 is mounted in the outer end of a tone arm 16 which is pivoted at the opposite end in a standard 18. A record 20 is shown engaged by the tip of the needle 10 and is in playing position on a turntable 22.

The needle 10 is illustrated in Fig. 2 as having a shank 24 of generally cylindrical shape throughout its length at the upper end which fits into the chuck of the pick-up 12. At its lower end the shank is provided with an offset portion 26 which has a V-shape as viewed in Fig. 2. The V-shape portion 26 fans outwardly until it is substantially wider at the connecting portion 28 than the diameter of the cylindrical portion 24. A slot 30 is formed in the portion 26 from the face of the needle toward the connecting portion 28, thereby dividing the portion 26 into two arms 32 and 34, the arm 34 forming a horizontally disposed tip for the needle. The slot 30 is so formed, and the mass of the material in the arms 32 and 34 is so distributed and proportioned, that the lower face of the arm 34 is substantially parallel to the surface of the record when the needle is supporting the weight of the tone arm and pick-up.

A hard metal alloy or jewel point 36 is mounted in the lower arm 34 with its central axis substantially aligned with the central axis of the cylindrical portion 24 of the shank. The slot 30 cutting from the front face of the needle toward the connecting portion 28 of the portion 26 may be bounded by side walls which in themselves form a V which is more acute than the V formed by the outer faces of the arms 32 and 34. It will be noted from Fig. 2 that the arms 32 and 34 are thickest at the face of the needle and taper down toward the connecting portion 28. It has already been pointed out that the width of the connecting portion 28 is greater than the diameter of the cylindrical portion 24 of the shank. Thus formation of the needle gives it compliance in a vertical direction and adds stiffness reactance in a lateral direction.

In operation the vertical vibrations of the point

36 are absorbed by the flexurally compliant portion which is provided by the connecting portion 28. The arm 34 being horizontally disposed, it will be seen that the radius angle from the hinged point to the end of the point 36 is comparatively low, thereby minimizing the forward and back component of the point 36.

The radius of curvature of the axis of the needle through the connecting portion 28 is substantially less than the thickness of the needle at this point, thereby providing a relatively abrupt bend which serves to decrease the stiffness of the needle at this point, with respect to vertical vibrations. With respect to horizontal vibrations, however, the stiffness is not reduced. The width of the needle increases somewhat toward the connecting portion to compensate for the reduction in thickness, so that lateral stiffness of the connecting portion will be substantially the same as the lateral stiffness of other portions of the needle, such as arm 32.

The needle shown in Figs. 2, 3 and 4 provides a relatively high lateral stiffness, in combination with the desired vertical compliance. A modified form of my invention is shown in Figs. 5 to 10, inclusive, in which the lateral stiffness is somewhat less than that of Figs. 2 to 4. In other words, the needle of Figs. 5 to 10 provides a vertical compliance in combination with a lateral compliance, and those portions of the needle which provide these compliances are separated from one another so that the lateral compliance may be controlled independently of the vertical compliance in order that the acoustic properties of the needle may be matched to the other portions of the pick-up.

The needle 38, shown in Figs. 5 to 10, comprises a shank 40, a substantially horizontally disposed tip 42 which is integrally formed with the shank, and a record engaging point 44 which is mounted in the remote end of the tip 42.

The shank 40 comprises three portions designated by reference numerals 46, 48 and 50. The portion 46 is that portion of the shank which is adapted to be received within the chuck of the usual pick-up. This portion is of circular cross section, and is preferably provided with a slight taper to facilitate the engagement of the needle with a tapered chuck, of the type which does not embody a set screw.

The portion 48 is immediately adjacent portion 46 and in axial alignment therewith. This portion is substantially cylindrical and is adapted to project a short distance from the chuck. Beneath the cylindrical portion 48 is a tapering portion 50, the axis of which is disposed at an angle to the axis of portions 46 and 48. In this particular embodiment of my invention, the axis of the tapering portion 50 is substantially perpendicular to the plane of the record, and the angle between that axis and the axis of portions 46 and 48 is substantially 150 degrees.

The angle between the axis of tapering portion 50 and tip 42 is slightly more than 90 degrees, with the result that the axis of tip 42 is disposed at a slight angle with respect to the plane of the record in the position shown in the drawings. This permits the needle to be used on record changers, in which the tone arm assumes an appreciable tilt, thereby bringing the tip 42 into horizontal position. That portion of the needle which connects the shank with the tip, and which constitutes the angle between these two parts, is designated by the reference numeral 52. This connecting portion 52 is flexurally

compliant with respect to vertical vibrations of the tip 42, but is not flexurally compliant with respect to lateral vibrations thereof. When pressure is applied to the point 42 in such a manner as to cause the flexing of the tip, it will be observed that the motion of the tip follows an arcuate path, the center or hinge point of which lies within the portion 52.

Figs. 8 to 10, inclusive, show cross sections of the needle at various points along portions 48, 50 and 42, and indicate the manner in which the cross sectional area of the needle is gradually reduced as one approaches the lower end of the needle. The transition from the circular cross section of section 48 to the rectangular cross section of the tip 42 takes place in portion 50, as shown in Fig. 5. By gradually reducing the width and thickness of the needle from the cylindrical portion 48 on downward, and out to the end of the tip 42, the mass of the lower portion of the needle is kept to a minimum, and hence needle point impedance is kept low and resonance avoided.

By the terms "width" and "thickness" I refer to the dimensions of the needle which are taken in a plane perpendicular to the centeral axis of the particular portion of the needle under discussion, the term "width" being the dimension in a direction which is parallel to the plane of the record, and the term "thickness" being the dimension which is perpendicular to the width. By the term "lateral vibrations" as herein used, I refer to that component of the motion of the needle in a direction parallel to the plane of the record and transverse to the groove. The lateral vibrations are the ones which it is desired to transmit from the point 44 to the chuck and to the crystal. By the term "vertical vibrations" I mean the up and down motion of the various parts of the needle in a plane perpendicular to the plane of the record and tangent to the groove.

As pointed out above, this up and down motion, as far as the point is concerned, consists of a perpendicular, or vertical, component, and a forward and back, or horizontal, component, the latter being of greater or less extent depending on the radius angle. By maintaining this radius angle low, as by disposing tip 42 substantially horizontally, as shown, the up and down motion of the point is confined to motion substantially perpendicular to the record. This reduces record wear and improves fidelity of response.

With respect to the lateral vibration of the point 44, the tip 42 acts as a lever arm which tends to rotate about the vertical axis of the portion 50. Although the major portion of the lateral vibrations is intended to be transmitted through the shank to the pick-up, it is desirable in certain instances to provide a certain amount of lateral compliance in the needle. The lateral compliance is provided by the portion 50 which is torsionally compliant to the desired extent, depending upon its dimensions, and the length of the lever arm afforded by the tip 42. By a proper proportioning of the parts, the desired torsional compliance may be provided.

In both of the above described embodiments of my invention, it will be noted that the record engaging point is offset to a minimum extent from the axis of that portion of the shank which is received in the chuck. Thus the torque on said portion, which might tend to loosen the needle in the chuck, is maintained small. This feature is particularly desirable in those con-

structions in which the needle is secured in the chuck by a wedging action, as in the case of the needle 38, but is not as important where the needle is to be secured in the chuck by the usual set screw, as shown in Fig. 11. In particular, certain advantages in the assembly of the point with the tip will result if the exact axial alignment of the parts of needle 10 is avoided.

A further embodiment of my invention is shown in Fig. 11, in which the shank of the needle 54 is a composite member, made up of a metallic insert 56 and a plastic body portion 58. The metallic insert 56 is slabbed as at 60 so that it may be engaged by the set screw of the usual type chuck.

Integrally formed with the plastic body portion 58 is a substantially horizontally disposed tip 62, in which the record engaging point 64 may be secured in the manner pointed out in the last mentioned copending application.

In this construction, the connecting portion 66 between the plastic body portion 58 and the tip 62 comprises the vertically compliant portion. The length of the lever arm provided by the tip 62 and the dimensions of the plastic body portion 58 may be such as to provide the desired amount of lateral compliance.

In the embodiment herein shown, the axis of the shank makes an angle of substantially 120 degrees with the axis of the tip, although this angle may be varied more or less in accordance with the type of chuck with which it is desired to use the needle.

In all of the above described embodiments of my invention, the angle formed by the bent portion of the needle is comparatively abrupt. As indicated above, the degree of abruptness can be measured by the ratio of the radius of curvature of the axis of the needle through the connecting portions 28, 52 or 66, to the thickness of the needle at that point, the lower the ratio, the greater the degree of abruptness. The greater the degree of abruptness, the greater is the effective reduction in the thickness of the needle at that point. In other words, the stiffness of the needle, with respect to vertical vibrations, diminishes with the value of the above mentioned ratio, although the stiffness with respect to lateral vibrations is substantially unaffected by the bend.

Although any desired degree of abruptness may be employed, I have found that the desired combination of vertical compliance in lateral stiffness is most evident when the ratio of the radius of curvature to the thickness is less than unity.

Although the principles of my invention are applicable to needles formed from various types of materials, I prefer to use a plastic material having a density of less than two grams per cubic centimeter and a Young's modulus of less than 10×10^{10} dynes per square centimeter. More specifically, I have achieved satisfactory results from a needle formed from nylon and made substantially in the proportions shown in the accompanying drawings, the total length of the needles shown being substantially six-tenths of an inch. For instance, the diameter of the needle 38 at the cylindrical portion 48 is .080 inch, which tapers down to a width of .065 inch, and a depth of .050 inch at the connecting portion 52, and to a width of substantially .045 inch and a depth of substantially .031 inch toward the outer end of the tip 42. Integrally formed with a tapering portion 46 may be a suitable key 47 which is adapted to cooperate with a keyway in the chuck in order that the needle may be properly oriented with the groove of the record.

The term "nylon" refers to a substance sold by E. I. du Pont de Nemours & Company, which is suitable for molding, which is understood as being a synthetic fiber-forming polymeric amide, having a protein-like chemical structure. Nylon may otherwise be defined as a "fiber-forming polymer including synthetic linear condensation polyamides formed by reacting organic diamines with dibasic acids or with the amide-forming derivatives of dibasic acids, and polyamides formed from polymerizable amino acids."

In those instances where the needles 10 and 38, as well as needle 54, are formed from a plastic material, and in particular, a plastic material which is characterized by a toughness and a certain amount of resilience, such as nylon, the manner in which the record engaging point is associated with the tip preferably comprises the formation of a bore in the tip which is a few thousandths smaller in diameter than the sapphire or metal point to be inserted therein. When the body of the needle is made of a somewhat resilient material, the point can be forced into this bore and through it so that it projects below the lower surface of the tip. The upper end of the point is squared off so that when the resilience of the material asserts itself by a slight contraction of the bore above the tip, the contracted portion will serve to prevent upward movement of the tip through the bore.

In all of the above described embodiments of my invention, the shank and tip together can be considered as a holder for the record engaging point. Although I have shown the point as being non-integral with the tip, it is obvious that under certain circumstances, such as when the holder is of a material which is also satisfactory for the point, the holder and the point may be integral. However, the tip is integral with the lower portion of the shank, so that the holder is an integral member as far as the tip is concerned. Whether the upper portion of the needle, that is, the portion which is engaged by the chuck, is integral with the holder, as in needles 10 and 38, or is a separate member, as in needle 54, is immaterial as far as the present invention is concerned.

Although I have shown and described herein only a preferred embodiment of my invention, it will be understood that various modifications and changes may be made therein without departing from the spirit of my invention. The foregoing specification and the accompanying drawings are intended to be illustrative only and the invention is to be limited only by the appended claims.

The subject matter of the aforementioned copending application Serial No. 533,494, insofar as it is consistent with the present case is hereby incorporated by reference into this present case.

I claim:

1. A phonograph needle comprising a record engaging point and a structurally integral holder for said point, said holder being characterized by a shank in substantially axial alignment with the point for attachment to a phonograph sound reproducing means, an offset section between said shank and the point, and a single point of flexibility in said offset section said shank and that portion of said offset section disposed between said shank and said single point of flexibility being of a thickness no less than the thickness of said offset section at said single point of flexibility, said point of flexibility being so positioned and arranged that the distance between said point of flexibility and the end of said point is

comparatively large with respect to the elevation of said point of flexibility above a record engaged by said point, and said offset section being of a width sufficiently great that it will absorb only endwise thrusts against said point.

2. A phonograph needle comprising a shank, a pair of arms arranged to form a structurally integral V, one of said arms tapering in thickness toward the apex of said V, said shank projecting from the outer end of said tapering arm, and a record engaging point secured to the outer end of the other of said arms, and projecting downwardly a short distance from the lower surface thereof, said last mentioned arm being substantially horizontally disposed, said apex providing a single point of flexural compliance with respect to vertical vibrations and said arms being relatively stiff with respect to the compliance afforded by said apex.

3. A phonograph needle for cooperative engagement with the chuck of a pick-up and with a phonograph record comprising a structurally integral member having a substantially horizontally disposed portion at its lower end, the connecting portion between said horizontally disposed portion and the remainder of said member constituting a bend providing a single localized flexurally compliant portion with respect to vertical movement of said horizontally disposed portion, the ratio of the radius of curvature of the central axis of said connecting portion to the thickness of the needle at said connecting portion being less than unity, the thickness of said remainder of said integral member being no less than the thickness of said connecting portion, and said remainder and said horizontally disposed portion being relatively stiff with respect to the compliance afforded by said flexurally compliant portion.

4. A phonograph needle comprising a structurally integral member divided into an upper and a lower portion by a relatively abrupt bend, the connecting portion between said upper and lower portions forming a localized flexurally compliant portion, and a record engaging point provided at the free end of said lower portion, that part of said upper portion which is immediately adjacent said connecting portion being substantially verically disposed with respect to a record engaged by said point and being of a thickness no less than the thickness of said connecting portion, and being of such dimensions with respect to the length of said lower portion as to be torsionally compliant with respect to lateral vibrations of said point, said connecting portion being flexurally compliant to vertical vibrations of said point, but being comparatively rigid flexurally with respect to lateral vibrations, said upper and lower portions being relatively stiff with respect to the compliance afforded by said connecting portion.

5. A phonograph needle for cooperative engagement with the chuck of a pick-up and with a phonograph record, and having a chuck engaging portion, a point portion, and an intermediate portion which at its upper end is connected to said chuck-engaging portion and at its lower end to said point portion, said intermediate portion being structurally integral and being provided with a relatively abrupt bend dividing the same into an end part which is adapted to be disposed substantially parallel to the plane of a record when said chuck engaging portion is received within the chuck of a pick-up, and an upper part, said upper part being of downwardly and inwardly tapering dimensions and having a thickness no less than the thickness of said intermediate portion at said relatively abrupt bend, said end part being relatively stiff with respect to the compliance afforded by said bend.

6. A phonograph needle for cooperative engagement with the chuck of a pick-up and a phonograph record, and having a chuck engaging portion, a point portion, and an intermediate portion which at its upper end is connected to said chuck engaging portion and at its lower end to said point portion, said intermediate portion being structurally integral and being provided with a bend dividing the same into an end part which is adapted to be disposed substantially parallel to the plane of a record when said chuck engaging portion is received within the chuck of a pick-up, and an upper part, the thickness dimension of said upper part being downwardly and inwardly tapering toward said bend and being no less than the thickness of said intermediate portion at said bend, said end part being relatively stiff with respect to the compliance afforded by said bend and the length of said end part being such with respect to the length and angular disposition of said point portion that the vibratory motion of said point in a vertical plane will have a vertical component greater than the horizontal component.

7. A phonograph needle as claimed in claim 6 in which said bend is relatively abrupt, thereby providing a localized flexurally compliant portion.

8. A phonograph needle according to claim 6 in which the ratio of the radius of curvature of the central axis of said bend to the thickness of the needle at that point is less than unity.

9. A phonograph needle according to claim 6 in which the record engaging point of said point portion falls within the space defined by the axial projection of said chuck engaging portion on the record.

10. A phonograph needle according to claim 6 in which said upper part is disposed at an angle to said chuck engaging portion and is substantially perpendicular to said end part, the length of said end part with respect to the width and thickness dimensions of said upper part being such that said upper part is torsionally compliant with respect to the lateral vibrations of said point portion.

WILLIAM H. HUTTER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
881,594	Konigstein	Mar. 10, 1908
1,235,154	Owen et al.	July 31, 1917
1,281,135	Claybrook	Oct. 8, 1918
1,290,295	Muller	Jan. 7, 1919
1,490,875	Wellman	Apr. 15, 1924
1,666,330	Ferree et al.	Apr. 17, 1928
2,320,416	Dally	June 1, 1943
2,320,427	Guedon	June 1, 1943
2,418,212	Williamson	Apr. 1, 1947
2,455,913	Bauer	Dec. 14, 1948

FOREIGN PATENTS

Number	Country	Date
333,416	France	June 27, 1903
393,571	Great Britain	Sept. 5, 1931