Nov. 24, 1953 F. C. HOLTZ, JR 2,660,438

PHONOGRAPH NEEDLE

Filed Aug. 3, 1948

Fig. 1.

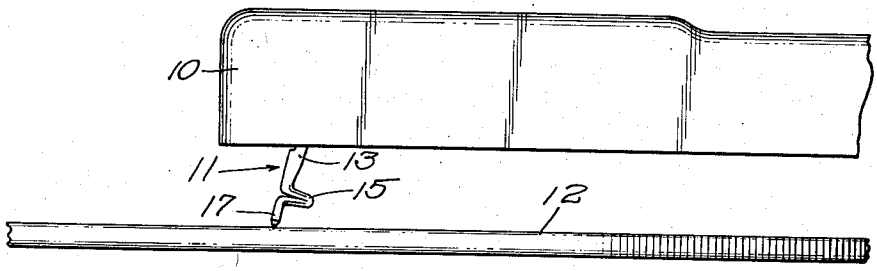


Fig. 2.

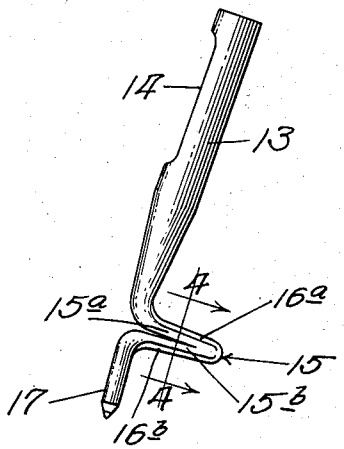


Fig. 3.

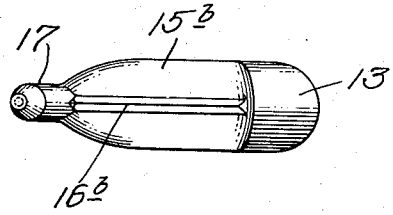


Fig. 4.

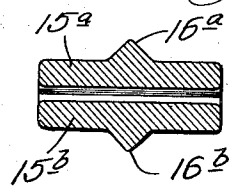


Fig. 5.

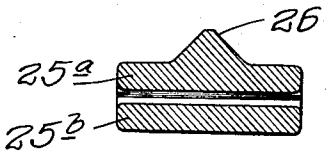
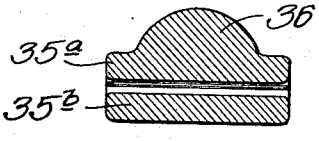


Fig. 6.



Inventor:
Frederick C. Holtz Jr.,
By Christian Schraeder
Merriam, Marshall & Bicknell, Attys.

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UNITED STATES PATENT OFFICE

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PHONOGRAPH NEEDLE

Frederick C. Holtz, Jr., Wadsworth, Ill., assignor to Pfanstiehl Chemical Company, a corporation of Illinois

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7 Claims. (Cl. 274—38)

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This invention relates to a phonograph needle, and more particularly to a phonograph needle having a flexible portion for improving the compliance of the needle.

One feature of this invention is that it provides an improved phonograph needle; another feature of this invention is that it provides a phonograph needle having compliance in the direction of all forces encountered during operation; a further feature of this invention is that it provides a phonograph needle having a flexible portion comprising a thin, flat spring section having a longitudinally extending ridge thereon, said needle being constructed in a manner to protect said flexible portion from deformation upon abnormal flexure thereof; still another feature of this invention is that the spring section comprises a loop lying in a vertical plane, said loop being flattened in a plane substantially transverse of the longitudinal axis of the shank of the needle and each section having a thickness preferably of the order of .005–.015 inch; yet a further feature of this invention is that the loop extends away from the shank substantially at right angles thereto and the loop is relatively short, preferably being substantially the same length as the tip portion of the needle; an additional feature of this invention is that the loop is not parallel to the surface of the record during operation; still another feature of this invention is that the axis of the tip of the needle is angular to the axis of the shank; and a further feature of the invention is that the needle can be formed from one piece of material and in one operation.

Other features and advantages of this invention will be apparent from the following specification and from the drawings in which:

Fig. 1 is a fragmentary side elevation of a tone arm carrying a needle constructed in accordance with the invention, the tip of said needle engaging the surface of a record;

Fig. 2 is an enlarged side elevation of the needle of Fig. 1 removed from the tone arm;

Fig. 3 is a bottom plan view of the needle shown in Fig. 2;

Fig. 4 is a cross section through the flexible portion of the needle taken along the line 4—4 of Fig. 2;

Fig. 5 is a cross section similar to Fig. 4, but of a modified form of needle; and

Fig. 6 is a cross section similar to Fig. 4 but of another modified form of needle.

In the reproduction of sound from a phonograph record, particularly from a laterally cut record in which the undulations representing the

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sound to be reproduced project into the record groove from the side walls thereof, a needle having compliance or yieldability in a vertical direction (speaking of the parts in the position in which they are illustrated in the drawings and in the position which they conventionally assume during operation) will eliminate much of the undesirable scratching which is ordinarily transmitted through the amplifying and transducing apparatus of phonographs which employs a rigid needle. In addition, a needle having such compliance will also lessen so-called "needle talk" and other surface noises which reach the ear directly from the needle without being transmitted through the amplifying system associated with the phonograph. To achieve satisfactory compliance in a vertical direction the needle which carries vibrations from the record to the crystal or other translating device must have a flexible portion which is thin compared to its length in a plane substantially transverse to the axis of the shank of the needle. In order to protect such a needle from deformation or breakage it is desirable that the flexible portion of the needle be strengthened and be guarded so that in the event the tone arm is dropped too hard the flexible portion of the needle will not be bent beyond its limit of elasticity. In the past efforts have been made to protect the needle by incorporating a separate guard device as a part of the pickup structure, or by adding an extending foot to the needle shank, the end of the foot extending from the shank and terminating closely adjacent the record-engaging tip of the needle. This arrangement is disadvantageous in that it adds extra mass and inertia to the needle so that the needle becomes insensitive, as the added mass absorbs some of the sound vibrations and has a dampening effect upon the needle.

Other attempts have been made to provide phonograph needles having vertical compliance by offsetting the record engaging tip of the needle at the end of a relatively long spring member which extends a considerable distance from the axis of the shank. A disadvantage of such an arrangement is that when the record engaging tip is spaced a considerable distance from the shank, a change in the angle of the tone arm causes a substantial change in the relative positions of the guard and needle tip with reference to the surface of the record. For example, in a phonograph having an automatic record changer the records are usually stacked one on top of the other during operation, and the height of the record surface changes with regard to the pivotal point of the

base of the tone arm, and consequently when only one or two records are on the turntable the angle of the needle tip and guard with respect to the record surface will be considerably different than when ten or twelve records are on the turntable. This change in angle changes the effectiveness of any bumper guard which might be provided, where the spring member terminates at a considerable distance from the axis, since as the height of the record surface changes the amount of deformation in the flexible portion in the needle may increase or decrease in an undesirable amount before the bumper guard becomes effective.

Other attempts to solve this problem have comprised constructing the needle with a relatively thick, heavy, but flexible portion in the form of a loop so that adjacent portions of the needle are adapted to abut to prevent abnormal flexure of the loop. These needles have been disadvantageous in that objectionable mass was added to the needle, and the compliance of the needle reduced; and such needles are subject to operational imperfections because the tip of the needle engages the record surface at a considerable angle thereto.

I have devised and am herewith disclosing and claiming an improved phonograph needle which possesses all the desirable advantages of vertical and lateral or horizontal compliance, particularly the former; in which adjacent but normally spaced opposite surfaces of two portions of the needle are adapted to abut upon abnormal flexure of the flexible portion of the needle to prevent deformation of the flexible portion beyond its elastic limit; in which the flexible portion is very light and relatively short and adds very little to the mass of the needle; in which the flexible portion does not lie in a plane parallel to the record surface and thereby further increases the compliance of the needle; and in which the tip portion of the needle is angular to the axis of the shank so that the tip portion rides more nearly vertical upon the surface of the record, resulting in improved reproduction.

Referring now to the drawings, in Fig. 1 a tone arm 10 carries a needle designated generally at 11 in a chuck (not shown), and the needle rides in a groove upon the surface of a record 12. The needle is responsive to undulations in the groove and transmits them as vibrations to a crystal or other translating device. In conventional operation the vibrations are translated into electrical variations, are amplified, and are reproduced by means of a speaker or other transducer. In Figs. 2 and 3 the needle of Fig. 1 is shown enlarged and removed from the tone arm chuck. The needle comprises an upper relatively rigid portion 13 providing a shank which is generally cylindrical in shape and has a flattened portion 14 which extends from the upper end of the shank along one side for a substantial portion of the length of the shank. This flattened portion serves to indicate the front side of the shank so that the shank may be properly positioned in the tone arm chuck, and in addition the shank cooperates with the holding end of a set screw or other holding device on the tone arm so that the needle may be held immovably in the tone arm chuck.

A flexible intermediate portion designated generally at 15 comprises a thin flat section having a longitudinally extending ridge thereon. In Fig. 2 this ridge is shown as comprising a portion 16*a* along the top of the flexible portion and a portion 16*b* along the bottom thereof. The flexible portion 15 is formed of resilient material and acts as a spring in the form of an elongated loop formed in a vertical plane and having a top portion 15*a* bent to extend away from the shank substantially at right angles thereto, and a bottom portion 15*b* bent to extend back towards said shank substantially at right angles thereto. The elongated loop is closely formed, the portions 15*a* and 15*b* being very closely spaced, preferably being spaced only a few thousandths of an inch at the widest point or mouth thereof. A lower tip portion 17 is carried by the flexible portion and, in the embodiment illustrated is bent downward therefrom. The tip may itself be adapted to engage the surface of a record, in which event the tip may or may not be of the same material as the shank and flexible portion; or if desired the record-engaging portion of the tip may comprise a different metal piece mounted at the end of the portion 17, or a jewel or other suitable device may be used as a record engaging tip.

As seen best in Fig. 2 the surface of the lower end of the rigid portion forming the shank 13 and the adjacent but normally spaced upper surface of the tip 17 are adapted to abut upon closure of the very small gap between the portions 15*a* and 15*b*. In operation the gap between the portions 15*a* and 15*b* is sufficient to permit normal vertical vibration of the tip under the pressure of even very heavy tone arms so that the needle has excellent vertical compliance and the gap will not close under normal conditions. However, in the event abnormal pressure is applied, as for example in the event the tone arm is dropped, abnormal flexure of the flexible portion 15 will cause the gap between the portions 15*a* and 15*b* to close so that the lower surface of the shank portion and the upper surface of the tip portion abut, and the abnormal force will no longer place a strain upon the flexible portion 15, but will be concentrated on the shank and tip. Since these parts at their narrowest portion are relatively heavy, generally having a diameter of between .033 inch and .040 inch, the needle is not easily bent. When the abnormal force is removed the resilience of the flexible spring portion 15 returns the parts to the position illustrated in Fig. 2 and no deformation of the flexible portion occurs.

In the needle illustrated the portions 15*a* and 15*b* which are flattened in a plane substantially transverse of the longitudinal axis of the shank 13 are very thin, these portions having a thickness only of the order of .005–.015 inch. This results in high vertical compliance of the needle, and a needle so constructed will rapidly attenuate high frequencies, as frequencies in excess of 5,000 cycles per second. In order to provide additional strength for the spring section, the ridges 16*a* and 16*b* are provided, these ridges giving increased strength without adding excessive mass and without causing the needle to lose its excellent vertical compliance, which would be the case if the flexible portion 15 were formed of thick metal sections. The extreme thinness of the spring sections 15*a* and 15*b* also enables the loop to be relatively short, thereby adding only very slightly to the mass of the needle, the tip portion 17 and loop 15 preferably being of substantially the same length as shown best in Fig. 2. This arrangement insures that the heel (the right end in Fig. 2) of the loop easily clears the record surface when the needle is secured in a tone arm at an angle of 21 degrees to the surface of the record, as is the usual case in practice, and additionally the provision of the

tip of substantially the same length as the loop adds to the lateral compliance of the needle.

Another feature of the needle is that the loop **15** is not parallel to the surface of the record when the needle is mounted in operating position. As shown in Fig. 1 the needle is generally mounted so that the shank extends at an angle of about 21 degrees from the vertical, and since the flexible portion extends substantially at a right angle to hte axis of the shank, it is not parallel to the record surface in operation. This causes the needle to be more compliant to forces in both vertical and horizontal directions. This is important, for irregularities in the bottom of the record groove will impart not only a vertical force to the record tip, but also a horizontal force in the direction of motion of the record, and the resultant force will be the vector sum of these two forces. While a needle which has compliance only in a vertical direction would tend to minimize only the vertical component of this resultant force, the needle disclosed herein minimizes both the vertical and horizontal components and consequently renders the resultant force practically negligible since the angle of the flexible portion with reference to the surface of the record gives the needle compliance to lateral forces and causes the needle to yield in a horizontal direction. However, if the needle were compliant to horizontal forces only in the direction of record movement and not transverse thereto the needle would operate to distort high frequencies since the high frequency undulations in the record groove project from the wall of the groove at a very sharp angle. However, no noticeable distortion is present in needles constructed in accordance with this invention since the construction disclosed renders the needle compliant to all forces in a horizontal plane as well as to vertical forces and consequently the needle provides desirably rapid attenuation of high frequency signals, as signals of frequencies in excess of 5,000 cycles per second. At lower frequencies the undulations project from the wall of the record groove at a smaller angle so that no distortion is present.

A further feature of the invention is that the tip portion **17** may be inclined backwards at an angle from the axis of the shank **13**, thus causing the tip to ride upon the record more nearly vertically to the surface of the record. This results in improved reproduction because the tip will have a smaller bearing area and the record engaging portion of the tip will engage the record at an angle more closely approaching the 90 degree angle at which the records are cut. I prefer to construct the needle so that the angle between the axis of the shank **13** and the axis of the tip portion **17** is between zero and 10 degrees.

While other dimensions may be suitable, in the needle illustrated in Figs. 2, 3 and 4 the shank portion may have a length of .5 inch and the tip portion a length of .150 inch, and the loop **15** may extend a distance of .150 inch from the axis of the shank. The loop shown in Fig. 4 has a width of .065 inch and is very thin, the flattened spring sections having a thickness of .010 inch while the triangular ridge portion **16***a* has a height of .007 inch and the triangular ridge portion **16***b* has a height of .005 inch.

Two needles having modified resilient portions are shown in Figs. 5 and 6, respectively. In Fig. 5 the ridge **26** is in the form of a truncated cone, and instead of extending throughout the entire

length of the loop it extends along substantially half the length of the loop, being located on the top **25***a* thereof and being absent from the bottom **25***b*. In this form of the invention the truncated cone may have a height of about .012 inch. In Fig. 6 a rounded ridge **36** is provided, this ridge extending throughout substantially half the length of the spring and again being formed only on the top portion **35***a* and not on the bottom portion **35***b*. In this form of needle the resilient portion **35** may be slightly narrower, as for example of a width of .060 inch while the rounded portion may have a maximum width of .040 inch and a maximum height of .015 inch.

The three forms of needles shown in Figs. 4, 5 and 6 differ primarily in the amount of vertical compliance due to the rigidity of the spring section. The dimensions given above are taken from needles which have been found to operate satisfactorily, but are merely representative examples and are not intended to limit the scope of the invention. Similarly, the shape and dimensions of the integral ridges of metal on the flattened sections are also shown as being representative, but these ridges may be of other shapes, square, semi-circular, etc. and they may represent combinations of various shapes on the top and bottom sections of the spring portions.

Another advantage of the needle disclosed and claimed here is that it may readily be formed in one piece and in one operation on a suitable machine, as for example, a punch press. After the needle is formed it is hardened and the natural resiliency of the metal causes the flattened section to open up slightly to form the desired gap of a few thousandths of an inch, and by this one piece and one operation construction the cost of manufacture is reduced considerably.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

I claim:

1. A phonograph needle of the character described, comprising: an upper relatively rigid portion providing a shank; a flexible intermediate portion comprising a thin, flat section having a longitudinally extending ridge thereon, said section being in the form of an elongated loop having a portion extending away from said shank substantially at right angles thereto and a portion extending back towards said shank substantially at right angles thereto and said spring being flattened in a plane substantially transverse of the longitudinal axis of said shank; and a lower tip portion carried by said flexible portion, adjacent but normally spaced opposite surfaces of two of said portions being adapted to abut upon abnormal flexure of said flexible portion to prevent deformation of said flexible portion beyond its elastic limit.

2. A phonograph needle of the character described, comprising: an upper relatively rigid portion providing a shank; a resilient intermediate portion comprising a thin, flat spring having a longitudinally extending ridge thereon, said spring being in the form of an elongated loop lying in a vertical plane and having a portion extending away from said shank and a portion extending back towards said shank and said spring being flattened in a horizontal plane; and a lower tip portion carried by said resilient por-

tion, said tip portion and loop being of substantially the same length, and adjacent but normally spaced opposite surfaces of two of said portions being adapted to abut upon abnormal flexure of said flexible portion to prevent deformation of said flexible portion beyond its elastic limit.

3. Apparatus of the character claimed in claim 2, wherein said flat spring has a thickness of the order of .005–.015 inch.

4. A phonograph needle of the character described, comprising: an upper relatively rigid portion providing a shank; a resilient intermediate portion comprising a thin, flat spring having a longitudinally extending ridge integrally formed therewith along at least substantially half the entire length thereof, said spring being in the form of an elongated loop lying in a vertical plane and having a portion extending away from said shank substantially at right angles thereto and a portion extending back towards said shank substantially at right angles thereto and said spring being flattened in a plane substantially transverse of the longitudinal axis of said shank; and a lower tip portion carried by said resilient portion, said tip portion and loop being of substantially the same length, at least a part of the surface of the lower end of said rigid portion and at least a part of an adjacent upper surface of one of said other portions being normally very closely spaced and adapted to abut, upon abnormal flexure of said resilient portion, to prevent deformation of said resilient portion beyond its elastic limit.

5. Apparatus of the character claimed in claim 4, wherein said ridge is in the form of a triangle.

6. Apparatus of the character claimed in claim 4, wherein said ridge is in the form of a truncated cone.

7. Apparatus of the character claimed in claim 4, wherein said ridge is rounded in shape.

FREDERICK C. HOLTZ, JR.

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