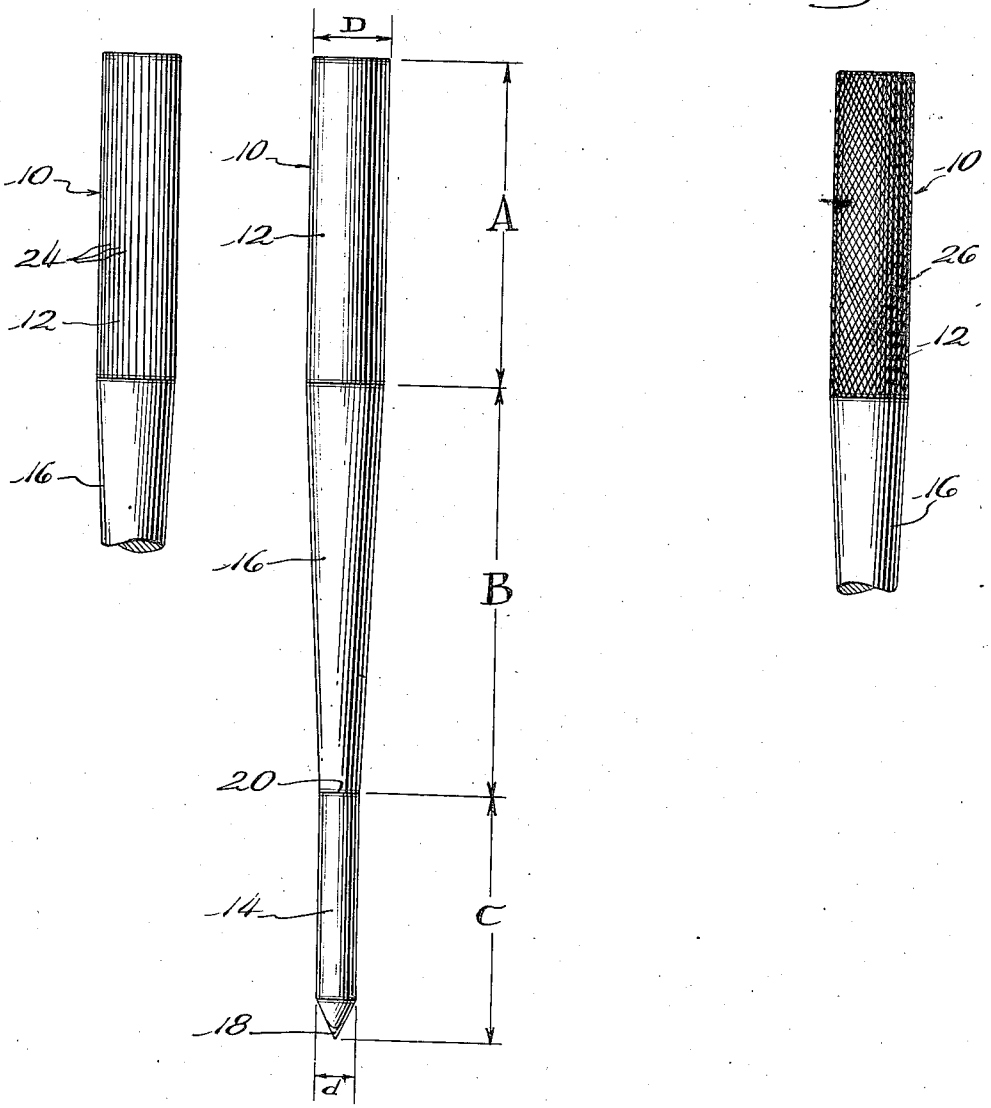
Aug. 6, 1946. W. H. HUTTER 2,405,307

PHONOGRAPH NEEDLE

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Fig. 2. Fig. 1. Fig. 3.



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PHONOGRAPH NEEDLE

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My invention relates generally to phonograph needles and in particular to a phonograph needle which possesses a very high reproduction fidelity and long life, and which minimizes record wear.

Although it has always been an object of those concerned with the development of the phonograph and the record reproducing art to provide a phonograph needle having the above characteristics, so far as I am aware, all currently used needles incorporate compromises. In general, little attempt has been made to save the record from wear when long needle life or high fidelity was desired, because it has been thought that the characteristics of long needle life and high fidelity were incompatible with long record life, and that one must be sacrificed to gain the other.

Under ordinary circumstances of record usage it is desirable to have both the record and the needle last as long as possible while retaining a high degree of reproduction fidelity. So far as I am aware, however, no needles presently obtainable incorporate these desirable characteristics to the same degree as the needle forming the subject of the present invention. As an example, all hard tip needles that I have tested, capable of playing from one thousand to four thousand records, seriously affect the fidelity of records in from fifty to one hundred plays, while under actual conditions my improved needle plays the same record fifteen hundred times before the fidelity of the record is affected.

Up to the present time it has been thought that for a phonograph needle to have high fidelity characteristics it must necessarily be very stiff and hard. This belief is based upon the desire to avoid needle resonance, one of the primary causes of sound distortion. Needle resonance is the inherent needle vibration superposed upon the vibration picked up from the record. This causes the pure tone of the record to be muddied and to be amplified out of proportion within the range of the needle resonance—usually at high frequencies. These stiff needles, however, wear out the record surfaces comparatively rapidly, and the tone then becomes fuzzy and scratchy. This effect is particularly apparent when such needles are used with automatic phonographs, wherein the records are played over and over again without the attention of an operator.

This condition led to the development of the flattened section in the spike type of needle in an attempt to reduce needle and record wear. Such needles are comparatively successful in that they reduce wear on the record and, therefore, extended its life to some extent. They are far from perfect, however, because they do not remove needle resonance, and the sharp edges bounding the connection of the flattened section with the barrel section of the needle tended to filter out the high tones. Such needles reduce record wear

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because they are flexible in one direction, that is, in a direction perpendicular to the plane of the flattened portion. But as this flattened portion is always perpendicular to the surface of the record, there is no vertical flexibility inherent in such a needle.

When it is realized that there is a tremendous pressure applied to the tip of a needle, it will be appreciated that rapid wear will result unless some means is provided to ease the pressure when the record tends to cause rapid vertical changes in the position of the pickup. Ordinarily, a phonograph needle used with a two ounce pickup imposes a load of approximately thirty-one thousand pounds per square inch upon a record surface. It is apparent, therefore, that some relative wear between the needle and record must be expected. In order to introduce flexibility in all planes, so as to protect the record against up and down as well as lateral shocks, some needles have been developed which are flexible in all directions, but in all of these prior art needles with which I am familiar, a shoulder has been provided between the flexible portion and the stiff portion of the needle, and this shoulder filters out the high tones and destroys the fidelity of reproduction.

My improved phonograph needle provides for flexibility in all directions, while at the same time retaining fidelity of reproduction to a greater extent than any prior needles with which I am acquainted.

Still another problem is caused by the fact that a record groove does not have a constant width, but at those points where the groove makes a sharp angle relative to the radius of the record, the transverse dimension is less, and thus, there is a pinching effect. The pinching effect tends to force the needle and the pickup upwardly. Because of the high pressure applied to the tip of the needle, as has heretofore been pointed out, the record groove at these places is worn to a greater extent than the groove at the wider places and, therefore, record wear is accentuated at these points. My improved needle, because of its flexibility, is not required to move the pickup rapidly to any great extent in a vertical direction and thus, the record wear at these points is minimized. The flexibility of my needle also permits the easy and accurate tracing of the needle through the groove at those points where the direction of the groove changes sharply, i. e., where an "explosive" sound occurs in the recording.

It will be apparent from the above that prior needles do not effect a solution to the real problem faced by the phonograph and record reproduction art, but in general compromise in favor of long life in the needles at the expense of the recordings.

In my experiments with phonograph needles I have discovered that the compromise between

high fidelity of reproduction and long life in the needle and in the record need not be made. My improved needle forming the subject matter of the present invention possesses extremely high fidelity and long life characteristics of both needle and record.

I have combined these desirable qualities in one needle by shaping it in such a manner as to give it a flexing and cushioning action during its travel in the record groove, which action compensates for variations in the groove width and assists in properly controlling and overcoming the inertia in the tone arm and pickup. I have also eliminated objectionable needle resonance by giving that portion of the needle below what I term the fulcrum a shape which will not have natural resonance within the audible range; the material from which the needle is made also assists in eliminating needle resonance.

From the foregoing it is clearly apparent that it is an object of my invention to provide an improved phonograph needle which possesses a high reproduction fidelity and also long life, and which does not wear the record surface with which the needle may be used to any appreciable extent when compared with prior art needles.

It is also an object of my invention to provide a novel phonograph needle possessing the desirable characteristics of high fidelity and long life both of the needle and the record and which is economical to manufacture.

Other objects and advantages will become apparent from the following description taken in conjunction with the drawing, in which

Fig. 1 is a greatly enlarged elevational view of a preferred embodiment of my improved and novel phonograph needle and;

Figs. 2 and 3 illustrate modified and improved forms of phonograph needle shanks.

Referring to Fig. 1, my improved phonograph needle 10 may be divided into three sections for convenience of reference and description of function. The needle is formed of conical and cylindrical integral sections and its diameter is greatest at shank portion 12 which is received by the needle chuck in a manner well known in the art. Connecting the shank portion 12 with end portion 14 is a tapered section 16. At the lower end of the end portion 14 is a long-wearing, hard alloy tip 18, which is preferably welded to the portion 14.

The tip 18 is extremely small and possesses a rounded end having a radius of curvature preferably not greater than 0.002 inch. Above the tip 18 the lower end of the portion 14 is tapered down to the tip at an included angle of between 25° and 60°.

It will be noted from the drawing that the longest of these sections is the tapered section 16. It is well known in the needle art that the danger point of needle resonance lies between the fulcrum point and the tip contacting the record. If this portion be of a length sufficient to be operable and act as a lever to transmit the vibrations from the record to the pickup, then it necessarily is of sufficient length to possess periodic resonance within the audible range; and if this needle be of constant diameter throughout the greater part of its length below the fulcrum, the tendency toward needle resonance is enhanced. But if this portion of the needle be of a constantly changing diameter presenting a regular taper, the resonance of the needle at each point on the tapered section is different and whatever resonance is possessed by the needle in that section is damped out. Furthermore, the tapered section does not present an abrupt shoulder which I have found has a blocking effect upon the higher frequencies.

To give my needle flexibility in the lower portion, I provide it with the cylindrical end 14 which is integral with the tapered portion 16. The section 14 is preferably less than one-half of the diameter of the shank 12 and, consequently, has very little mass or inertia in itself. It is desirable that this portion of the needle be made as small as is compatible with the strength necessary to support the effective weight of the pickup and tone arm and to absorb the thrusts which are imposed upon it by the vibration and the oscillating groove for operating mechanical trip means frequently used to set automatic record changing mechanism into operation.

Because the tip section 14 is of comparatively small diameter, it has a springy or cushioning action which permits it to follow the groove in the record accurately and whip around the sharp angles corresponding to the explosive sounds. Probably the major portion of this cushioning or springing action takes place at the junction 20 of the tapered section 16 with portion 14. The cushioning or springing action of the end section is of the universal type and permits the needle to follow the record groove accurately and continuously. At the narrowest points where the groove pinches the needle and imparts a tendency to ride out, the cushioning action compensates for the inertia of the tone arm and the pickup, thereby minimizing record wear, and consequently record scratch. The end section 14 possesses no needle resonance, or at least none within the audible range, because of its short length and low mass.

It will also appear from the drawing that my improved phonograph needle is slightly longer than most prior art needles. The increased length is further important to maintain fidelity and long record wear in those passages where whip action is imparted to the needle as it passes around the sharper angles of a groove since less pickup weight will suffice to prevent groove jumping or chattering when this flexibility is present.

It is important to note the approximate relative sizes of the shank 12, the tapered section 16 and end portion 14. The combined length of the portions 14 and 16 is greater than that of the shank 12 to provide a lever below the fulcrum which will transmit more accurately the vibrations picked up from the record. The positioning of the hinge or junction 20 between the tapered section 16 and the end portion 14 must be such that the reactance of the needle is substantially less than the reactance of the pickup. Thus, if the portion 14 be too short with respect to the section 16, the needle compliance would be too little and the effect of the hinging or cushioning action would be completely lost. On the other hand, if the portion 14 be too long, the tapered section 16 must be appreciably shortened, which would result in a needle having too much flexibility or compliance, and the taper would be so great that an appreciable percentage of the high pitch tones having shorter periods of vibration would be filtered out; and because of the excessive flexibility, some of the base tones would also be lost. As exemplitive of a typical needle embodying my invention, the figures in the accompanying drawing are made to scale. The total length of the needles illustrated is actually three-quarters of an inch; the dimension A of the shank

12 is one-quarter of an inch; the dimension B, the length of the tapered section, five-sixteenths of an inch; and dimension C, the length of the tip portion 14, is three-sixteenths of an inch (including the tip 18). The shank has a diameter D of 0.061 inch, and the end portion 14 has a diameter *d* of 0.029 inch. It is thus seen that the tapered section is nearly twice as long as the end portion 14 and that the shank is only one-third of the entire length of the needle. These proportions appear best for ordinary use, but may be modified if the compliance and resistance ratios of the pickup are known accurately. If it is found necessary to shorten the over-all length of the needle, I have found that the reduction may be made by shortening the shank portion 12 the requisite amount, retaining the relative length of the sections 14 and 16.

In order further to reduce needle resonance, I prefer to make my improved needle from a soft steel having high internal resistance. As an example, I have found that a steel possessing a Rockwell hardness of 25 is ideal for the manufacture of my needle. It is also possible to manufacture my improved needle from other metals or metal alloys which possess the same desirable characteristics.

In Figs. 2 and 3 I have illustrated a further modification of my improved needle in which the shank 12 is formed in a manner to prevent relative angular and longitudinal movement between the needle and the chuck when secured by the chuck set screw. It has heretofore been the practice to provide the shank with a flattened section to be engaged by the set screw, but the flattened section has the deleterious effect of acting as a filter for the higher audible tones. I prefer to form the shank 12 of my needle with longitudinal or crossed knurling. Fig. 2 shows longitudinal knurling 24, and Fig. 3 shows crossed knurling 26. Forming the shank in this manner has no effect on the transmission of the recorded vibrations and provides a good surface to be engaged by the tip of the set screw.

From the foregoing description of my invention, it will be apparent to those skilled in the record reproducing art that I have invented a phonograph needle which successfully combines high fidelity of tone reproduction and long needle life with long record life. This is accomplished through the use of a longer and more flexible needle having a cushioned or hinged action and which is shaped to remove needle resonance, and through a choice of material, to assist in reducing resonance.

In view of the fact that persons skilled in the art can, from the teachings of the present specification and drawing, make changes without departing from the spirit and scope of my invention, I desire to be limited only by the appended claims.

What I claim as new and useful and desire to secure by United States Letters Patent is:

1. As a new article of manufacture, a phonograph needle having a shank, a cylindrical end portion having a diameter less than the diameter of said shank, and a substantially conically shaped tapered portion connecting said shank with said end portion and integral therewith, said tapered portion merging at either end with said shank portion and said end portion respectively.

2. As a new article of manufacture, a phonograph needle having a shank, a cylindrical end portion having a diameter less than the diameter of said shank, and a substantially conically shaped tapered portion connecting said shank with said end portion and integral therewith, said tapered portion being longer than said end portion and merging at either end with said shank portion and said end portion, respectively.

3. As a new article of manufacture, a phonograph needle having a shank, a cylindrical end portion having a diameter not greater than one-half the diameter of said shank, and a tapered end portion connecting said shank with said portion and integral and merging with both, said tapered portion being longer than said end portion, and the angle included by the surfaces of said shank and said tapered portion being not less than 170°.

4. As a new article of manufacture, a phonograph needle having a shank, a cylindrical end portion having a diameter not greater than one-half the diameter of said shank, and a tapered portion connecting said shank with said end portion and integral and merging with both, the ratio of the length of the tapered portion to the length of the cylindrical end portion being of the order of 5 to 3, and the angle of taper being substantially 3°.

5. As a new article of manufacture, a phonograph needle made from soft steel and having a shank adapted to be received by a pickup, a tip formed of a long wearing, hard alloy adapted to follow in the groove of a record, and an intermediate portion connecting said shank with said tip and having a point of greatest flexibility therein, said point of greatest flexibility being closer to said tip than to said shank, the upper part of said intermediate portion being tapered so that it merges both with said shank and with the lower part of said intermediate portion, said lower part being of a lesser diameter than said shank.

6. As a new article of manufacture, a phonograph needle made from a metal or metal alloys having a high internal resistance and having a shank adapted to be received by a pickup, a tip formed of a long wearing, hard alloy adapted to follow in the groove of a record, and an intermediate portion connecting said shank with said tip and having a point of greatest flexibility therein, said point of greatest flexibility being closer to said tip than to said shank, the upper part of said intermediate portion being tapered so that it merges both with said shank and with the lower part of said intermediate portion, said lower part being of a lesser diameter than said shank.

7. As a new article of manufacture, a phonograph needle having a shank, a cylindrical end portion and a tapered portion connecting said shank with said end portion and integral and merging with both, said shank having a knurled surface adapted to be engaged by a needle retaining means to prevent relative angular and longitudinal movement between the needle and the needle retaining means.

8. In a phonograph needle having a shank, a tip adapted to follow in the groove of the record and an intermediate portion connecting said shank with said tip and providing a point of maximum flexibility therein, which point is equally flexible in all directions, a knurled surface formed on said shank adapted to be engaged by a needle retaining means to prevent relative angular and longitudinal movement between the needle and the needle retaining means.

WILLIAM H. HUTTER.

Certificate of Correction

Patent No. 2,405,307. August 6, 1946.

WILLIAM H. HUTTER

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 6, line 11, claim 3, strike out "end" before "portion" and insert the same after "said" second occurrence, same line; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 5th day of November, A. D. 1946.

[SEAL]

LESLIE FRAZER,
First Assistant Commissioner of Patents.