Dec. 14, 1948. B. B. BAUER 2,455,913

STYLUS CONSTRUCTION

Filed Oct. 16, 1944

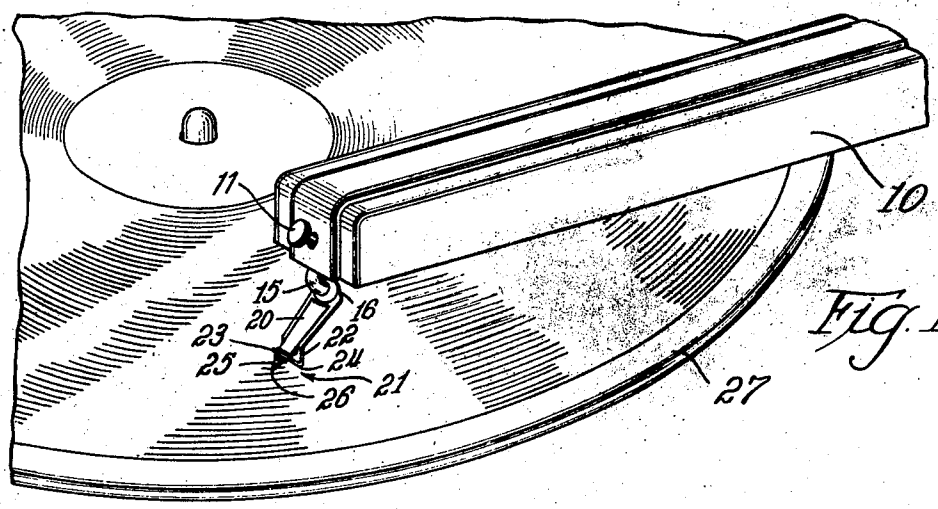


Fig. 1.

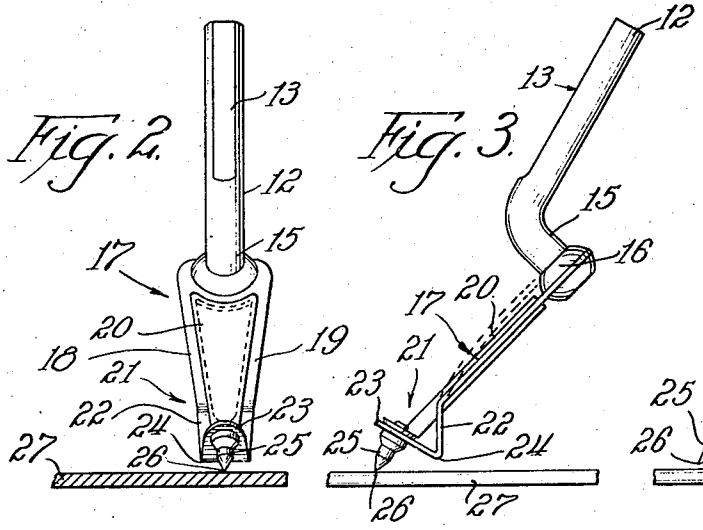


Fig. 2.

Fig. 3.

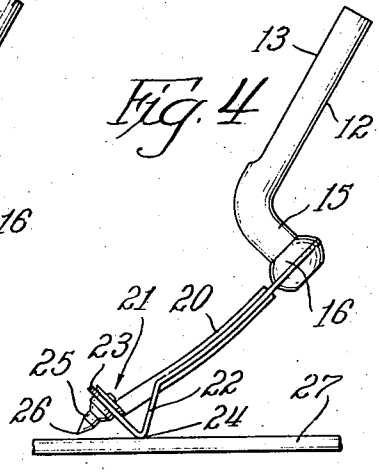


Fig. 4.

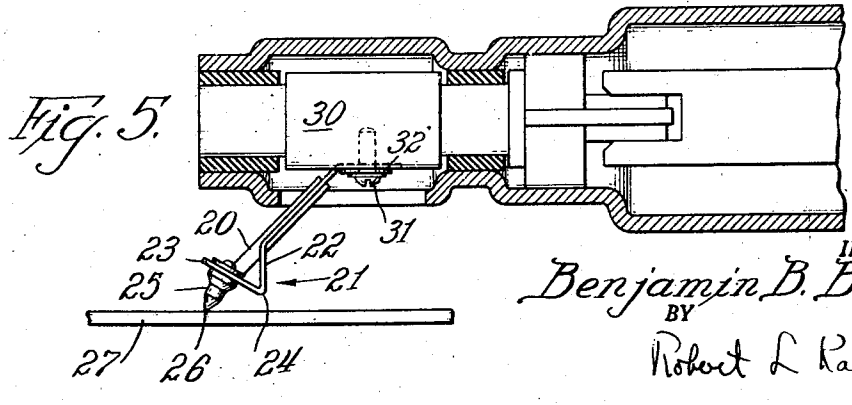


Fig. 5.

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STYLUS CONSTRUCTION

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11 Claims. (Cl. 274—38)

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This invention relates to a stylus construction for use in phonograph reproducers and pick-ups. The stylus construction of this invention is particularly adapted for use with reproducers operating on records having a laterally sinuous sound groove.

In reproducing from records having such a laterally sinuous sound groove, there is customarily present so-called record noise or scratch. This is generally present in new records and increases with use. Such record scratch exhibits a continuous or band spectrum over a substantial frequency range, but usually has a substantial part of its energy in frequencies above 3000 cycles per second. The precise energy spectrum depends upon the record material, reproducer and other factors.

In order to eliminate record noise or scratch in the case of electrical pick-ups, recourse has been had to so-called scratch filters. Such filters, usually an electrical low-pass system, operate upon the pick-up output to eliminate frequencies in the so-called scratch band. As a rule such filters are adapted to eliminate frequencies above about 3500 cycles per second as a compromise between scratch elimination and fidelity of reproduction. It is evident that reproduction is impaired and the higher frequencies, characteristic of individual instruments and voices, are entirely lost.

It has been determined that scratch in an electrical pick-up not only involves an electrical scratch output at the pick-up terminals but also includes generation of audible noise at the region of stylus vibration. Apparently mechanical vibration incident to reproducer operation generates noise which is partly generated by record vibration and partly by stylus and reproducer vibration and reflected from the record surface.

The invention herein provides a stylus construction which provides reproduction from normal sound tracks in a record but is remarkably free from reproduction of scratch particularly the mechanically generated type. In addition thereto, the invention provides a construction which protects the record against mechanical shock and abuse.

It has long been known that desirable stylus characteristics demand substantial lateral stiffness with substantial vertical compliance. The terms lateral and vertical refer to the normal playing position with a pick-up riding on top of a substantially horizontal flat record. The lateral rigidity involves rigidity substantially

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along a line perpendicular to a sound track i. e. a line substantially parallel to a record radius at the stylus tip. The vertical compliance refers to compliance along a vertical line substantially perpendicular to the record at the stylus tip. Thus by having lateral stylus rigidity, vibrations generated at the stylus tip in following a sound track are faithfully transmitted to the reproducer proper. On the other hand, any sudden stylus movements along a vertical line are substantially attenuated prior to reaching the reproducer proper. Gradual stylus movements to accommodate record unevenness due to warping for example are transmitted to the reproducer proper so that floating at a constant stylus pressure may be effected.

Prior art constructions have been undesirable for various reasons. Thus mechanical simplicity and efficiency are essential. Complicated mechanical structures usually have a complex response to vibrations, particularly when the range of frequencies is extended. Such structures are difficult to manufacture in quantity and tend to change their response characteristics as parts age or are stressed. The more simple structures have not been satisfactory for the reason that a high vertical compliance was inconsistent to a large degree with lateral rigidity. The two have been dependents in prior art structures with the actual design having a compromise. By virtue of the invention herein, the mutual dependence of vertical compliance and lateral rigidity has been largely eliminated.

The invention achieves the above without sacrificing mechanical simplicity. By virtue of the invention, a structure embodying the invention is endowed with highly desirable mechanical characteristics and great ruggedness. Thus the invention provides a structure within which a delicate interplay of forces may take place during normal use but which is protected against shock and rough usage. The resulting structure thus is capable of substantially scratchless record reproduction at a high level of efficiency without sacrificing ruggedness or mechanical simplicity.

In general, the invention contemplates the insertion of a truss-like structure between the stylus tip and reproducer proper. The truss-like structure is so designed that for lateral stylus vibration a rigid vibration transmitting path is provided. For vertical stylus vibration, however, a path having great compliance is presented. By virtue of the mechanical structure near the stylus point, advantage of vertical compliance is taken to endow the structure with shock pro-

tection. In addition, the parts are so shaped and disposed with relation to each other that undesirable moments are effectively eliminated. It is also possible to obtain great vertical compliance without utilizing relatively weak and fragile parts.

In another aspect, the invention generally provides a spring between the stylus tip and reproducer proper. Between the spring and stylus tip, there is provided shock absorbing means, which function by virtue of the vertical spring compliance. Thus damage to record grooves by excessive vertical loading is effectively prevented.

For a further description of the invention, reference will now be made to the drawings wherein Figure 1 is an elevation showing the invention in use in a pick-up. Figure 2 is a front elevation partly in section of the needle structure detached from a pickup but with normal vertical loading. Figure 3 is a side elevation of the structure shown in Figure 2. Figure 4 is a side view similar to Figure 3 but showing the position assumed by the construction when subjected to excessive vertical loading. Figure 5 is a side elevation of a modified form of the invention.

Referring to Figures 1–4 inclusive, tone arm 10 may be provided with a suitable stylus clamping means such as screw 11 for retaining a stylus in predetermined fixed position for reproduction. The tone arm and reproducer may be of any desired construction and since they are not part of the invention will not be shown or described in detail. The reproducer may either be of the mechanical type or may be a pick-up adapted to translate mechanical vibrations directly or indirectly into electrical waves. As shown, the stylus consists of shank 12 having flattened portion 13 adapted to be engaged by clamping means 11 for firm retention. Shank 12 may be made of any suitable material such as steel, aluminum, or any other elastic material and as shown here has a portion thereof shaped to form a lateral stub 15.

Stub 15 may be downwardly bent at any desired angle away from the axis of shank 12 and as shown is bent at an angle somewhat less than 90 degrees. Stub 15 terminates in knob or head portion 16 to which may be rigidly attached a spring truss generally designated as 17. Since the shank is generally inclined as shown, due to conventional reproducer design, and since it is desirable to incline spring truss 17 away from vertical to utilize its compliance, the addition of stub 15 is beneficial.

The structure designated by numeral 17 is an open truss-like structure which may advantageously taper in width from a small width at the stylus end to a maximum width at the upper shank end. This is not essential but does endow the structure with desirable mechanical properties. As shown here, truss-like structure 17 is in the form of a spring leaf and may be fastened to head 16 in any desired manner. Thus the spring may be suitably apertured to permit threading on stub 15 and the metal of head 16 may be rolled or peaned over to maintain the same firmly in position. Spring 17 may be made of spring steel, beryllium copper, phosphor bronze or other elastic material and, as shown in Figure 2, is generally tapering with the wide portion adjacent head 16. Spring 17 has two arms 18 and 19 whose ends are rigidly coupled at head 16 and an end portion 21. End portion 21 is shaped to form a generally V spring heel having portions

22 and 23 with a fold section 24 as the V tip. The entire V portion is bent down from truss-like structure 17 as seen in Figures 3 and 4. Part 23 of the V is provided with a stylus point 25 which may be of any suitable material such as steel, carboloy, osmium, a jewel, or the like. Stylus point 25 may be mounted in part 23 in any desired fashion. If desired the heel may simply be fastened to spring 17 near the lower end with the spring extending continuously beyond it. It is clear that the heel is rearwardly of the stylus tip as seen from the front of the tone arm.

As evident from Figure 3, V portions 22 and 23 are so disposed with respect to each other and with respect to truss-like structure 17 that point 25, particularly tip 26 thereof, substantially lies on the prolongation of the axis of shank 12. Furthermore, the spring structure and stylus tip 25 are so proportioned that tip 26 is substantially in the plane determined by truss-like structure 17. In other words, it is preferred to so proportion and dispose the various parts of the structure below shank 12 that the prolongation of the axis of shank 12 will intersect the plane of truss-like structure 17 substantially at the stylus tip. It is understood that the above relationship is true when the normal load is on the stylus tip. The truss-like structure is ordinarily bowed as shown in dotted lines in Figure 3 when the stylus is free of all loading. Hence when normal vertical loading is applied, truss-like structure 17 becomes straight.

The truss-like structure may be formed of spring wire with the ends rigidly coupled to the shank and end portion 21. If desired, a solid leaf spring may be used.

It is clear that lateral rigidity will be present so long as the arms do not buckle under compressive forces. In order to provide additional support to the truss-like structure, it is preferred to dispose a pad 20 between the arms. This pad is preferably of material like "Viscoloid," rubber, leather or the like having substantial vibration damping properties. While the pad shape may vary, it is preferred to provide a pad filling the entire open space between the arms. The pad may be forced into position and since it is thicker than the truss-like structure, it will retain itself in place. Preferably pad 20 extends not only the full length of truss-like structure 17 but bridges the V heel portion to abut against stylus tip 25. Thus pad 20 tends to stiffen the entire structure and provides damping in both lateral and vertical directions.

Vertical damping is clearly desirable and tends to suppress scratch vibrations. Lateral damping is so designed as to improve the vibration transmission characteristics of the truss-like structure and flatten out any resonance peaks which may be present. The damping in two planes tends to suppress any complex modes of vibration and restricts the truss to simple modes of vibration in lateral and vertical directions.

The entire stylus construction may be mounted in any desired manner. However, for ease of manipulation in setting the pick-up in playing position and ease of tracking, it is preferred to dispose the stylus construction as shown. Thus the plane generally determined by truss-like structure 17 may be inclined to the record to form an acute angle in the direction of record travel. It is preferred to have the general plane of the truss-like structure intersect the record in a line generally parallel to a line passing through the stylus point and perpendicular to the sound track. Then

there will be a minimum tendency for lateral stylus vibrations to be resolved into vertical vibration components. The various parts are so proportioned and disposed that stylus tip **26**, under normal playing conditions, is substantially collinear with the shank axis and in the general plane of truss-like structure **17**. This collinear relationship is of substantial importance. Thus lateral stylus tip movements create shank bending movements. This is the desired mode of operation. No torsional moments on the shank are created since the force on the stylus tip is applied on the shank axis. The reproducer does not have impressed on it any forces or moments which it is not normally designed to receive.

Another advantage inherent in the disposition and relationship of parts is that it permits a long truss-like structure to be used. In prior art structures, the resilient portions have been comparatively short. Thus unless weak springs were used, compliance was low. Any increase in spring length would generally interfere with proper pick-up operation. Here however, the length of truss-like structure **17** is independent of proper pick-up operation. Since the shank axis and general plane of the truss-like structure intersect at the stylus tip, length of the truss-like structure will not affect transmission of later stylus vibrations. However, a long truss-like structure permits greater compliance for undesired vertical vibrations without using objectionably thin truss material.

In normal operation, components normally tending to generate record scratch and vibrate the stylus tip generally vertically to the record will be attenuated because of vertical flexibility of truss **17**. On the other hand, lateral reproducing stylus movements will be transmitted by the lateral rigidity of the truss-like structure to the shank proper.

The heel structure has parts **22** and **23** so dimensioned with regard to physical length, width and thickness that under normal playing conditions, such as shown in Figure 3, fold **24** is disposed a short distance above record **27** in the rear of the stylus tip. Fold **24** is preferably curved so no edge will mar the record. Thus, if the stylus happens to be overloaded, as during dropping, and moved across record grooves at the same time, a smooth surface will slide over the record and no damage to sound grooves will be possible. The elasticity of the truss material together with the dimensioning of the various portions of the truss-like structure and dissipation insert are such as to provide a shock absorbing action. Thus in the event of excessive vertical loading as when the entire pick-up structure is dropped on stylus **25**, flexure of truss-like structure **17** will result. It is evident that the entire truss-like structure will be flexed in the manner shown in Figure 4; i. e. to bow the truss-like structure generally toward the record. The insert of dissipation material has sufficient flexibility so it will bend also. Thus flexure of the truss-like structure will depress fold **24** so that it engages record **27** or whatever is hit. Stylus **25** will be swung upwardly to clear record **27**. By proportioning the length of truss-like structure **17**, the relative width of various portions of the truss-like structure and designing the proper insert, it is possible to obtain the action shown in Figure 4. This action is important since it protects the stylus tip from breakage and also protects the delicate record grooves from being damaged in case the reproducer head travels across sound tracks.

Referring now to Figure 5, a modified structure is shown wherein the pick-up generally is provided with a torsion rod **30** whose axis is generally parallel to the plane of record **27**. An example of a pick-up of this character is disclosed in Patent 2,326,280, issued August 10, 1943. Torsion rod **30** may have a suitable clamping screw **31** extending into the same from the bottom face. Clamping screw **31** rigidly maintains a spring truss structure of the same general construction as shown in Figures 1–4 inclusive. The truss-like structure may be retained in place by a clamping end portion **32** engaged by screw **31**. In this modified construction, stylus tip **26** is normally in the general plane of spring truss-like structure.

It is clear that the stylus construction acts in precisely the same manner as in Figures 1–4 inclusive. In the preceding figures, the alignment of stylus tip and shank axis prevented the generation of torsional moments on the shank. Hence the shank was generally subjected to transverse moments tending to bend it. Its stiffness is ample to transmit such bending moments to the reproducer proper. In the construction of Figure 5, the shank is entirely eliminated. However the forces from the truss-like structure are in the same direction as in the previous construction.

In the event that truss-like structure **17** is replaced by a solid flat spring, it is clear that the parts will have to be properly proportioned to obtain the shock-absorbing action described in connection with Figure 4. In such case, the spring may be elongated to promote flexibility.

By virtue of the invention, a highly desirable stylus construction is provided. In use, the construction protects both the usually fragile stylus tip and fine record grooves against serious damage. The usual scratches across a number of record grooves resulting from careless handling will be generally eliminated. In addition to all this, reproduction is effected at substantially no reduction in efficiency.

While the stylus construction has been disclosed as generally inclined in the direction of record travel, it is clear that the stylus may be reversed if so desired.

What is claimed is:

1. In a phonograph reproducer having a vibratable member, a stylus construction including a generally flat spring normally extending from said reproducer downwardly toward a record, said spring having its upper end coupled to said vibratable member, said spring having at its lower end a generally V-shaped heel portion normally extending downwardly toward said record but clearing the same in normal playing position, a stylus tip carried by the free end of said V and having normal engagement with a sound track in said record, said V having the arms thereof relatively rigid, said spring generally determining a plane intersecting the record along a line generally perpendicular to the sound track at the stylus tip, said spring being flexible along lines perpendicular to the general spring plane and being rigid along lines lying within the spring plane, said spring being adapted to yield upon excessive vertical loading to move said heel into record engagement and clear the stylus from said record.

2. The structure of claim 1 wherein said spring has an interior open region extending longitudinally thereof and wherein a vibration dissipation material is disposed within said region and extends substantially the full length of said spring and across said V to engage said stylus tip.

3. A stylus construction for use with a phonograph reproducer comprising a rigid shank adapted to be gripped in a reproducer and during normal operation pointing generally downwardly from said reproducer toward a record, a generally flat spring rigidly carried by said shank and extending toward said record, a stylus tip carried by the lower end of said spring for engagement with a sound track in said record, said spring generally determining a plane free of the shank center line and intersecting the record along a line generally perpendicular to the sound track at the stylus tip, said spring being flexible along lines perpendicular to the general spring plane and being rigid along lines lying with the spring plane, said stylus tip being disposed substantially at the intersection of the shank longitudinal center line and the general plane of said spring.

4. The structure of claim 3 wherein a generally V-shaped heel portion is disposed between the lower end of said spring and said stylus tip, said V having the arms thereof relatively rigid, said heel portion extending downwardly toward the record and adapted to engage the same only upon excessive vertical loading on the stylus tending to flex said spring excessively whereby upon engagement of said heel with said record said stylus tip is cleared from said record.

5. A phonograph stylus construction including a stylus tip for engaging a record groove during normal reproduction, said stylus construction comprising a rigid shank to be gripped in a reproducer and during normal operation positioned so that its longitudinal axis is inclined in the direction of record travel at an acute angle to the record plane, an elongated generally flat leaf spring having one end thereof rigidly carried by said shank and normally extending downwardly toward a record and inclined in the direction of record travel, said leaf spring generally determining a plane intersecting the record plane in a line generally parallel to a line perpendicular to the direction of record travel at the stylus tip, a stylus tip carried by the free end portion of said leaf spring and normally engaging a record groove, said free end portion having a heel portion extending downwardly toward the record rearwardly of the stylus tip, said heel portion and stylus tip being relatively rigid, said heel portion including a record engaging portion normally clear of the record, said leaf spring being so inclined with respect to the shank axis that the stylus tip is substantially in line with said shank axis, said leaf spring being adapted to yield upon excessive vertical loading upon the stylus to move said heel record engaging portion to engage said record surface and raise the stylus tip out of normal engagement.

6. A phonograph stylus construction including a stylus tip for engaging a record groove during normal reproduction, said stylus construction comprising a rigid shank to be gripped in a reproducer and during normal operation positioned so that its longitudinal axis is inclined in the direction of record travel at an acute angle to the record plane, an elongated generally flat leaf spring having one end thereof rigidly carried by said shank and normally extending downwardly toward a record and inclined in the direction of record travel, said leaf spring generally determining a plane intersecting the record in a line generally perpendicular to the direction of record travel at the stylus tip, a stylus tip carried by the free end portion of said leaf spring and normally engaging a record groove, said free end portion having a heel portion extending downwardly toward the record rearwardly of the stylus tip, said heel portion and stylus tip being relatively rigid, said heel portion including a curved record engaging portion normally clear of the record, said leaf spring being so inclined with respect to the record plane that excessive vertical loading upon the stylus will cause downward flexure of the leaf spring and a downward movement of said heel record engaging portion to engage said record surface and raise the stylus tip out of normal engagement.

7. A phonograph stylus construction including a stylus tip for engaging a record groove during normal reproduction, said stylus construction comprising a rigid shank to be gripped in a reproducer and during normal operation positioned so that its longitudinal axis is inclined in the direction of record travel at an acute angle to the record plane, an elongated generally flat leaf spring having one end thereof rigidly carried by said shank and normally extending downwardly toward a record and inclined in the direction of record travel, said leaf spring having an interior portion thereof cut out, vibration absorbing material disposed in said cut-out portion, said leaf spring generally determining a plane intersecting the record in a line generally perpendicular to the direction of record travel at the stylus tip, a stylus tip carried by the free end portion of said leaf spring and normally engaging a record groove, said stylus tip and leaf spring being so inclined with respect to the record plane that said stylus tip is substantially coincident with the longitudinal axis of said shank, said stylus tip being normally in the plane determined by said leaf spring, the free edge portion of said leaf spring being shaped to form a general V with the tip of the V pointing generally downwardly toward the record and normally being clear of the record, said leaf spring being adapted to flex under excessive vertical loading so that the tip of the V will engage the record surface and rock the stylus tip clear of the record.

8. A stylus construction for use with a reproducer, said construction comprising a spring member having one end adapted to be coupled to a transducer, a heel structure disposed at the other end of said spring, a stylus tip disposed adjacent said heel, said stylus tip being relatively rigid with respect to said heel, said heel normally clearing the record surface but being forced down against the record upon excessive vertical loading of said stylus tip, said heel upon engagement with said record surface functioning as a pivot so that additional flexure of said spring due to excessive loading causes said stylus tip to be swung upwardly from a record.

9. A stylus construction for use with a reproducer, said construction including a spring truss-like structure normally extending from a reproducer downwardly toward a record, said structure having its upper end coupled to a vibratable member in said reproducer, a heel portion at the lower end of the spring structure and extending downwardly toward the record, a stylus tip rigidly joined to said heel portion, said heel portion being between said spring structure and stylus tip, said truss-like structure generally determining a plane intersecting the record along a line generally perpendicular to the sound track at the stylus tip, said structure being flexible along lines perpendicular to the general plane of the structure and being rigid along lines lying within the general plane of the structure, said heel portion being

normally out of contact with said record but upon excessive vertical loading and consequent yielding of said structure said heel approaches said record and contacts the same to function as a pivot for rocking the stylus tip up from the record.

10. A stylus construction for use with a phonograph record reproducer, said construction comprising a spring member having one end adapted to be coupled to a transducer, a heel structure disposed at the other end of said spring member, a stylus tip disposed adjacent said heel, said stylus tip being relatively rigid with respect to said heel, said heel normally clearing the record surface but being forced down against the record upon excessive vertical loading of said stylus tip, said heel upon engagement with said record surface functioning as a pivot so that additional flexure of said spring due to excessive loading causes said stylus tip to be swung upwardly from a record, and vibration damping material disposed along said spring member.

11. A stylus construction for use with a phonograph record reproducer, said construction comprising a rigid shank adapted to be gripped in a reproducer and during normal operation pointing generally downwardly from said reproducer toward a record, the downward end of said shank including a lateral extension, a spring member rigidly carried at one end by said extension and

extending toward said record, a heel structure disposed at the record end of said spring member, a stylus tip disposed adjacent said heel, said stylus being relatively rigid with respect to said heel, said heel normally clearing the record surface but being forced down against the record upon excessive vertical loading of said stylus tip, said heel upon engagement with said record surface functioning as a pivot so that additional flexure of said spring member due to excessive loading causes said stylus tip to be swung upwardly from a record.

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