No. 831,606. PATENTED SEPT. 25, 1906.

T. A. EDISON.

SOUND RECORDING APPARATUS.

APPLICATION FILED NOV. 8, 1901.

4 SHEETS—SHEET 1.

Fig. 1

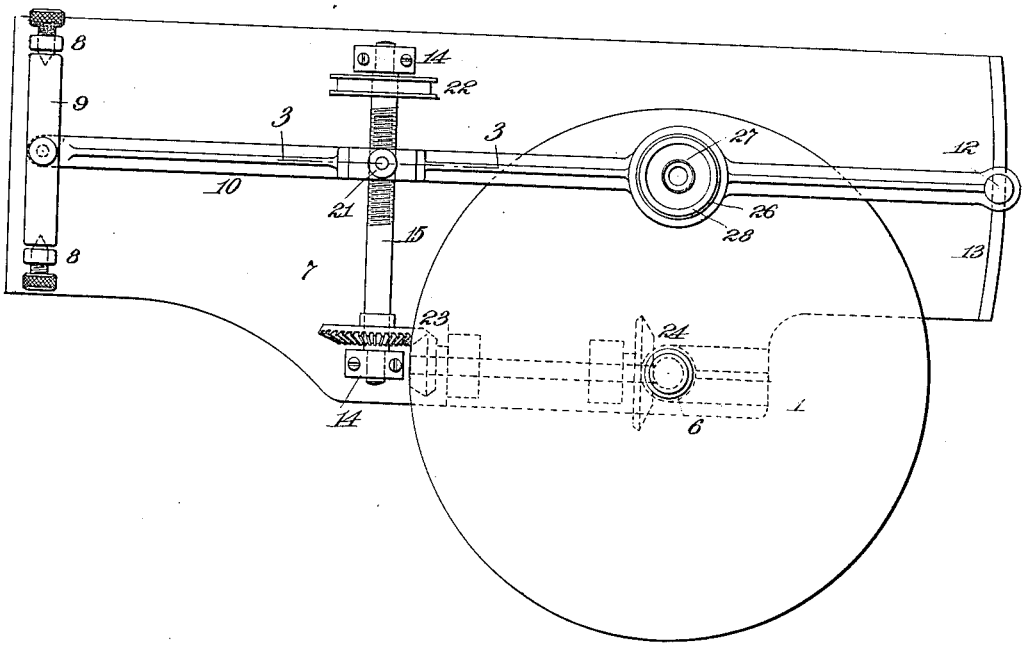
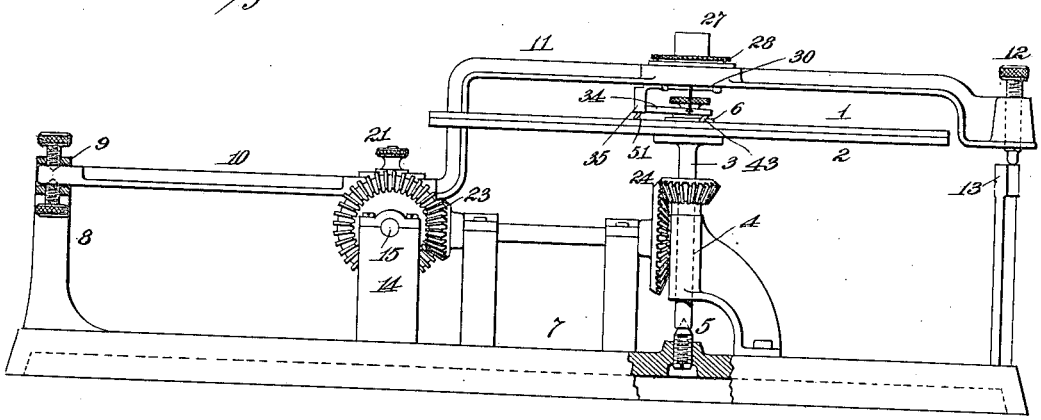


Fig. 2



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4 SHEETS—SHEET 2.

Fig. 3

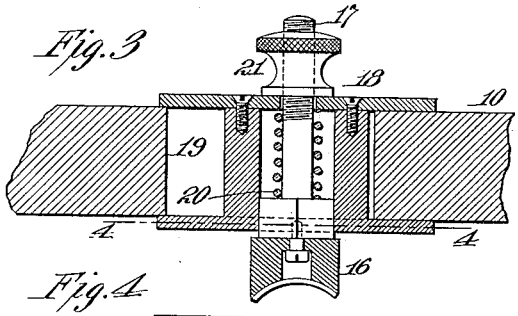


Fig. 4

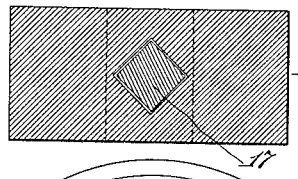


Fig. 5

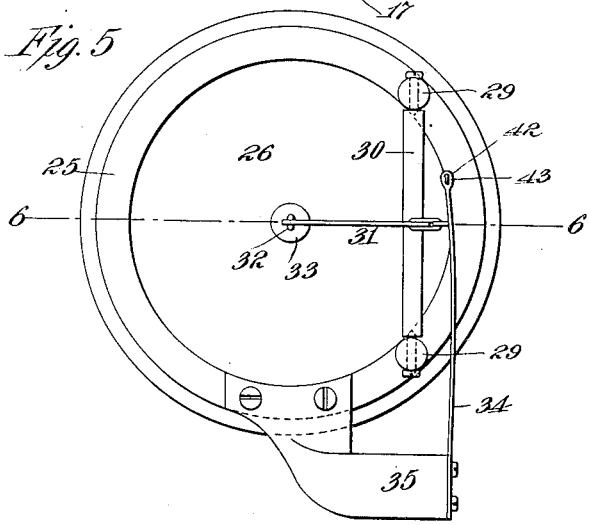
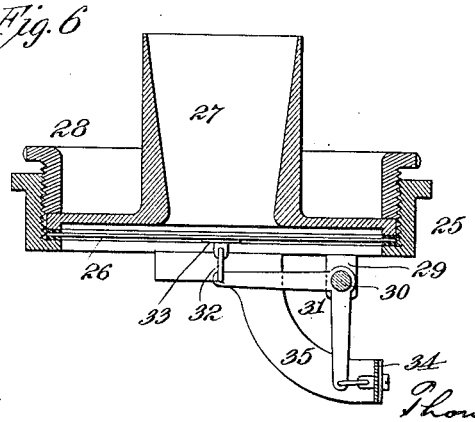


Fig. 6



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4 SHEETS—SHEET 3.

Fig. 7

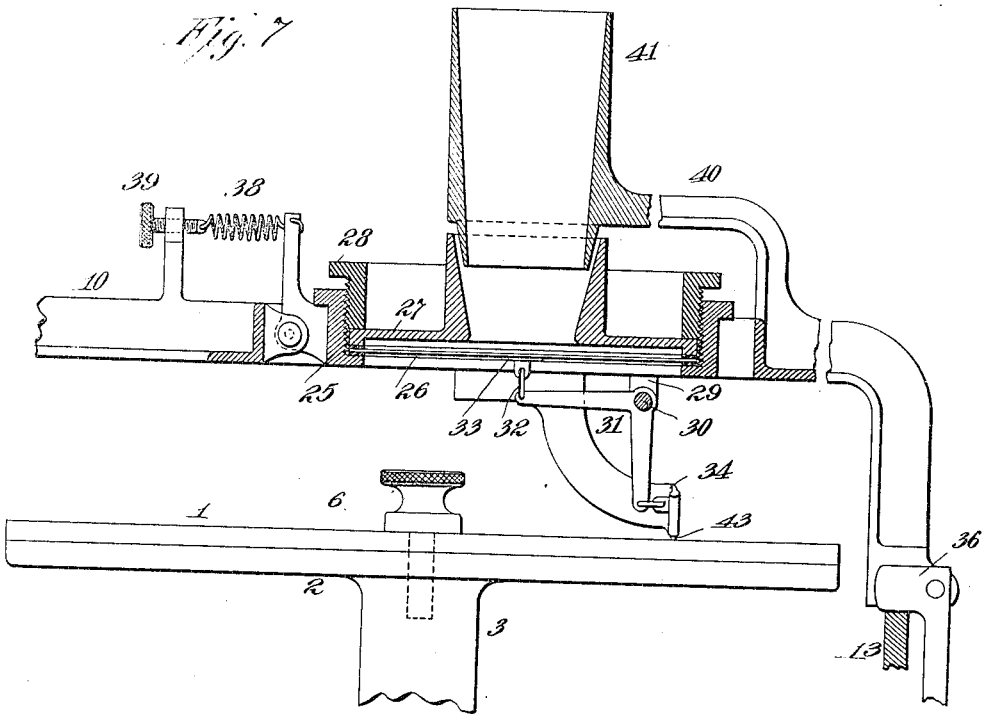
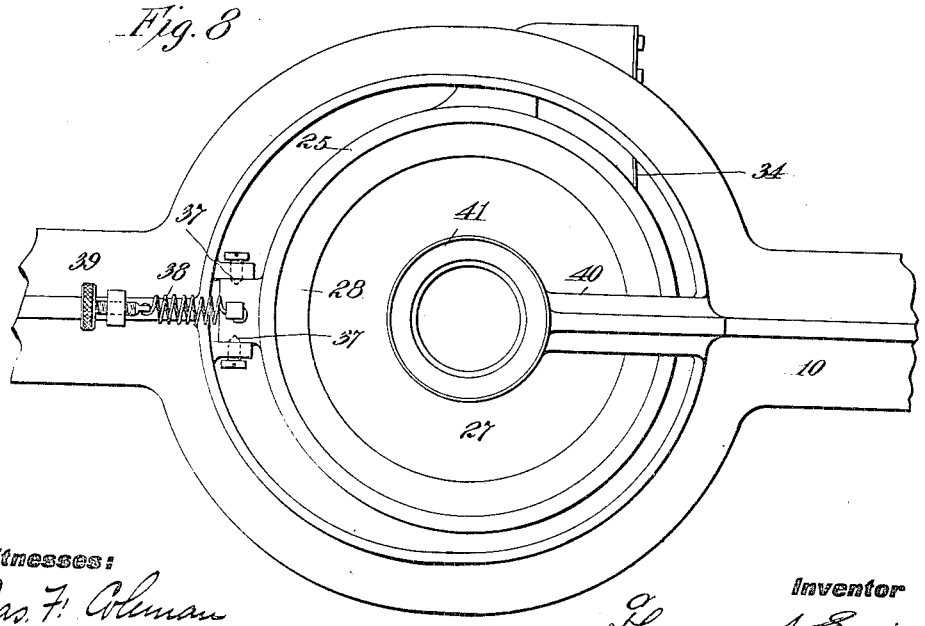


Fig. 8



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4 SHEETS—SHEET 4.

Fig. 9

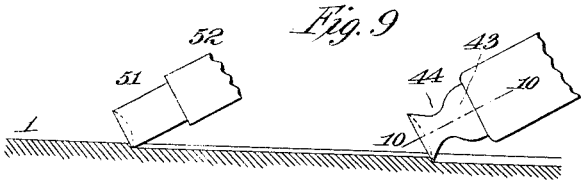


Fig. 10

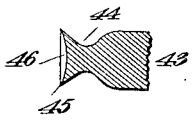


Fig. 11

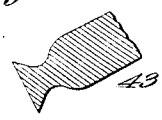


Fig. 12

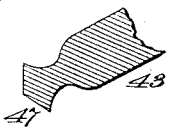


Fig. 13

Fig. 14

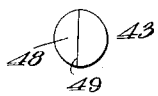


Fig. 15

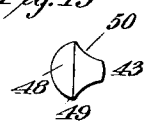


Fig. 16

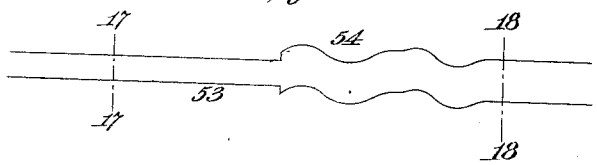
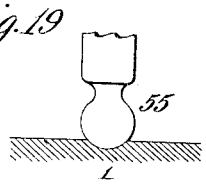


Fig. 17

Fig. 18

Fig. 19



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UNITED STATES PATENT OFFICE.

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SOUND-RECORDING APPARATUS.

No. 831,606. Specification of Letters Patent. Patented Sept. 25, 1906.

Application filed November 8, 1901. Serial No. 81,534.

To all whom it may concern:

Be it known that I, THOMAS ALVA EDISON, a citizen of the United States, residing at Llewellyn Park, Orange, Essex county, State of New Jersey, have invented a certain new and useful Improvement in Sound-Recording Apparatus, of which the following is a description.

My invention relates to improved sound-recording apparatus of the type wherein a graphic sound-record is produced on a disk-like or cylindrical blank and which is formed of a sinuous groove of substantially uniform depth and width as distinguished from my phonograph wherein these dimensions of the record-groove are not uniform.

Sound-records of the kind to which my present invention relates are relatively simple in character, and the matter of duplicating them does not present the difficulties of duplicating phonographic records.

Prior to my invention in the making of sound-records on a disk blank—for example, in the form of a sinuous groove of substantially uniform depth and width—a suitable plate or foundation was covered with a thin layer or film of wax-like material, which was engaged by a needle-like recording-stylus connected to the diaphragm, the arrangement being such that in the absence of vibrations the stylus removed the film of wax-like material to its full depth to disclose the foundation and in the form of a spiral groove of uniform width. By vibrating the diaphragm the said groove was caused to partake of sinuosities and undulations corresponding graphically to the sound-waves. By suitable etching, electroplating, photographic, or allied processes a matrix was secured from the master so formed and used for the production of duplicates by various methods. The processes used prior to my invention for the making of these records were objectionable for many reasons, and especially because the records produced are not accurately representative of the sound-vibrations, first, because the recording-stylus, in order that it may certainly cut through the depth of the wax-like material, must be engaged with considerable friction against the foundation on which the wax is carried, thereby offering unnecessary resistance to the vibration of the stylus, and, second, because the stylus, being unprovided with cutting edges, in its vibrations merely displaced or compressed the wax-like material in the formation of the groove, instead of cleanly cutting it.

The object of my invention is to provide improvements in the art of making records of this kind in the apparatus involved and by which the resulting records will be more perfect and capable of more accurate reproduction than records of the kind as heretofore made.

The invention in its preferred form resides in the utilization of means coöperating with the recorder for causing the latter to always cut to the desired depth in the wax-like material irrespective of variations in the thickness of the blank or other eccentricities in the plane of the recording-surface. This feature of the invention is carried into effect by engaging the recorder to the desired depth in the recording material by gravity and mounting the recorder so that it is free to rise and fall to accommodate itself to any changes in the plane of the recording-surface.

My invention comprises also such other features as are hereinafter set forth and claimed.

In order that the invention may be better understood, attention is directed to the accompanying drawings, forming part of this specification, and in which—

Figure 1 is a plan view of the complete apparatus for operating on a disk-like blank and showing the recording-stylus as being mechanically adjustable with respect to the blank; Fig. 2, a side elevation of the same; Fig. 3, a section on the line 3 3 of Fig. 1; Fig. 4, a section on the line 4 4 of Fig. 3; Fig. 5, a bottom view of the recorder proper in its preferred form; Fig. 6, a longitudinal section on the line 6 6 of Fig. 5; Fig. 7, a longitudinal section through the swinging arm, illustrating an embodiment of that feature of the invention by which the recorder will engage the blank by gravity so as to cut to the desired depth irrespective of mechanical variations in the blank; Fig. 8, a plan view of the same; Fig. 9, a greatly-enlarged view showing the blank in section, also the preferred form of recording-stylus in operative position and on the same scale, a grooving-tool preced-

ing the same; Fig. 10, a section on the line 10 10 of Fig. 9, showing the side cutting edges of the preferred recording-stylus; Fig. 11, a sectional view of a modification of the stylus; Fig. 12, a corresponding view of a further modification thereof; Fig. 13, a view corresponding to Fig. 11, showing a further modification of the recording-stylus; Fig. 14, a bottom view of the stylus shown in Fig. 13; Fig. 15, a corresponding view illustrating a slight modification of the stylus shown in Figs. 13 and 14; Fig. 16, a greatly-enlarged view of the record-groove formed with a cutting-edged recording-stylus of the improved type, showing also the smaller non-sinuous groove; Fig. 17, a section on the line 17 17 of Fig. 16; Fig. 18, a section on the line 18 18 of Fig. 16, and Fig. 19 an enlarged cross-sectional view illustrating the engagement with the record-groove of a spherical reproducer.

In all of the above views corresponding parts are represented by the same numerals of reference.

A suitable blank 1, made, preferably, of the ordinary photographic wax-like composition, in the form of a relatively thin disk (say one-quarter inch in thickness) is carried on a rotating support 2 from a shaft 3, the latter being mounted in a bearing 4 and stepped at its bottom on a cone-pivot 5. The blank 1 is held in place on the support 2 in any suitable way, as by means of a disk 6, screwed in place. It will be understood, of course, that when the blank is cylindrical in form it may be received on a tapered mandrel, as in an ordinary phonograph. The bearings 4 and 5 are suitably carried by a frame 7, which extends rearwardly and is formed with bearings 8 8, in which is supported a rock-shaft 9, to which an arm 10 is pivoted, whereby the latter may partake of universal movement, as will be obvious. The arm 10 is preferably arched at 11, where it passes over the blank 1, and at its forward end is supported by an adjustable screw 12 on a suitable track or guide 13. The adjusting-screw 12 permits the arm 10 to be adjusted with respect to the surface of the blank 1 in order that the required depth of cut of the recording-stylus may be secured, as will be explained. Mounted in suitable bearings 14, extending up from the frame 7, is a feed-screw 15, which is engaged by a nut 16 and by means of which the arm 10 will be swung on its pivot to carry the recorder radially across the face of the blank 1 in order to form the spiral record-groove. The nut 16 is pivoted to a shank 17, which latter is vertically movable within a two-part block 18, arranged to slide in an opening 19 in the arm 10. Mounted within the block 18 is a spring 20, tending to force the nut 16 downwardly. Extreme movement of the shank 17 is limited by a nut 21. By this construction it will be observed that the arm 10 is free to move pivotally without disengaging the nut 16 from the feed-screw 15, and the arm can be adjusted vertically with respect to the blank 1 without affecting the engagement between said nut and feed-screw. When, however, it is desired to remove the completed record or to put a new blank in place, the arm 10 is swung upward pivotally to disengage the nut 16 from the feed-screw, and thereby completely disclose the support 2. In the drawings I illustrate a band-wheel 22 for rotating the feed-screw 15, and I show bevel-gearing 23 and 24 for transmitting motion from said feed-screw to the shaft 3. The band-wheel 22 is driven from a spring, electric, or other motor.

The arm 10 carries the diaphragm and intermediate connections between the same and the recording-stylus, the preferred construction of which parts is shown in Figs. 5 and 6. An internally-threaded ring 25 carries a diaphragm 26, held in place between rubber gaskets, as shown, and also the disk 27, to which the speaking tube or horn is connected, said disk being held in position by a clamping-ring 28. Mounted in bearings 29 on the under side of the ring 25 is a light rock-shaft 30, carrying a very light and rigid bell-crank lever 31. The free end of the horizontal arm of this lever is connected by a link 32 to a disk 33, which is cemented to the under side of the diaphragm 26, while the free end of the vertical arm of said lever is connected by a link to a spring 34, mounted on an arm 35, secured to the under side of the ring 25. The free or forward end of the spring 34 inclines slightly from the horizontal and toward the blank 1. In use the spring 34 is maintained normally under tension, so that as the diaphragm moves downward the elasticity of the spring moves it toward its unflexed position, while a reverse movement of the diaphragm increases the tension on said spring. In this way it will be seen the tension of the spring keeps the connections between it and the diaphragm always under stress, so that there can be no lost motion, and the spring will be caused to respond accurately to the vibrations.

With the form of device shown in Figs. 1 and 2 the recorder as a whole is carried directly within an eye or opening in the arm 10, so that by means of the adjusting-screw 12 the recording-stylus can be adjusted with respect to the blank so as to cut therein to the desired depth. As explained, such an adjustment does not affect the engagement between the nut 16 and the feed-screw. When the recording-surface of the blank is perfectly accurate, a mechanical adjustment of the recording-stylus with respect to the recording-surface is satisfactory; but under ordinary conditions blanks of wax-like material, particularly when in the form of disks of considerable diameter, become warped or otherwise made eccentric, so that the record-

ing-surfaces do not lie in a perfect plane. With such blanks, therefore, it would be difficult to make use of a mechanical adjustment which would cause the recording-stylus to cut always to the required depth. I therefore prefer to so mount the recording-stylus in the apparatus that it will engage the blank by gravity, cutting to the required depth therein and raising or falling to accommodate itself to any mechanical variations in the record-surface. This might be done in any well-known way—as, for example, by pivoting the recorder as a whole so as to permit the recording-stylus to rest on the blank or to interpose between the diaphragm and the recording-stylus a compensating weight, which without affecting the connection between the diaphragm and stylus presses the latter to the required depth in the recording material. I illustrate a compensating mechanism of the latter type in Letters Patent No. 705,829, granted July 29, 1902, and wherein I describe and claim a new reproducing apparatus for use in connection with the records made by the present machine, while an apparatus of the former type is shown in Figs. 7 and 8 of the accompanying drawings. With this arrangement the adjusting-screw 12 may be dispensed with and the arm 10 provided at its forward end, with the usual cam 36 for elevating and depressing it. Said arm is provided centrally with an enlarged opening or eye in which the recorder is mounted on pivots 37, so that the recorder will be free to swing thereon. A spring 38 is employed for sufficiently counteracting the weight of the parts to permit the recording-stylus to track to the desired depth in the blank, and the tension of said spring is adjusted by a screw 39. An arm 40 carries the speaking-tube 41, so that the latter will be independent of the recorder, which will therefore be free to rise and fall with any variations in the blank, compelling the recording-stylus, therefore, to always track to the desired depth in the material. The spring 34 carries the recording stylus or tool. The preferred form of tool or stylus is shown in Figs. 9 and 10, which are generally enlarged. The free end of the spring 34 carries a suitable socket 42, which receives the stylus 43. The latter is formed of cylindrical material, either steel or the ordinary sapphire, and is cut away at the neck 44 to form a sharp cutting edge 45. The extreme outer end of the stylus is slightly concaved at 46, as with ordinary phonographic recorders. The essential feature of the improved stylus is that it presents the thin cutting edge 45, which in the formation of the sinuous groove, as will be explained, performs a true cutting operation, instead of merely displacing or compressing the material, as is the case with a recording-stylus unprovided with cutting edges. The stylus 43, as shown, is arranged so that its main portion behind the neck 44 will not interfere with the material and is ordinarily placed almost horizontally, as shown.

In Fig. 11 the recording-stylus is constructed exactly as that of Figs. 9 and 10, except that the concavity 46 is omitted.

In Fig. 12 a further modification of the stylus is shown, differing from that illustrated in Fig. 11 in being provided with a conical extension 47 beyond the cutting edge 45. This form of cutter does not present so sharp a cutting edge as the forms previously described, but is somewhat more durable than such forms.

With the recording-stylus shown in Figs. 13 and 14 I make the device spherical in shape and cut away one side, as shown at 48, so that the angle 49 will effect the cutting operation. If desired, the sides of the cutter shown in Fig. 13 may be removed at 50, Fig. 15, behind the cutting edge, so as to reduce the thickness of the cutting edge at the sides and enable it to perform a more efficient cutting action. In some instances I may make use of a grooving-tool 51, (see Figs. 2 and 9,) supported in a socket 52, secured to the bottom of the ring 25 and which tracks in the recording material in advance of the stylus. The grooving-tool 51 is preferably made like an ordinary phonographic recorder, but of less diameter, being generally cylindrical in form with a concaved end to form a sharp cutting edge. This grooving-tool, as shown in Figs. 16 and 17, cuts a relatively shallow and narrow groove 53, so as to thereby remove a part of the material from the path and in advance of the recording-stylus, and therefore minimize the work which the latter device is required to perform. Thus, having reference to Fig. 16, it will be seen that the record-groove 54, which is cut in the recording composition by the stylus, amounts practically to an enlarging and deepening of the groove 53. This record-groove presents in cross-section at all portions of its length an arc of a circle and is of substantially uniform depth and width throughout. It is characteristically different from records formed with needle-like recorders used before my invention in being smoothly cut throughout instead of resulting from the crowding or displacing of the material with the inherent disadvantages incident to the latter operation, as I have before described.

Having formed a sinuous groove with curved sides and bottom, I am enabled to make use of a spherical reproducer 55, (see Fig. 19,) which engages the groove and accurately tracks it throughout its entire portion. If, however, the record is formed at a relatively slow speed or if the sounds which are recorded are of high pitch or great volume, so that the waves of which the record is composed are closely crowded together, I may make use of a reproducing device of the type

described in my Reissue Patent No. 11,857, dated September 25, 1900, and wherein the longitudinal axis of the bearing-surface is materially less than the transverse axis. By making use of a reproducer having a curved bearing-surface I reduce wear thereon to a minimum, and therefore do away with the necessity of employing a new reproducer after a comparatively few reproductions have been secured therewith, as is now the case.

It will be understood, of course, that the records made as I have explained can be used in the first instance for securing reproductions or that such records can be employed as masters from which to make a matrix or mold for use in the manufacture of duplicate copies thereof by any ordinary and well-known electroplating, photographic, or other process.

Having now described my invention, what I claim as new therein, and desire to secure by Letters Patent, is as follows:

1. In an apparatus of the character described, a base, a record-holder rotatably supported thereby, a feed-screw, means for driving said record-holder and feed-screw, a diaphragm-supporting arm connected at one end to said base by a universal joint and provided with a feed-nut adapted to engage said feed-screw, a diaphragm-support pivoted to said arm on a substantially horizontal axis and means for partially counterbalancing the weight of said diaphragm-support, substantially as set forth.

2. In an apparatus of the characer described, a base, a record-holder rotatably supported thereby, a feed-screw, means for driving said record-holder and feed-screw, a diaphragm-supporting arm connected at one end to said base by a universal joint and provided with a feed-nut adapted to engage said feed-screw, a track carried by said base for supporting the free end of the diaphragm-supporting arm, a diaphragm-support pivoted to said arm on a substantially horizontal axis, and means for partially counterbalancing the weight of said diaphragm-support, substantially as set forth.

3. In an apparatus of the character described, the combination with a record-tablet and means for moving the same, of a pivotally-supported diaphragm, means for partially counterbalancing the weight of said diaphragm and its support, a spring maintained under normal tension, a recording stylus carried by said spring, and a pivotal connection between said spring and diaphragm, substantially as set forth.

4. In an apparatus of the character described, a supporting-base, a record-holder rotatably supported thereby, a feed-screw, means for driving said record-holder and feed-screw, a diaphragm-supporting arm connected at one end to said base by a universal joint, and a spring-pressed feed-nut carried by said arm and engaging said feed-screw, substantially as set forth.

5. In an apparatus of the character described, a supporting-base, a record-holder rotatably supported thereby, a feed-screw, means for driving said record-holder and feed-screw, a diaphragm-supporting arm connected at one end to said base by a universal joint, and a vertically-adjustable feed-nut carried by said arm and engaging said feed-screw, substantially as set forth.

6. In an apparatus of the character described, a supporting-base, a record-holder rotatably supported thereby, a feed-screw, means for driving said record-holder and feed-screw, a diaphragm-supporting arm connected at one end to said base by a universal joint, and a vertically-adjustable spring-pressed feed-nut carried by said arm and engaging said feed-screw, substantially as set forth.

7. In an apparatus of the character described, a diaphragm-supporting arm having a longitudinally-extending opening therethrough, a block movably supported in said opening, a shank extending through said block, a spring interposed between said shank and block and a feed-nut connected to said shank, substantially as set forth.

8. In an apparatus of the character described, a diaphragm-supporting arm having a longitudinally-extending opening therethrough, a block movably supported in said opening, a shank extending through said block, a spring interposed between said shank and block and means for varying the pressure of said spring, substantially as set forth.

9. In an apparatus of the character described, a supporting-base, a record-holder rotatably supported thereby, a feed-screw, means for driving said record-holder and feed-screw, a diaphragm-supporting arm connected at one end to said base by a universal joint, a feed-nut carried by said arm and engaging said feed-screw and a track carried by said base for supporting the free end of said diaphragm-supporting arm, substantially as set forth.

This specification signed and witnessed this 24th day of October, 1901.

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Witnesses:

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