

Oct. 26, 1937.

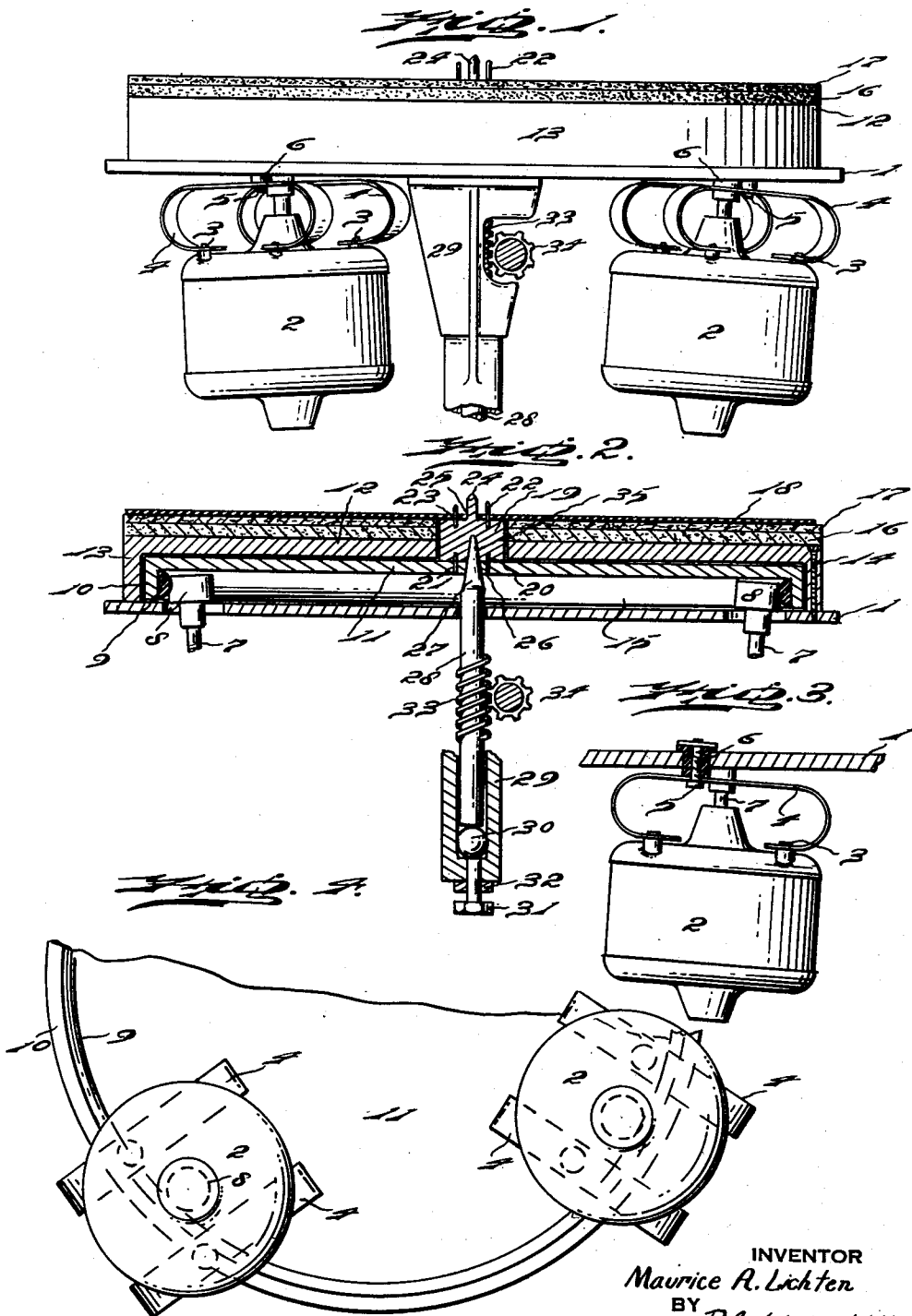
M. A. LICHTEN

2,097,071

RECORD ROTATING MECHANISM

Filed Nov. 27, 1935

4 Sheets-Sheet 1



INVENTOR
Maurice A. Lichten
BY Robert Irving Williams
ATTORNEY

Oct. 26, 1937.

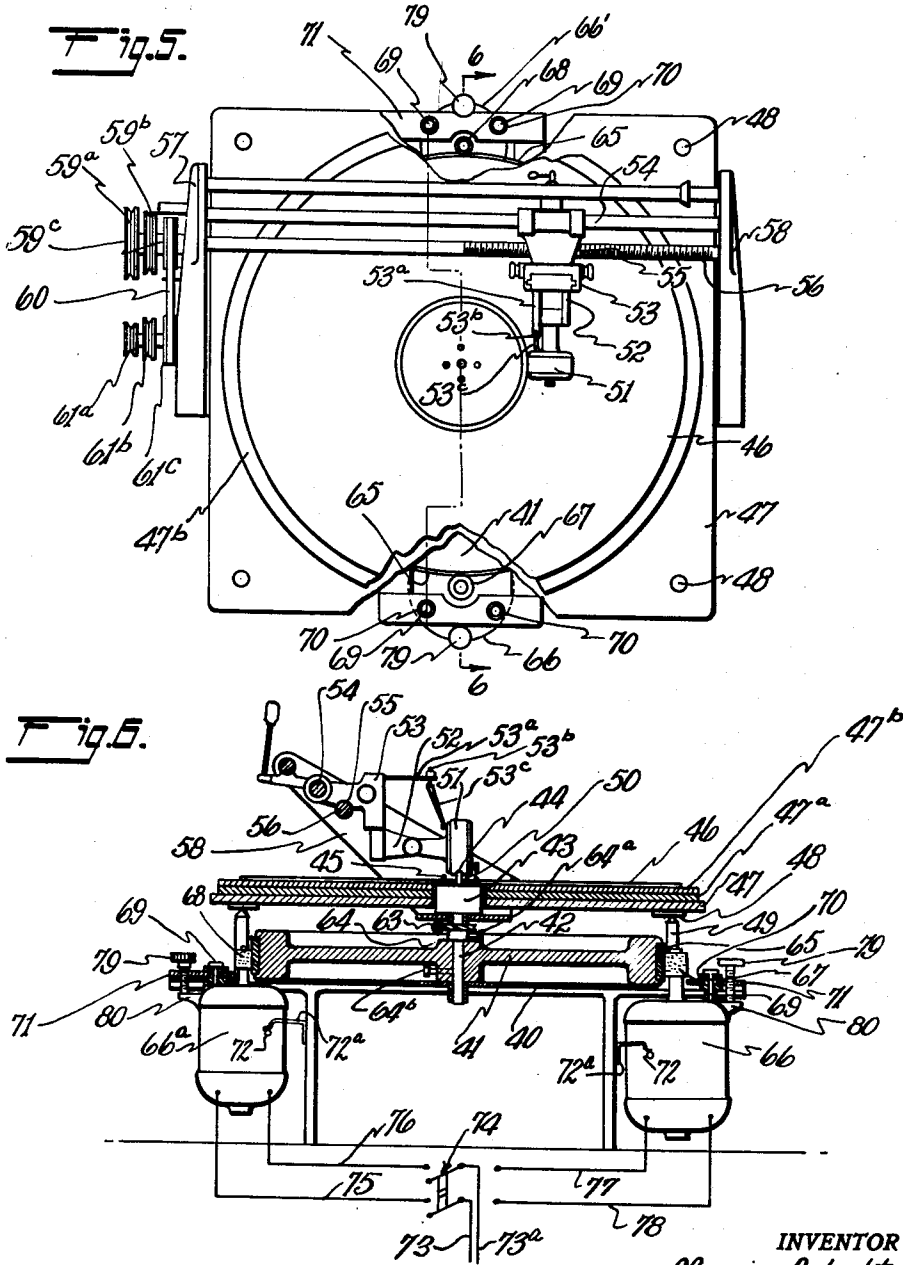
M. A. LICHTEN

2,097,071

RECORD ROTATING MECHANISM

Filed Nov. 27, 1935

4 Sheets-Sheet 2



Oct. 26, 1937.

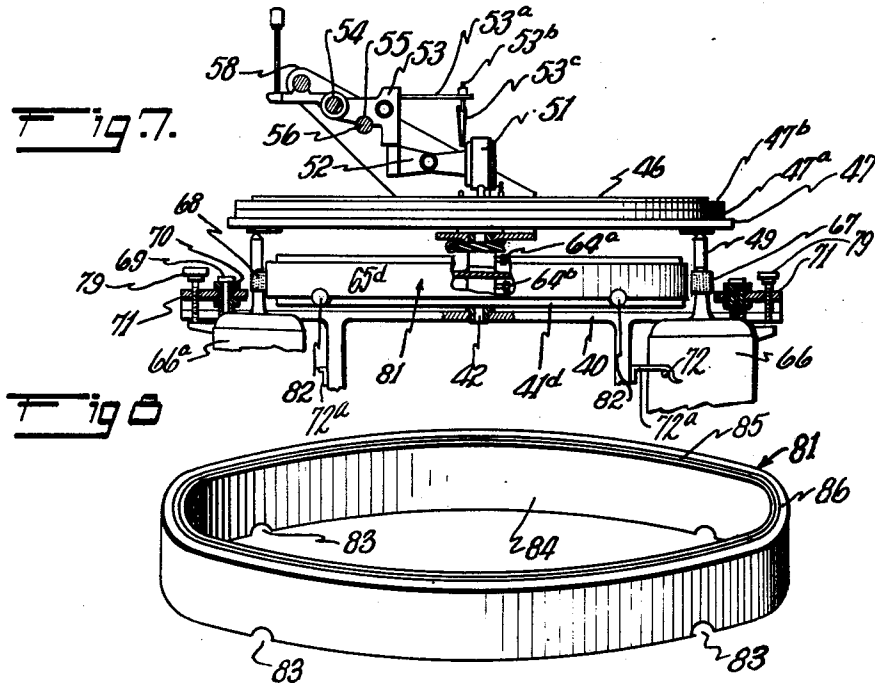
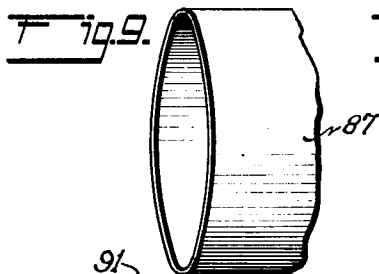
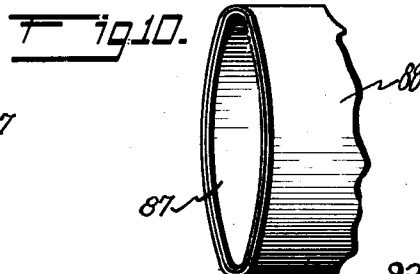
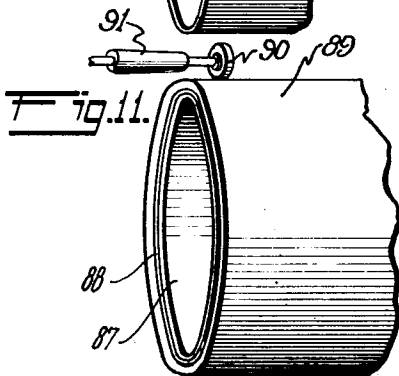
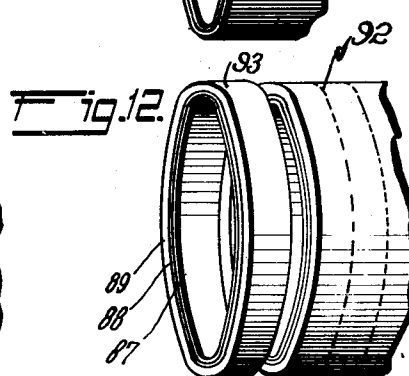
M. A. LICHTEN

2,097,071

RECORD ROTATING MECHANISM

Filed Nov. 27, 1935

4 Sheets-Sheet 3



INVENTOR

Maurice A. Lichten

BY

Robert Irving Williams
ATTORNEY

Oct. 26, 1937.

M. A. LICHTEN

2,097,071

RECORD ROTATING MECHANISM

Filed Nov. 27, 1935

4 Sheets-Sheet 4

Fig. 13.

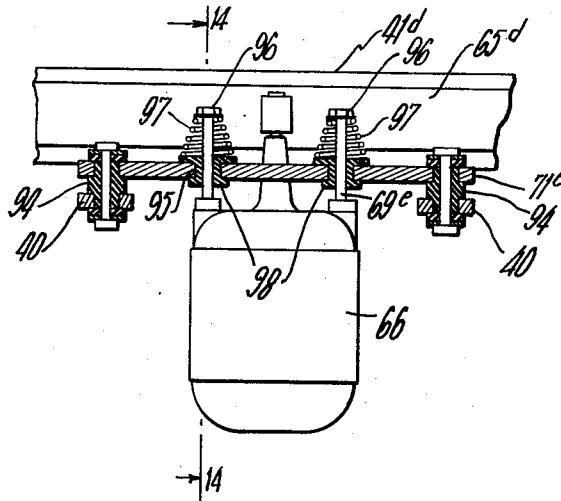
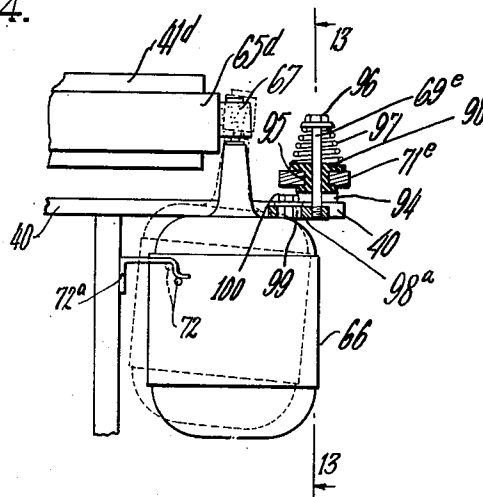


Fig. 14.



INVENTOR
Maurice A. Lichten
BY Robert Irving Williams
ATTORNEY

UNITED STATES PATENT OFFICE

2,097,071

RECORD-ROTATING MECHANISM

Maurice A. Lichten, Long Island City, N. Y., assignor to Fidelitone Records, Inc., New York, N. Y., a corporation of New York

Application November 27, 1935, Serial No. 51,776

25 Claims. (Cl. 274—9)

This invention relates to the recording and reproduction of sound, and more particularly to apparatus for effecting relative movement of the parts during such recording and reproduction, and to correlated improvements and discoveries appertaining thereto.

This application is a continuation-in-part of my co-pending application, Serial No. 654,782, filed February 2, 1933.

An object of the invention is the provision of means whereby a sound record may be rotated with a high degree of smoothness and accuracy.

A further object is the provision of means for effectuating a smooth and accurate movement of a portion utilized in the recording or reproduction of sound, which means is simple of construction and economical to manufacture and use, and which may be readily operated and controlled.

Other objects are directed to the provision of various improved features of construction in driving means for a device for the recording or reproduction of sound.

Still another object is the provision of an improved friction drive unit adapted to be associated with a rotatable member.

An additional object is the provision of an improved method for the provision of a friction drive unit adapted to be removably disposed on a rotatable member.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combinations of elements and arrangement of parts, and the several steps and the relation and order of one or more of such steps with respect to each of the others thereof, all of which will be exemplified hereinafter and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a side view of one form of apparatus embodying the invention;

Fig. 2 is a vertical section thereof;

Fig. 3 is a fragmentary sectional view illustrating the motor mounting in detail;

Fig. 4 is a fragmentary bottom view;

Fig. 5 is a plan view of another form of apparatus embodying the invention;

Fig. 6 is a vertical sectional view along the line 55—55 of Fig. 5;

Fig. 7 is a similar view of a modified form of apparatus;

Fig. 8 is a perspective view on a larger scale of the friction drive unit shown in Fig. 7;

Figs. 9, 10, 11 and 12 are perspective views showing various stages in a manner of formation of units such as shown in Fig. 8, in accordance with the invention; Fig. 9 showing a metallic cylindrical member; Fig. 10, this member with a layer of additional material thereon; Fig. 11, this member with a yieldable friction layer thereon; and Fig. 12, this member with one unit cut from it;

Fig. 13 is an enlarged detail side view of a portion of a machine such as shown in Fig. 7 showing a modified form of construction; and

Fig. 14 is a vertical sectional view along the line 14—14 of Fig. 13.

For the purposes of facility of expression the term "sound" is used herein to include all impulses in the recording and reproduction of which problems similar to those present in the recording and reproduction of sound impulses are involved, and the term "sound record" is used herein in its broad sense to designate record blanks adapted to have sound vibrations or other impulses recorded thereon and also record members bearing such recordings.

In the rotation of sound records, and particularly in the rotation of flexible sound records for the recording of impulses thereon, it is important that tendencies toward vibrations be minimized, that variations in the rotative movement be as smooth and accurate as possible; and, especially in recording, that both the rotation of the record and the movement of a stylus across a record be effected with smoothness and accuracy. Difficulties have been encountered in previous efforts to provide driving means which are free from jerkiness or other variations in movement; and which, at the same time, do not impart undesirable vibrations to the operative portions of the device.

With the foregoing and other considerations in view, there may be provided in accordance with the invention a motor drive whereby a smooth and accurate movement of the driven parts is obtained and vibration avoided and whereby greatly improved results are obtained.

Since driving means embodying the invention preferably comprise cooperating friction drive portions, at least one of which is yieldable, and since yieldable members of this nature need to be replaced at fairly frequent intervals, the invention further contemplates the provision of a replaceable friction drive unit which is particularly adapted for use in apparatus embodying 55

the invention and also the provision of an improved method for the formation of such units.

In the embodiment of the invention exemplified in Figs. 1 thru 4, there is provided recording mechanism adapted to be carried on a base 1 in the form of a supporting plate which may be mounted within any suitable type of cabinet if desired. From this plate there depend electric motors 2, two of which, spaced 120° apart in the present instance, are provided to obtain a particularly high degree of smoothness of operation. By means of fastening devices 3 each motor is yieldably carried by a pair of bowed springs 4 mounted on members 5 passing thru yieldable bushings 6 which may be formed of rubber and which are carried on the plate 1. The shaft 7 of each motor carries at its free end a driving roller 8 which may be formed of resilient material, such as rubber, and which, due to the off-center support of the motor from the member 5 is adapted, due to the weight of the motor, to bear upon an annular friction drive portion 9 secured to the inner edge of a depending flange 10 on a fly-wheel 11. The springs serve to assure a firm, effective and smooth engagement of the roller with the portion 9. The annular portion 9 may be formed of rubber or other suitable material. The fly-wheel 11 rotates beneath a record-supporting table 12, which, in accordance with my said application, Serial No. 654,782, is stationary and is provided with a resilient supporting surface. The table 12 is formed in the present instance with a depending flange 13 secured to the base 1 by fastening devices 14 so that the fly-wheel is enclosed in a chamber 15 between the base and the stationary support. The upper portion of the support 12 comprises, in the present instance, a layer of sponge rubber 16 and a layer of felt 17 on which a sound record, such for instance, as the flexible record exemplified at 18, is adapted to rest. The record may be rotated from the fly-wheel by a coupling 19 carrying pins 20 which extend into apertures 21 in the fly-wheel. From the upper surfaces of the coupling, pins 22 adapted to be received by apertures 23 in the record extend upwardly, and the coupling member 19 is also provided with the usual center pin 24 adapted to extend thru an aperture 25 in the record. In order to permit the stylus carrier to be driven from the motors 2, the fly-wheel and coupling are provided with a tapered opening 26 adapted to closely engage a tapered portion 27 of a shaft 28 journaled in a bearing 29 and having its lower end resting on a ball 30 which can be vertically adjusted by means of a set screw 31 provided with a lock nut 32. This bearing 29 may be carried from the base 1 in any desired manner. The shaft 28 is provided with a worm 33 which is adapted to mesh with a worm gear 34 from which a stylus-carrying arm may be driven across a record, all as fully disclosed in said co-pending application, Serial No. 654,782. The coupling 19 is recessed at 35 to receive the free end of the shaft 28. The mounting 5-6 is connected to the springs 4 at such a point that the motors are carried off-center, so that the rollers will be thrust by the weight of the motor against the annular portion 9 in such manner that the driving engagement will be in a direction radial to the axis of rotation of the fly-wheel,—horizontally, in the present instance,—so that even though the motor shaft shifts, the speed of the fly-wheel and consequently of the record, will not be substantially altered. Because of the yieldability of the mounting 6 and

also of the springs 4, the weight of the motor presses the roller effectively against the annular drive portion.

The height of the fly-wheel may be varied by the adjustment of the set screw 31 which effects a raising or lowering of the shaft 28 and of the members carried thereby.

In the present exemplification, both of the motors are adapted to be in circuit at the same time. By the provision of a pair of motors, each of these acts to control the movement imparted to the fly-wheel by the other, so that a balanced, smooth drive of the fly-wheel, and hence of the record, and also of connected parts, such as a stylus carrier, may be obtained. By the mounting of these motors at 120°, or in some other position where they are not directly opposed to each other, tendencies toward a periodicity of variation characteristics is minimized.

In the form of construction exemplified in Figs. 5 and 6, there is provided a recording machine comprising a main support 40 on which there is rotatably mounted a fly-wheel 41 on the shaft 42 of which is carried a rotatable head or coupling 43. From the head 43 there extends a center pin 44 and driving pins 45. These pins are adapted to enter openings in a flexible record 46 and to revolve the same on a rotatable stationary support, as claimed in my said application, Serial No. 654,782. This support comprises a plate 47 carrying a layer of rubber 47a and a layer of felt 47b, and is mounted thru the medium of rubber inserts 48 on posts 49 extending from the plate 40. In order to engrave a record rotating on said support, there may be employed means such as exemplified in my co-pending application, Serial No. 44,138, filed October 9, 1935, comprising a stylus 50 carried by a sound head 51 which is pivotally mounted on an arm 52 slidably connected with a bracket 53. From the bracket 53 there extends an arm 53a carrying an adjustable screw 53b from which an elastic band 53c extends to the sound head 51 to elastically support the same. The bracket 53 is slidably and pivotally mounted on a lateral rod 54 and is formed with a threaded portion 55 adapted to engage a worm on a rotatable shaft 56. The rod 54 and the shaft 56 are mounted in frame members 57 and 58 and the shaft 56 carries at its outer end one of a plurality of different sized pulleys 59a, 59b, and 59c, connected by a belt 60 to one of a plurality of cooperating pulleys 61a, 61b, and 61c, carried on a shaft 62. By shifting the belt from one pair of pulleys to another the spacing of the grooves cut in a record may be readily varied. The shaft 62 carries a worm 63 meshing with a worm gear 64 on the shaft 42. In the present instance the worm on the shaft 56 only extends from the center of the record to the periphery in one direction. The fly-wheel 41 and the worm 64 are secured to the shaft 42 by means of set screws 64a and 64b, upon the loosening of which the shaft may be slid upwardly to permit the fly-wheel to be moved laterally of the machine so that the bearing portion 65 may be replaced when deteriorated or worn.

In accordance with the invention there is provided at the periphery of the fly-wheel an annular friction drive portion 65 having a vertical engaging surface; and motors 66 and 66a are hung off-center from the plate 40, so that rollers 67 and 68 respectively on their shafts will engage the annular drive portion in a direction which is radial to the axis of rotation of the fly-wheel—

in a horizontal direction in the present instance—so that it is impossible for any longitudinal shifting of the motor shaft to result in a substantial variation of the drive. As exemplified, the motors are mounted so that the weight of the motor will press its drive roller against the annular portion 65; the mounting means for a motor being of a yieldable nature and comprising fastening members 69 extending from one side of the motor casing and carried by rubber inserts 70 in a plate 71 secured to the plate 40. Preferably one or the other of the drive means 65, or 67—68, or both, are formed of resilient material, the annular band 65 being formed of rubber in the exemplified construction, and the rollers 67 and 68 having knurled micarta surfaces. In the present instance it is contemplated that only one of the motors will serve as the driving means at any given time; the motors being arranged, in accordance with the invention, to drive the fly-wheel at different speeds, so that records rotated thru the medium of the fly-wheel may be turned fast or slow, as may be desired in any particular case, as for instance when a small record or a large record, respectively, is being rotated. In certain instances both rollers may be maintained in engagement with the annular drive means, although only one motor will be energized, the other motor serving to overcome certain unbalanced conditions or lack of smoothness of rotation sometimes occurring. In other instances, one or the other of the rollers will be disengaged, as by swinging its motor inwardly so that a lug 72 thereon will engage a bent spring 72a to hold the motor out of engagement, in the manner hereinafter indicated in Fig. 7. In the present instance, the roller 67 is larger than the roller 68, and also the motor 66 has a higher speed of rotation than the motor 66a so that when the motor 66 is in circuit, the fly-wheel and the record will be rotated more rapidly than when the motor 66a is in circuit than when the motor 66 is in circuit. In order to energize one or the other of the motors as desired, there are provided means comprising conductors 73 and 73a, a switch 74, leads 75 and 76 to the motor 66a, and leads 77 and 78 to the motor 66.

Since the annular drive portion 65 is compressible, the exact speed at which the fly-wheel is driven will depend upon the pressure exerted by that motor which is in circuit, and in order to make this speed exactly proper for the desired type of recording, there is provided an adjustable means whereby the pressure of each roller against the annular drive portion may be controlled. In the present instance, this means comprises screws 79 each threaded thru one of the parts 71 and bearing against an outward extension 80 on the casing of a respective motor.

Since the outward movement of the stylus is controlled from the fly-wheel, the provision of means assuring the smooth movement of the fly-wheel likewise is of advantage in avoiding tendencies for uneven outward movement of the stylus carrier, so as to assist in preventing convergence of the grooves, and, in avoiding superimposed undesirable sound effects, particularly where the stylus vibrates laterally, as in the usual case.

In the embodiment of the invention shown in Fig. 7, the arrangement is similar to that of Figs. 5 and 6, and the parts are designated by similar reference numerals, except that the motor 66 is shown swung inwardly with its lug 72 held in the bend of the spring 72a, and with its roller 67 out of engagement; and except that the fly-wheel 41

is replaced by a fly-wheel 41d, on the periphery of which there is provided a removable friction drive unit 81 carrying a friction drive portion 65d of the same general character as the friction drive portion 65.

As will be apparent, the unit 81 is removably mounted on the periphery of the fly-wheel 41d, so as to permit the removal of the fly-wheel or of the unit 81, so that one unit may be removed from the fly-wheel and a similar unit fitted over it. The fly-wheel is formed with projections 82, and the unit 81 with cooperating notches 83 adapted to be received by those projections so that the drive unit and the fly-wheel will rotate together. By the provision of a removable unit of this nature, the friction drive portion may be readily replaced by a similar portion when it has undesirably deteriorated or worn down. Due to the removability of the fly-wheel, upon the loosening of the set screws 64a and 64b and the raising of the shaft 42 as above indicated, a drive unit 81 may be readily removed from the fly-wheel and replaced by a similar unit.

While removable units of any of a variety of suitable types may be utilized, the invention in certain of its aspects contemplates the provision of a friction drive unit of a simple and highly effective character, such as exemplified in Fig. 7 and shown in detail in Fig. 8. This unit comprises a metallic annulus 84 having a layer 85 of hard rubber secured thereto and a facing layer 86 of soft rubber adhering firmly to the hard rubber and providing the friction drive portion.

In forming the drive units, such as shown at 81, in accordance with the invention, there is provided a metallic cylinder 87 as shown in Fig. 9. On this cylinder there is vulcanized a layer 88 of hard rubber, as shown in Fig. 10, the hard rubber adhering firmly to the cylinder. Thereupon a layer of yieldable soft rubber 89 is vulcanized upon the hard rubber layer 88 and the surface of the soft rubber is smoothed off to a uniform circumference, as by a grinding wheel 90, as shown in Fig. 11, which may be kept wet, and may be shifted along the surface of the soft rubber thru a bearing 91. Thereupon the cylindrical assembly thus formed is cut transversely, as along lines 92, to provide units 93 in which notches 83 may be suitably formed, if desired, to provide friction driving units such as shown in Fig. 8.

In Figs. 13 and 14 there is exemplified a construction which is similar to that shown in Fig. 7 and wherein the parts not appearing in the drawing and wherein all of the parts except those having to do with the motor mounting are similar to those of the construction of Fig. 7, and so far as they appear in the drawings are designated by similar reference numerals. In the present exemplification, each of the motors 66 and 66a are supported by means particularly exemplified in connection with the motor 66. This means comprises a plate 71e supported on the plate 40 thru the medium of rubber inserts 94. Thru openings 95 in the plate 71e there extend supporting posts 69e having heads 96 which are carried on coil springs 97 which serve to yieldably and resiliently hold the posts on the plate 71e in the openings 95 and about the posts there are disposed yieldable rubber collars 98 which are adapted to permit the posts 69e to swing during the adjustment of the motor. At their lower ends the posts carry horizontal extensions 98a having horizontal slots 99 therein thru which there extend screws 100 secured to the casing of the motor 66. By the adjustment of the screws

100 inwardly or outwardly along the slots 99 a motor may be shifted so that its roller 67 or 68, as the case may be, may be aligned to bear upon the drive portion 65d in different amounts, but with equal pressure thruout the vertical extent of the rollers. By such means the motors are spring-supported, as are the motors 2, so as to assure a particularly effective engagement of the rollers with the annular friction drive portion 65d. Furthermore the transmission of vibration to the record support and other members is substantially eliminated, and a simple and highly effective motor mounting provided.

It will thus be seen that, in accordance with the invention, there may be provided simple, effective, and readily adjustable means whereby sound records may be rotated with a high degree of smoothness and accuracy under a variety of conditions, and a variety of advantageous results secured.

Since certain changes in the construction set forth and in carrying out the above method and different embodiments of the invention may be made without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

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

1. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction drive portion on the rotatable member, a motor carrying a cooperating friction drive portion on its shaft, and means including yieldable supporting means for mounting said motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, said drive portions being so arranged that the second mentioned drive portion will bear toward or away from the axis of rotation of the rotatable member.

2. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction drive portion on the rotatable member, a motor carrying a cooperating friction drive portion on its shaft, and means including yieldable supporting means for mounting said motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, said drive portions being so arranged that the second mentioned drive portion will bear toward or away from the axis of rotation of the rotatable member, at least one of said drive portions being resilient.

3. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction drive portion on the rotatable member, a motor carrying a cooperating friction drive portion on its shaft, means including yieldable supporting means for mounting said motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, said drive portions being so arranged that the second mentioned drive portion will bear toward or away from the axis of rotation of the rotatable member, and means to control the pressure of said drive portions against each other.

4. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction drive portion on the rotatable

member, a motor carrying a cooperating friction drive portion on its shaft, and means including spring means for mounting said motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, said drive portions being so arranged that the second mentioned drive portion will bear toward or away from the axis of rotation of the rotatable member.

5. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction drive portion on the rotatable member, a motor carrying a cooperating friction drive portion on its shaft, means including yieldable supporting means for mounting said motor, and means including said mounting means to cause the friction drive portion on the motor shaft to be pressed in driving engagement with said annular drive portion, said drive portions being constructed and arranged to maintain the distances between each of their axes and the position of driving engagement constant whereby a uniform speed relation is maintained between said motor and said rotatable member irrespective of the longitudinal position of the motor drive shaft.

6. Apparatus for the recording or reproduction of sound comprising a rotatable member, a motor, an annular friction drive portion on the rotatable member, a cooperating friction drive portion on the shaft of the motor, supporting means, a yieldable portion on said supporting means, and means to support said motor dependently from said yieldable portion at a point at one side of the center of gravity of the motor, the said drive portions being so arranged that the drive portion on the motor shaft will bear against the drive portion on the rotatable member in a direction perpendicular to the axis of the rotatable member.

7. Apparatus for the recording or reproduction of sound comprising a rotatable member, a motor, an annular friction drive portion on the rotatable member, a cooperating friction drive portion on the shaft of the motor, supporting means, a yieldable portion on said supporting means, means to support said motor dependently from said yieldable portion at a point at one side of the center of gravity of the motor, the said drive portions being so arranged that the drive portion on the motor shaft will bear against the drive portion on the rotatable member in a direction perpendicular to the axis of the rotatable member, at least one of said drive portions being resilient, and means to control the pressure of the drive portion on the motor shaft against the drive portion on the rotatable member.

8. Apparatus for the recording of sound comprising an annular member, supporting means, a yieldable portion on said supporting means, means to support a motor off-center from said yieldable portion, an annular friction drive portion on the annular member, a cooperating drive portion on the shaft of the motor, said motor and said annular member being so disposed that the drive portion on the motor shaft will bear against the drive portion on the annular member in a direction perpendicular to the axis of the annular member, record-rotating means adapted to turn with said annular member, a stylus carrier, and means to drive said stylus carrier from said annular member.

9. Apparatus for the recording or reproduction of sound comprising a rotatable member, an an-

nular friction drive portion on the rotatable member, a motor carrying a cooperating friction drive portion on its shaft, said motor being mounted off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, said drive portions being so arranged that the second mentioned drive portion will bear toward or away from the axis of rotation of the rotatable member.

10. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction drive portion on the rotatable member, a plurality of motors each carrying on its shaft a friction drive portion adapted to cooperate with the friction drive portion on the rotatable member, and means including yieldable supporting means for mounting each motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, said drive portions being so arranged that the drive portions on the motor shafts will bear toward or away from the axis of rotation of the rotatable member.

11. Apparatus for the recording or reproduction of sound, comprising a rotatable member and a plurality of motors each carrying a drive portion adapted to engage said rotatable member to drive the same, said motors being adapted to be energized simultaneously.

12. Apparatus for the recording or reproduction of sound, comprising a rotatable member and a plurality of motors each carrying a drive portion adapted to engage said rotatable member to drive the same, each of said motors being adapted to drive said rotatable member at a different speed, and means to energize one or another of said motors as desired.

13. Apparatus for the recording or reproduction of sound, comprising a rotatable member and a plurality of motors each carrying a drive portion adapted to engage said rotatable member to drive the same, each of said motors being adapted to drive said rotatable member at a different speed, and means to prevent the engagement of the drive portion of any of said motors with said rotatable member so that the drive portion of only a desired one of said motors will be operative to drive the rotatable member.

14. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction drive portion on the rotatable member, a plurality of motors each carrying on its shaft a friction drive portion adapted to cooperate with the friction drive portion on the rotatable member, means including yieldable supporting means for mounting each motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, said drive portions being so arranged that the drive portions on the motor shafts will bear toward or away from the axis of rotation of the rotatable member, and means to energize said motors at the same time, said motors being well spaced but asymmetrically disposed with respect to said rotatable member.

15. Apparatus for recording sound, comprising means to rotate a record blank, a stylus carrier, means driven from said rotating means to move said stylus carrier transversely of a record blank during the rotation thereof by said rotating means, and a driving connection between said

rotating means and said stylus carrier adapted for adjustment to enable the speed of transverse movement of the stylus carrier to be varied.

16. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction drive unit removably mounted on said rotatable member and providing an annular resilient friction drive portion, a motor carrying a cooperating friction drive portion on its shaft, means for mounting said motor, and means including said mounting means to cause the friction drive portion on the motor shaft to be pressed in driving engagement with said annular drive portion.

17. Apparatus for recording sound comprising a rotatable member, an annular friction drive unit removably mounted on said rotatable member and comprising a rigid annulus and a resilient annular friction drive portion, a plurality of motors each carrying on its shaft a friction drive portion adapted to cooperate with the friction drive portion on the rotatable member, means including yieldable supporting means for mounting each motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, said drive portions being so arranged that the direction of driving engagement will be radial to the axis of rotation of the rotatable member.

18. A friction drive unit adapted to be removably mounted on a rotatable member and comprising a metallic annulus having a layer of soft rubber on one side thereof and secured thereto by an intermediate layer of hard rubber adherent to both the metal and the soft rubber.

19. A friction drive unit comprising a metallic annulus adapted to be removably fitted upon a cylindrical surface of a rotatable member, a layer of hard rubber vulcanized on said metallic annulus and a layer of soft rubber vulcanized on said layer of hard rubber and providing a yieldable engageable surface, said unit being formed with means providing a driving connection with the rotatable member.

20. The method of forming friction drive units which comprises vulcanizing rubber on a metal cylinder to provide a layer of hard rubber thereon, vulcanizing rubber on the hard rubber layer to provide a surface layer of soft rubber thereon, smoothing the surface of the soft rubber layer, and dividing the cylinder transversely into annular driving units.

21. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction-drive portion on the rotatable member, a motor carrying a cooperating friction-drive portion on its shaft, and means including yieldable supporting means for mounting said motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, at least one of said drive portions having an elongated driving surface which is parallel to its axis of rotation.

22. Apparatus for the recording or reproduction of sound comprising a rotatable member, an annular friction-drive portion on the rotatable member, a motor carrying a cooperating friction-drive portion on its shaft, and means including yieldable supporting means for mounting said motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement

with said annular drive portion, the axes of said drive portions, when the same are in engagement, being substantially parallel.

23. Apparatus for the recording or reproduction of sound comprising a base, a rotatable member mounted on said base, an annular friction-drive portion on the rotatable member, a motor carrying a cooperating friction-drive portion on its shaft, a housing for said motor, means including yieldable supporting means for mounting said motor off-center at such a point that the weight of the motor will cause it to tilt to press the drive portion on its shaft in driving engagement with said annular drive portion, and means to control the pressure of said drive portions against each other, said means comprising a lip on said motor housing and an adjustable element mounted in said base and engaging said lip.

24. Apparatus for the recording or reproduction

of sound comprising a rotatable member and a plurality of motors each carrying a drive portion adapted to engage said rotatable member to drive the same, means for urging said drive portions into engagement with said rotatable member, and means for holding the drive portion of any one of said plurality of motors out of engagement with said rotatable member.

25. Apparatus for the recording or reproduction of sound comprising a rotatable member, a laminated annular friction-drive unit mounted on said rotatable member and providing an annular resilient friction-drive portion, and a motor, carrying a cooperating friction-drive portion on its shaft, mounted for causing frictional driving engagement of said friction-drive portions.

MAURICE A. LICHTEN.