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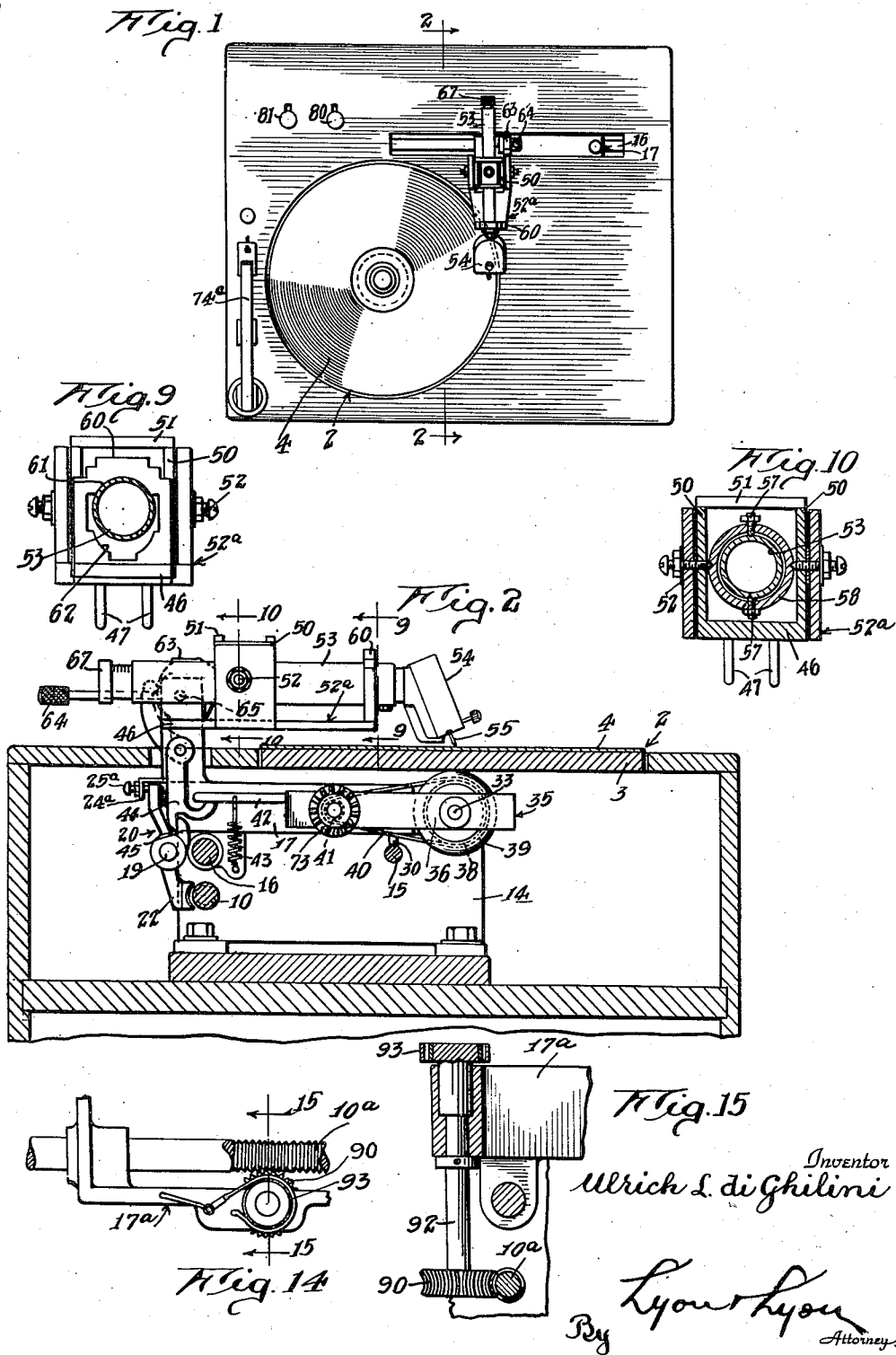
U. L. DI GHILINI

2,446,324

RECORDING AND REPRODUCING APPARATUS

Filed May 26, 1943

4 Sheets-Sheet 1



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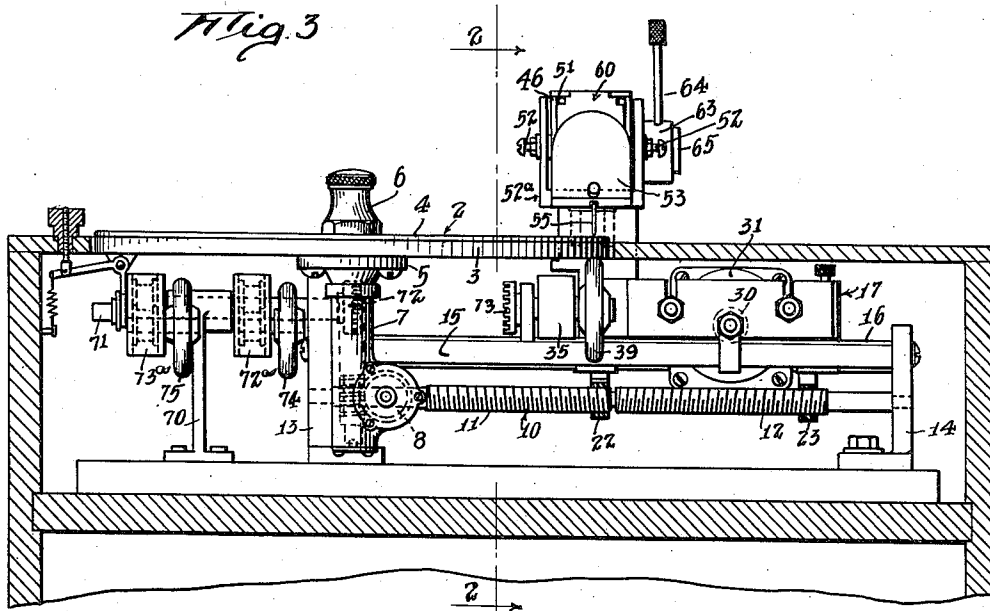
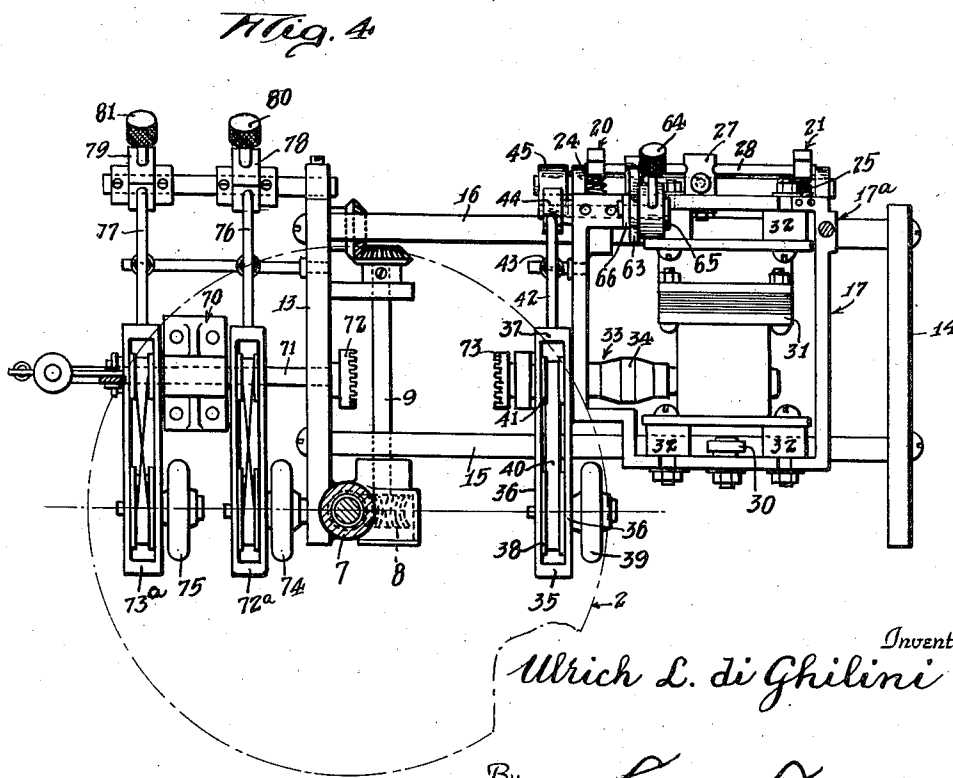
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4 Sheets-Sheet 2



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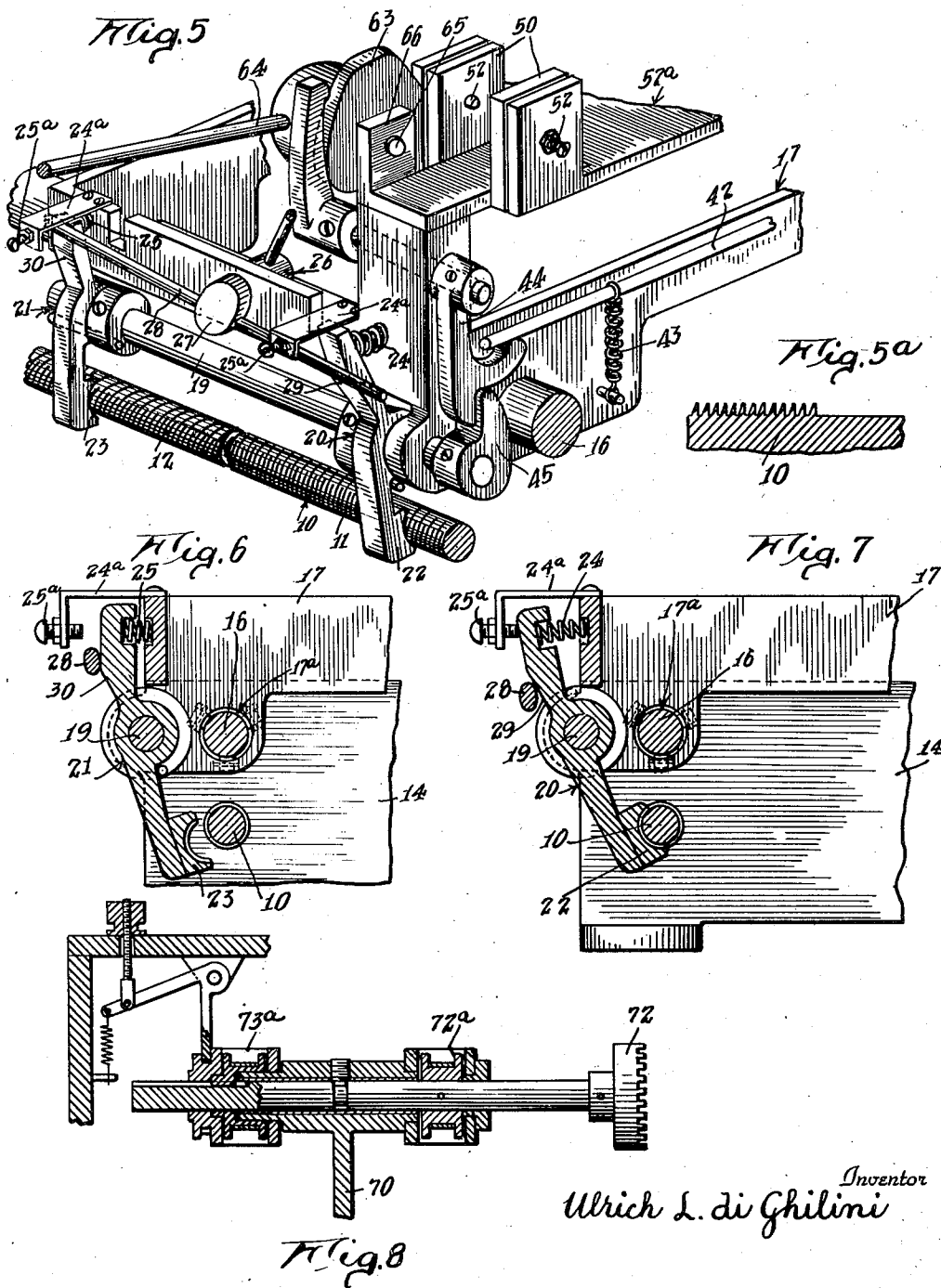
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4 Sheets-Sheet 3



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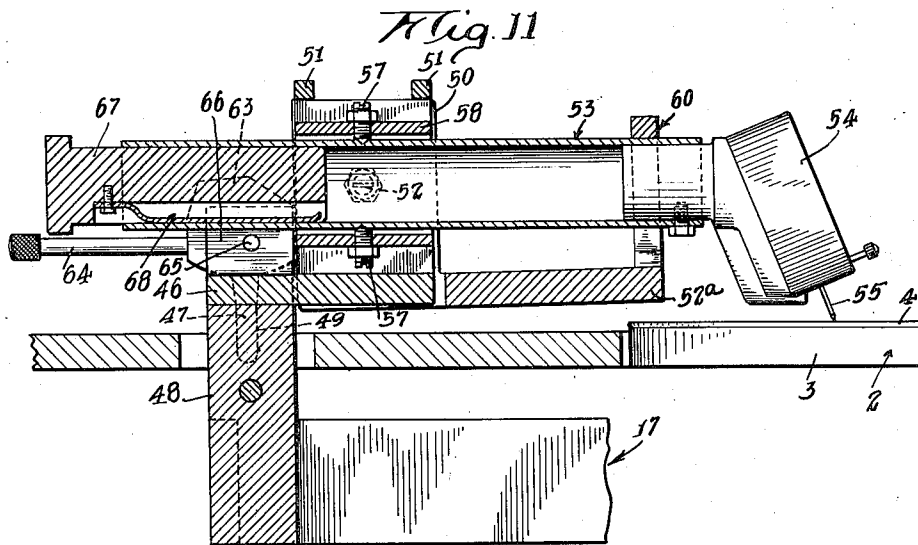
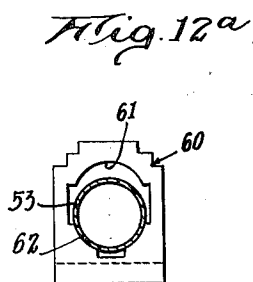
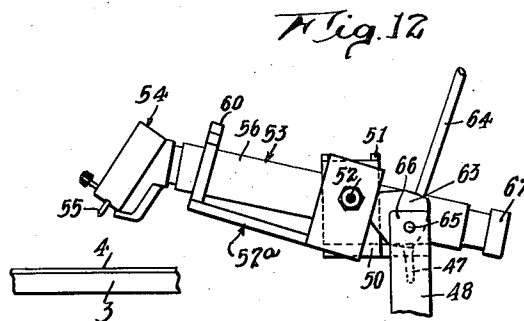
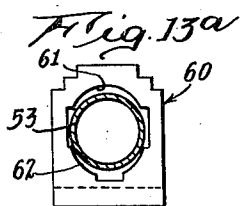
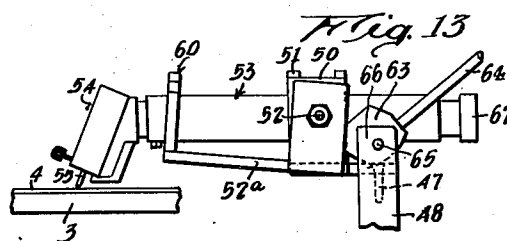
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RECORDING AND REPRODUCING APPARATUS

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4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE

2,446,324

RECORDING AND REPRODUCING
APPARATUS

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1 Claim. (Cl. 274—13)

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This invention relates to a sound recording and reproducing machine or apparatus which is particularly directed to sound recording and reproducing of sound by the principle of "constant groove speed"; this is obtainable on any flat or semi-flat standard recording disc or other disc of suitable composition, such as Celluloid, wax, certain plastics, and certain metals.

Constant groove speed recording of sound in this instance is meant to be the embossing or cutting of a like length of sound groove lineage per second on any or all positions of the recording disc, regardless of the changing diameter of same at the point of recording. Constant groove speed reproduction of sound utilizes the same sound groove lineage per second as it took for the recording of same.

Both recording and reproducing of sound as described above is accomplished in part by a constantly changing speed of the turntable on which the disc rotates. This compensates for the changing diameter of the disc at the point of recording or reproducing.

The general object of the present invention is to provide a constant groove speed recording and reproducing apparatus capable of greatly increasing the amount of recording time obtainable on a similar size disc used on standard recording machines of the 78 R. P. M. and 33 R. P. M. type, with a higher fidelity and more freedom from disc surface noises without need of so-called "tone-compensation" required in the amplification systems used in conjunction with orthodox machines.

The apparatus of the present invention is especially designed to obtain a fluency or smoothness of operation and freedom from mechanical and motor noises. By means of the present invention, the recording speed is reduced considerably below the recording speeds heretofore employed in recording apparatus, with the result that the length of time during which recording may be carried out on a given size disc is markedly increased over that of usual practice. By decreasing the recording speed, i. e., the speed in sound groove lineage per second passing the recording stylus or reproduction needle point, the surface noises from the recording disc may be decreased.

I have discovered several important mechanical construction principles which determine the fluency and smoothness of operation of a recording apparatus, and have incorporated mechanical means in the apparatus consistent with these principles so as to produce a recording and reproducing apparatus of an improved type. The first of these principles is that the mechanical construction of the apparatus should be as free as possible from inherent friction. The recording apparatus must be simple in construction,

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relatively free of friction, and capable of being operated by a motor having a low horsepower. Where the mechanical design is maintained simple, free of friction, and operated by a low horsepower motor, better fidelity of recording can be effected than is the case where more complicated apparatus having a higher inherent friction and driven by a heavier motor is employed. Where more complicated apparatus having higher friction and using a heavy motor is employed, higher recording speeds are necessary in order to secure fidelity in recording, with the result that increased surface noises are obtained from the recording disc.

Of primary consideration in the construction of the apparatus is the problem of torque. The torque in a recording apparatus increases the friction to be overcome, decreases the smoothness of operation, creates distortion in the recording, tends to produce overlapping of the sound tracks in recording, increases surface noise, and increases the tendency of the apparatus in reproducing to fail to follow properly the sound track. The torque in the mechanical construction of a constant groove speed recording apparatus arises mainly from faulty design of the drive for the carriage of the apparatus.

In the apparatus of the present invention, the lead screw is positioned relative to the support for the tone arm on the carriage so as to greatly reduce the torque on the carriage; also the distance between the lead screw and the motor carriage carrying the tone arm is reduced as much as possible.

Other factors in the apparatus of the present invention which tend to improve the fluency and smoothness of operation are that the drive from the motor operates only the turntable directly, the power for moving the carriage being taken from the turntable rather than directly from the carriage. Furthermore, a turntable light in weight is employed.

Another object of the present invention is to provide a sound recording and reproducing apparatus which is capable of being operated to record either from the inside to the outside of the disc, or vice versa if desired.

Another object of the invention is to provide a sound recording and reproducing apparatus in which a single recording head is employed for both the purposes of recording and playing back the recording, which single recording head is provided with a simple mechanically actuated means for properly varying the weight on the recording head for these different purposes.

In the apparatus of the present invention, provision is made for mechanically varying the weight on the recording head in order to provide for the best possible conditions of operation for all types of recording disc. Means also are provided by

which the recording head may be locked in position during recording so that it is capable of movement relative to the carriage only in a vertical plane and also for releasing the recording head during play-back operations so as to be capable of a limited horizontal movement relative to the carriage.

The sound recording and reproducing apparatus of the present invention, together with various further objects and advantages of the invention, will be fully understood from the following description of the preferred form of the apparatus. The following description is given in connection with the accompanying drawings, in which

Figure 1 is a top plan view.

Figure 2 is a section on the line 2—2 of Figure 1.

Figure 3 is a side elevation with certain walls of the housing in section.

Figure 4 is a plan view with the top wall of the housing and with the turntable and recording head removed.

Figure 5 is a fragmentary perspective view showing certain of the control mechanism.

Figure 5a is an enlargement of the buttress thread of the lead screw.

Figure 6 is a fragmentary section of the feed mechanism in the released position.

Figure 7 is a similar view in the engaged position.

Figure 8 is a fragmentary section of the control mechanism for the attachments for playing standard records.

Figure 9 is a section through the recording arm on the line 9—9 of Figure 2.

Figure 10 is a section on the line 10—10 of Figure 2.

Figure 11 is a fragmentary section, mainly through the recording arm.

Figure 12 is a side view of the recording arm in the elevated position.

Figure 12a shows the position of the yoke relative to the tube of the recording arm in the elevated position of Figure 12.

Figure 13 is a similar view in the play-back position.

Figure 13a shows the relative positions of the tube and yoke of the recording arm in the play-back position of Figure 13.

Figure 14 is a fragmentary view of a modified form of engagement between the carriage and lead screw.

Figure 15 is a section on the line 15—15 of Figure 14.

Referring to the drawings, the apparatus comprises a turntable 2, which may be of any usual or preferred construction, and preferably is light in weight to insure reduction in friction of the apparatus. The turntable 2 may comprise a disc portion 3 for the support of a record 4 and a stem. The stem is provided with a flange 5 by means of which it is bolted to the disc portion 3. The stem extends through the disc portion 2 and is there threaded to receive a nut 6 for clamping the record 4 in position. The stem extends downwardly into a housing 7 and is provided within the housing with a worm for cooperating with a worm wheel 8 on a shaft 9.

The shaft 9 extends substantially radially from the axis of the turntable and is geared to a lead screw 10. The form and position of the lead screw constitutes an important element of the apparatus of the present invention. The lead screw 10 has a horizontal axis which is spaced

from the axis of the turntable 2 at a distance slightly beyond the radius of the turntable 2 or any disc record to be employed thereon. The lead screw 10 has two threaded portions 11 and

12. The threaded portions 11 and 12 are pitched in opposite directions to provide for driving of the carriage (hereinafter described) in opposite directions with respect to the turntable from the same direction of rotation of the lead screw.

The spacing of the lead screw 10 with reference to the axis of the turntable serves the further function of permitting a reduction in torque and reduction of friction in the operation of the apparatus by allowing the carriage to be driven from a lead screw located substantially in the same horizontal plane as the point of support of the recording arm, as will be hereinafter more apparent.

The apparatus includes the side plates 13 and 14, which mount two supporting rods or tracks 15 and 16 for the carriage 17. The carriage 17 consists of a rectangular frame pivoted, as indicated at 17a, to the rear supporting rod or track 16. The rear supporting rod 16 is mounted directly over the lead screw 10 and parallel therewith, and the distance between the lead screw 10 and rod 16 should be made small, if possible, in order to reduce the torque arm connecting the carriage with the lead screw.

The double clutch includes two pivotal feed members 20 and 21, each of which is pivoted to shaft 19 and is provided with threaded lead shoes 22 and 23 for engagement with the lead screw 10; the shoe 22 being intended for forming a driving engagement with the threads 11 of the lead screw, whereas the shoe 23 is intended for forming a driving engagement with the threads of the lead screw 12. Springs 24 and 25 are provided between the frame and the lead shoes for normally urging such members into driving connection with the threaded portions of the lead screw.

There is also provided a stop or regulator 24a having an adjustment screw 25a engaging the feed members for the purpose of governing the depth that the lead shoe enters the lead screw. I have found that a substantial reduction in friction in operation of the apparatus is obtained by preventing the lead shoe from setting too tightly into the lead screw.

Referring to Figures 14 and 15 of the drawings, I have shown a modification of the feeding mechanism for the carriage, in which the lead screw 10a is permanently in engagement with a gear 90. The gear 90 is loosely journaled on the rod 92 supported by the carriage 17a. In order to regulate the feeding of the carriage, I provide a brake 93 connecting the gear 90 with the rod 92.

A clutch control means is provided, which comprises the shaft 26 journaled in the rear frame and carrying a sleeve 27 rigid therewith, from which there extends a rod 28, the ends of which rod contact cam faces 29 and 30 on the lead members 20 and 21. When the rod 28 is in a horizontal position, it contacts the lead shoes so as to hold both of the lead shoes 22 and 23 in disengaged position. Rotation of the arm 28 in one direction allows one of the lead shoes to engage the lead screw 10 under the influence of its spring, whereas rotation of the rod 28 in the opposite direction permits the opposite lead shoe to engage the lead screw 10. The clutch mechanism thus provides means by which the carriage may be released from driving position with re-

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spect to the lead screw 10 and provides a means by which the carriage may be connected with the lead screw 10 so as to be driven radially towards the turntable connected to the lead screw 10 so as to be driven radially outwardly from the turntable 10.

The carriage is provided with a roller 30 for supporting the free end of the carriage on the rod 15, the roller 30 being journaled in the frame. The carriage is also provided with an electric motor 31 having a gear reduction box, which is supported in the carriage frame by four rubber bushings 32. The motor 31 is provided with a driving shaft 33 including the rubber flexible connection 34.

To the shaft 33 is pivoted a friction wheel arm 35, which includes two side plates 36 and end spacer members 37. Journaled between the side plates is provided a shaft carrying a pulley 38 and a friction wheel 39. Pulley 38 is connected by a belt drive 40 to a pulley 41 on the shaft 33. The friction wheel 39 is supported in position beneath the turntable 2, so that when the friction wheel arm is pivoted upwardly the friction wheel engages the underside of the turntable 2 at a point lying on a line passing through the axis of the turntable and lying parallel to the direction of transmission of the carriage 17. In normal recording and reproducing operations with the apparatus of the present invention, the turntable 2 is rotated by the friction wheel 39, which in turn is driven by the motor 31. The rotation of the turntable 2 in turn effects rotation through the worms 8, shaft 9 to the lead screw 10. An engagement between the lead screw 10 in one of the lead shoes 22 and 23 connects the carriage so that it is moved radially with respect to the turntable in operation. The radial movement of the carriage in turn alters the position of contact between the friction wheel 39 and turntable 2, so that in operation the speed of rotation of the turntable undergoes constant change as the friction wheel moves with respect to the axis of the turntable, the normal recording and reproduction thus being carried out with constant linear recording and reproducing speed.

The friction wheel arm 35 is provided with a rod 42, which is connected to a spring 43, tensioned to normally pivot the friction wheel arm 35 into position to bring the friction wheel 39 into contact with the turntable 2. A release control lever is provided including an operating member 44, which is attached to a cam 45 rigidly attached to the shaft 19 of the clutch control means. The cam 45 is shaped so that when the operating member 44 is rotated upwardly, as viewed in Figure 5, the cam engages the rod 42 on the friction wheel arm 35, depressing the friction wheel from driving contact with the turntable 2. This action simultaneously rotates the shaft 19 of the clutch means to insure release of both driving lead shoes 22 and 23 from the lead screw 10. In this position of operation, the friction wheel is disconnected from the turntable, the carriage is released from the lead screw and moved to any desired starting position.

The apparatus also includes a recording and reproducing assembly, including a mounting plate 46 which is provided with two vertical mounting pins, by means of which the same is adapted to be detachably supported on a block 48 having bores 49 to receive the mounting pins 47. This block 48 is positioned on the carriage so as to lie at a point substantially vertically above the lead screw. The vertical alignment between the point of sup-

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port of the recording mechanism on the carriage and the supporting bar 16 of the carriage and the lead screw 10 for the carriage are of importance to the production of an apparatus capable of accurate recording at low speeds of operation with a minimum of friction and with a minimum of distortion from torque interference.

The mounting plate 46 is provided with two upright plates 50 and cross-members 51, which carry pintles 52, to which is pivotally supported a control arm 52a. There is also provided a universally mounted recording head arm 53 carrying at its end the electric recording or reproducing head 54 having the usual recording or reproducing stylus 55. The recording head arm 53 includes the main tube 56 pivoted to the ends of pins 57 carried by the short sleeve 58. The short sleeve 58 in turn is pivotally mounted by the ends of the pintles 52, thus providing for at least a limited universal movement of the recording head arm 53. This universal type of mounting has been found to constitute an important element in the design of apparatus for faithful reproduction of recordings made at low recording speed.

The control arm 52a is intended for weighting the recording arm 53 during recording operations. It is well understood in the art that more pressure is required on the stylus 55 during the recording operations than is desirable in the reproducing operations. Furthermore, in the recording operations, it is essential that the recording arm 53 be rigidly connected to the carriage, whereas in reproducing operations it is desirable that the weight on the recording stylus be reduced and at the same time the recording arm be loosely mounted on the carriage, so that its position is capable of being governed by the grooves of the record being reproduced. To permit the same recording assembly to fulfill these different conditions, the control arm 52a is provided. This control arm 52a has the yoke 60 straddling the arm 53. The yoke 60 has a curved portion 61 adapted to closely fit the arm 53 when the weighting of the control arm 52a is allowed to be superimposed upon the recording arm 53. The control arm 52a is rigidly supported (as far as horizontal movement is concerned) from the carriage 17, and, thereby when its weight is imposed upon the arm 53, it in turn locks such arm 53 rigidly with respect to the carriage. The yoke 60 of the control arm is provided with an opening of sufficient size so that in one pivoted position of the control arm the recording arm 53 may assume the position shown in Figure 13a, where clearance is provided between the recording arm 53 and the yoke. In this position of operation, neither the weight of the control arm 52a is imposed upon the recording stylus, nor is the motion of the control arm 53 in any way restrained by the yoke 60; on the contrary, the control arm is free to be controlled by the recorded grooves on a record in reproducing operations. The bottom of the opening of the yoke is provided with a curved surface 62 for engagement with the arm 53, as shown in Figure 12a, when it is desired to elevate the recording arm from contact with the record in carriage-shifting operations.

For controlling and holding the control arm 52a in its various intended operating positions, there is provided, as indicated in Figures 12 and 13, a cam 63 having a control handle 64, which cam 63 is mounted on a pin 65 carried by an ear 66 on the mounting block 48 of the carriage. Figure 12 of the drawings indicates how the rotation of the cam 63 by engagement with the con-

trol arm 52a elevates the control arm, and thereby the recording arm 53 into a disengaging position. Figure 13 illustrates how in the second position of the cam 63 the control arm 52a is lowered to permit engagement of the stylus 55 with the record in reproducing operations while holding the weight of the control arm 52a of the arm 53. By further clockwise pivoting of the cam 63 to the third position, the weight of the control arm 52a is superimposed upon the arm 53 and the apparatus positioned for recording operations.

In order to adapt the recording assembly to the best conditions of operation for records of different types, I provide an adjustable counterbalancing weight 67 slidable into the end of the tube 53 and frictionally held in any adjusted position by the spring 68. I have discovered that for the best reproduction from different records, the weight of the reproducing arm requires adjustment. The composition of the material used in different records varies. Moreover, reproduction from different recordings on the same type of record may also render it desirable to vary the reproduction pressure. By the adjustable counterbalancing weight 67, I have been able to find it possible to considerably improve the reproduction in practice. I have also found in numerous cases, for reasons not fully understood, that the adjustable counterbalance 67 may be used as a tone control adjustment, the amount of weight imposed on the stylus during reproducing operations varying the pitch of the reproducing operations.

In order to adapt the apparatus for reproduction of standard records produced by constant rotary speed in recording, I provide two supplemental drives for the turntable 2. These two supplemental drives are indicated for the reason that there are two rotary turntable speeds commonly used in recording records. As indicated more particularly in Figures 3 and 4 of the drawings, to the left of the turntable axis there is mounted a stationary support 70 supporting a shaft 71. The shaft 71 is provided with a gear 72 adapted to be engaged by a gear 73 on the shaft 33 of the carriage 17. When it is desired to use the apparatus of the present invention for reproducing records made by the constant rotary speed method, the carriage 17 is disengaged from the lead screw 10 and shifted to the left into position to engage gears 72 and 73. The friction wheel 39 carried by the carriage is disengaged from the turntable and at the same time the recording head assembly removed. A supplemental reproducing arm 74a is indicated in Figure 1 for such operations. In these operations the record is driven by one of two friction wheels 74 and 75. The friction wheels 74 and 75 are carried respectively by the two friction wheel arms 72a and 73a pivoted on shaft 71. These two friction wheels 74 and 75 are spaced radially from the axis of the turntable a proper distance to give two selective constant rotary speeds to the turntable upon operation of the motor 31. These friction wheel arms carry the friction wheels 74 and 75 and are provided with rods 76 and 77, by means of which the friction wheels may be pivoted into and out of engagement with the turntable by cams 78 and 79, controlled by operating members 80 and 81.

The recording and reproducing machine thus described possesses many advantages over those heretofore employed. The machine of the present invention may be constructed to operate satisfactorily at a much slower recording speed than

any other constant groove speed disc recording machine hitherto commercially sold. For example, with the apparatus of the present invention, recording of voice and music may be carried out at recording speeds of 2.5 inches per second; whereas the minimum recording speed heretofore employed was about 3.85 inches per second for voice and about 8 inches per second for the purpose of recording music. The standard 78 R. P. M. recording machines employ a recording speed of approximately 47 inches per second on the outside of the disc and 13 inches per second on the inside of the disc.

Furthermore, the standard recording apparatus is extremely heavy and impractical for home use. With the apparatus of the present invention, I may record both voice and music over a period of approximately 3½ hours on a 16 inch disc, and this recording time may be increased if voice alone is to be recorded. The standard 78 R. P. M. recording machine records only for about 3.5 minutes on a 12 inch disc, whereas the 33 R. P. M. recording apparatus records for approximately 15 minutes using the 16 inch disc.

While the particular form of apparatus herein described is well adapted to carry out the objects of the present invention, various modifications and changes may be made coming within the scope of the appended claim.

I claim:

In an apparatus for recording and reproducing sound by the constant groove method, the combination with a carriage, a stylus arm supported by said carriage, and a motor-driven friction wheel mounted on said carriage for driving said turntable, of a feed screw driven by said turntable and having two separate oppositely pitched screw portions, and selective means for connecting said carriage selectively with the different portions of said feed screw including a separate half nut carrying arm engageable with each of said feed portions, said arms each being provided with spring means normally urging the same into the engaging position, and cam-actuated control means therefor simultaneously engaging both of said arms and operative in positions to maintain either or both of such arms in the released position.

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