Nov. 11, 1941. M. M. GRUBER 2,262,732

SOUND RECORDING APPARATUS

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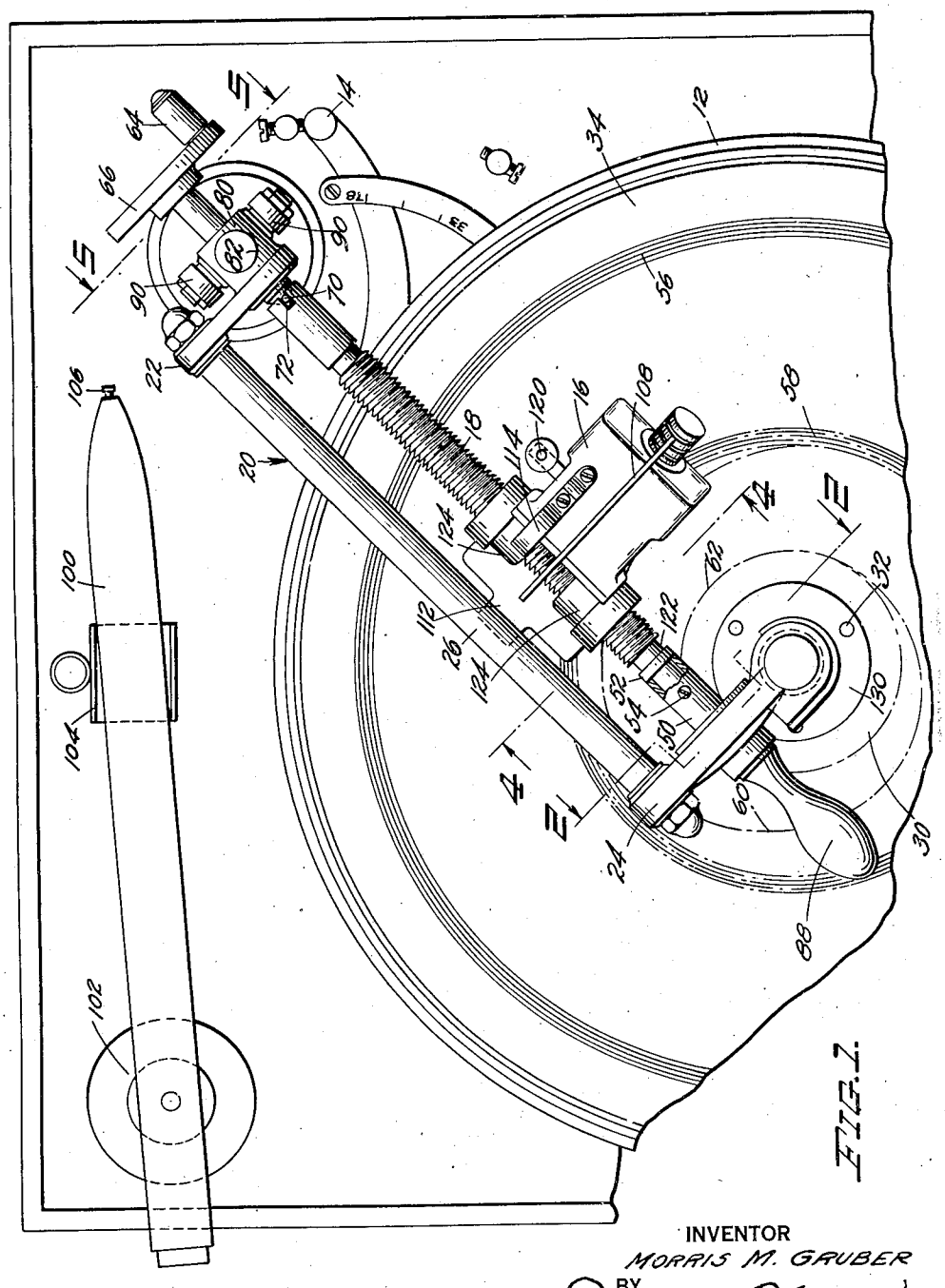


FIG. 1.

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FIG. 2.

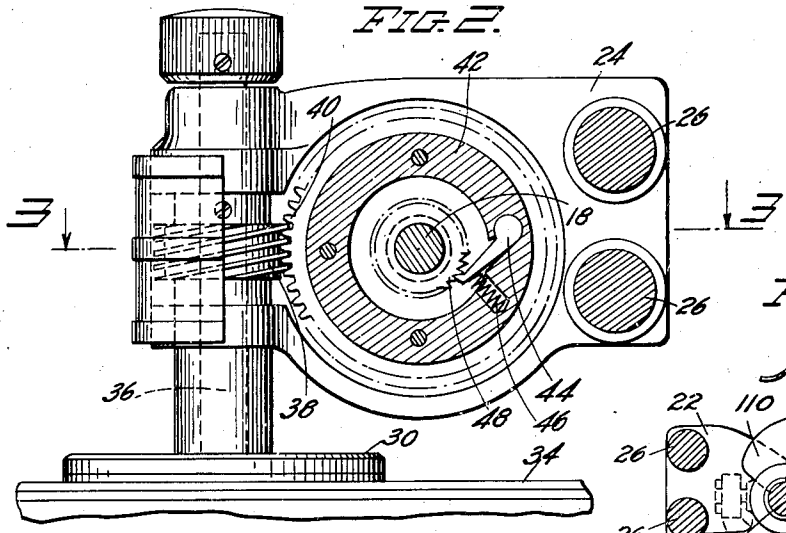


FIG. 4.

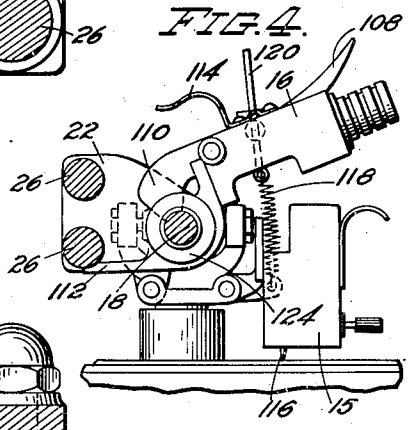


FIG. 3

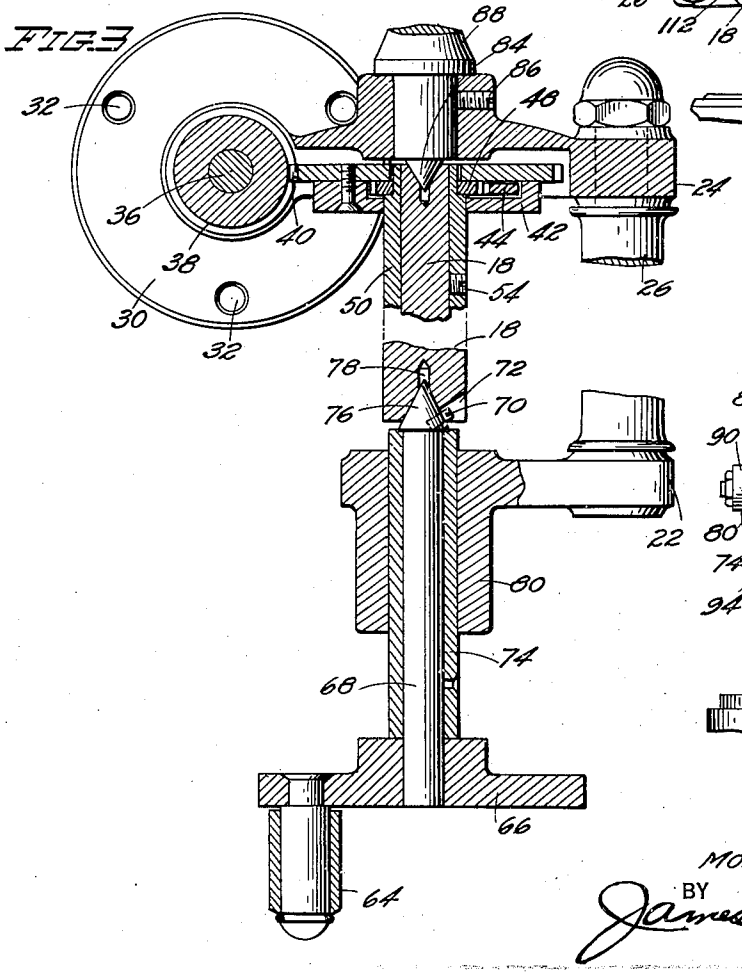
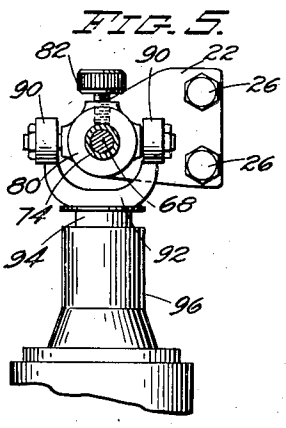


FIG. 5.



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FIG. 6.

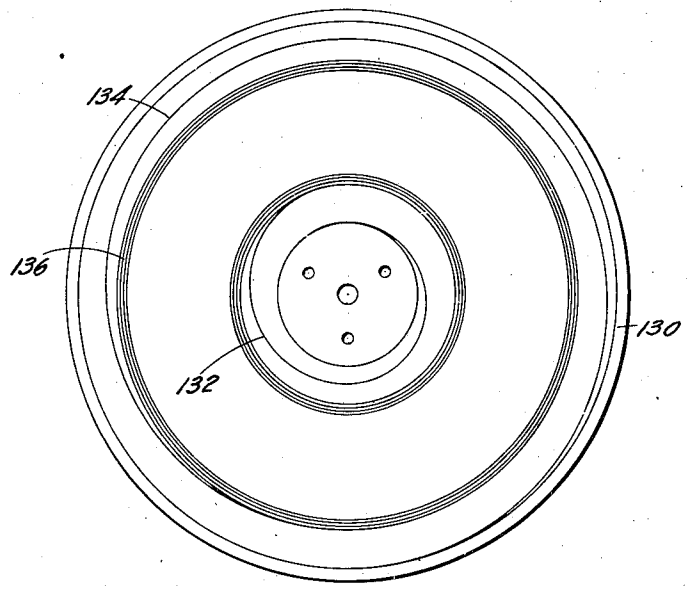
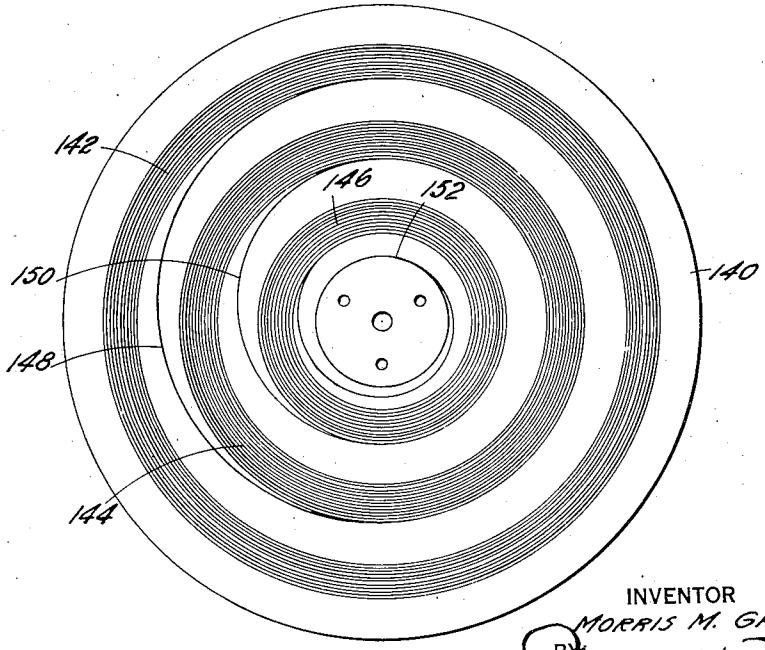


FIG. 7.



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UNITED STATES PATENT OFFICE

2,262,732

SOUND RECORDING APPARATUS

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Application December 17, 1938, Serial No. 246,305

17 Claims. (Cl. 274—13)

This invention relates to sound recording apparatus, and more particularly to the provision in such apparatus of mechanism for producing a terminal or finishing track, or any high pitch spiral groove.

The primary object of my invention is to generally improve sound recording apparatus, and more especially, sound recording apparatus of the so-called "instantaneous play-back" type.

Machines which record sound on disc records for instantaneous play-back are already known. The records may be made of metal, but the better and more popular type of record now in use is the so-called acetate disc. The sound track cut on such a disc is exceedingly fine, and a large number of lines may be recorded per inch, thus making possible long-playing records.

The pick-up and pick-up arm used with such records is light in weight and freely oscillatable. A pick-up arm for play-back is commonly provided directly on the recording apparatus. When the play-back is finished and while the pick-up needle is running in one of the few extra grooves commonly provided at the end of the recording, the pick-up arm is lifted from the record and replaced on its support.

Difficulty arises if the operator is not attentive or is busy with other matters, so that the pick-up is not lifted promptly from the record. When the needle reaches the end of the track, it usually swings rapidly inwardly and then strikes the driving pins near the center of the record, whereupon it rebounds outwardly and may cross the sound grooves at the inner part of the record, thereby spoiling a part of the record. To overcome this difficulty, a special finishing track may be provided at the end of the record. This is preferably an extra-deep circular track concentrically related to the record. It is convenient to make this track of uniform small diameter on all records, and to use a spiral run-out groove of very large pitch which moves the reproducing stylus rapidly but safely inwardly from the end of the recording to the extra-deep circular groove at the center of the record.

The records produced on the recording apparatus may be played back on ordinary phonographs. These are commonly equipped with automatic stopping mechanism which is tripped in response to a rapid inward movement of the pick-up arm or by movement of the pick-up arm to a position corresponding to minimum record groove diameter. The special run-out groove which is provided on the disc by my invention is ideally suited to promptly and positively trip such automatic stopping mechanisms.

In instantaneous recording apparatus the lead screw is often appropriately mounted for ready removal and replacement, thus making it conveniently possible to change the pitch of the sound track, and the direction of recording. By direction I mean whether the disc is cut from the outside in, or from the inside out, the latter procedure being preferred by many. The better grade machines are frequently supplied with a series of lead screws of different pitch and direction. The object of my invention is to provide spiralling mechanism of the character already outlined, which mechanism further affords ready removal and replacement of the lead screw.

I am aware, of course, that standard commercially manufactured records which are pressed from a master plate have been provided with run-out grooves. However, the recording machines used in that field are not provided with multiple and readily interchangeable lead screws.

Further objects are to provide spiralling mechanism which is simple and inexpensive; which may be manually operated at any point on the record; which may therefore be used not only to provide a spiral run-out groove, but also a spiral starting groove and spiral connecting grooves between short recordings, as for spot announcements, sound effects, etc.; and which may also be used to increase the sound track spacing or pitch at a particular point in a record where the sound being recorded is of unusually great amplitude.

To the accomplishment of the foregoing and such other objects as may hereinafter appear, my invention consists in the recording and spiralling elements and their relation one to the other, as hereinafter are more particularly described in the specification and sought to be defined in the claims.

The specification is accompanied by drawings in which:

Fig. 1 shows the major part of the recording apparatus in plan;

Fig. 2 is a transverse section drawn to enlarged scale and taken in the plane of the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary horizontal section taken in the plane of the line 3—3 of Fig. 2;

Fig. 4 is a transverse section taken in the plane of the line 4—4 of Fig. 1;

Fig. 5 is a transverse section taken in the plane of the line 5—5 of Fig. 1;

Fig. 6 schematically illustrates a record pro-

vided with a spiral starting groove as well as a run-out groove; and

Fig. 7 schematically illustrates a record having a series of short recordings thereon interconnected by spiral run-out grooves.

Referring to the drawings, and more particularly to Fig. 1, the recording apparatus comprises a turntable 12 driven by appropriate mechanism which is not shown in the drawings, except for the starting lever 14. The cutting head 15 (see Fig. 4) is carried by a cutting head carrier 16 (Figs. 1 and 4) which moves along a lead screw 18. Lead screw 18 is rotatable in a carrier arm generally designated 20, said arm comprising end pieces 22 and 24 rigidly connected and properly spaced apart by tie rods 26. In the present case there are two such rods in superposed relation, as is best shown in Figs. 2, 4 and 5.

At its inner end the carrier arm 20 is provided with a driving flange 30 (Figs. 1, 2 and 3). The flange 30 is provided with holes 32 which receive driving studs on the turntable in order to insure synchronous rotation. It will be understood that the turntable carries the conventional centering pin, and that the record disc 34 has a center hole for the centering pin and three additional holes for the driving studs.

Flange 30 is secured at the lower end of an upright shaft 36 (Fig. 2), said shaft carrying a worm 38 which meshes with a worm gear 40. The worm gear drives the lead screw 18.

In accordance with the present invention, this drive, instead of being direct, takes place through a suitable overrunning clutch. Specifically, and referring to Figs. 2 and 3, in the present example of the invention, the worm gear 40 has a housing 42 secured thereto, said housing carrying a pawl 44, which pawl is normally moved inwardly by means of spring 46. Pawl 44 cooperates with a ratchet wheel 48, said wheel being located within housing 42 and being immovably secured to a sleeve 50. The housing 42 and worm gear 40 may turn freely about the sleeve 50. The inner end of lead screw 18 is received in sleeve 50, it being inserted in the sleeve as far as permitted by a collar 52 (see Fig. 1), and it being locked against rotation by suitable means such as the set screw 54. This must not project, for the outside of sleeve 50 acts as a smooth or unthreaded part of the lead screw.

It will be evident from inspection of the drawings that the pawl and ratchet wheel are so faced that the turntable normally drives the lead screw, thus moving the cutting head gradually over the face of the record from the outside toward the inside of the record. This produces the desired sound track, and while the track is a spiral track, I shall in the present description limit the term "spiralling" to the finishing track. Thus, in Fig. 1, the first lines of the sound track are indicated at 56. The recording is not yet completed, and the last few lines to be recorded are indicated in broken lines at 58. When the recording is finished, the cutting head is moved rapidly inward to produce the spiral finishing track 60 which in turn leads directly to an extra-deep circular finishing groove 62. It is manifest that the spiral finishing track 60 may be produced by rotating the lead screw 18 far more rapidly than it is normally driven by the turntable. It will also be understood that the overrunning clutch, or pawl and ratchet mechanism, permits the lead screw to be driven faster than the worm gear.

Appropriate means may be provided to drive the lead screw at the desired increased speed. In the present case, this is done simply by means of a crank. The crank is clearly shown in Figs. 1 and 3, it comprising a handle 64 mounted on a crank disc 66. The disc 66 turns a shaft 68, the inner end of which has means 70 keying the crank shaft to the lead screw 18. In the present case, the means 70 is a pin or screw set into the crank shaft and received in a mating slot 72 cut radially at the end of the lead screw. Crank shaft 68 is preferably rotatably received in a sleeve 74. The shaft is held against axial movement in sleeve 74 by means of the disc 66 at the outer end, and the rear edge of cone bearing 76 at the inner end. Cone bearing 76 is received within a conventional centering hole 78 at the outer end of the lead screw. The sleeve 74 is axially slidable in the bearing 80 forming a part of the end or head 22 of carrier arm 20. Referring to Figs. 1 and 5, it will be seen that bearing 80 is provided with a thumb screw 82, said thumb screw being tightened against the sleeve 74 in order to lock the same in position.

The use of cone bearings is customary in these machines in order to insure accurate centering of the lead screw and to prevent end play. The present arrangement retains cone bearings with their usual advantages. Referring to Fig. 3, the inner end of the lead screw is supported by cone bearing 84 which is held in position by set screw 86. This cone bearing may, if desired, be formed on the handle 88 which is best shown in Fig. 1, and which may be used when swinging the carrier arm 20 away from the turntable.

For this purpose the outer end of the carrier arm is pivotally mounted on horizontal trunnions and on a vertical bearing. Referring to Figs. 1 and 5, it will be seen that bearing 80 is received in horizontal bearings 90 in a bearing yoke 92, the vertical spindle 94 of which is received in a stationary bearing 96. With this arrangement, the inner end of the carrier arm together with the driving flange 30 may be lifted and swung outwardly to a point clear of the turntable. This is done when loading the turntable with a record, and is also done when playing back a record, the carrier arm 20 being swung out of the way of the pick-up arm 100. This pick-up arm is pivoted for vertical and horizontal oscillation on a support pedestal 102. When not in use, it is placed on a rest 104. The free end of the pick-up arm carries a reproducing needle or stylus, said needle being held in position by screw 106. The pick-up may be of any conventional type.

In operation, the record 34 is placed on turntable 12, and carrier arm 20 is then positioned with flange 30 coupled to the turntable. The cutting head carrier 16 may be released from lead screw 18 by depressing the feed lever 108. As is best shown in Fig. 4, when feed lever 108 is depressed, the inner end 110 is elevated and is thereby freed from the lead screw. When the cutting head has been lowered at a suitable starting point near the beginning of the record, the feed lever 108 may be released, thus engaging the carrier 16 with the lead screw. The carrier is, of course, swung downwardly to the position shown in Fig. 4 in order to bring the cutting head into engagement with the record. At this time the arm 112 extending rearwardly from the carrier bears against the smooth, polished surface of the lower tie rod 26. It will be understood that the carrier and cutting head may be swung upwardly and rearwardly until the stop

strap 114 of the carrier rests over the upper tie rod 26, at which time the cutting head is held out of engagement with the record. The cutting pressure exerted by the cutting stylus 116 is controlled by a spring 118, the tension of the spring being adjustable by means of an adjusting screw 120.

After a few revolutions of the turntable, the recording is begun and continues until completed. When completed, the normal feed may be continued for another few revolutions, following which the crank 64 is turned by hand, thereby rapidly feeding the cutting head inwardly to produce the spiral run-out groove 60. Finally, the feed lever 108 reaches the deep cut-away part or groove 122 at the inner end of the lead screw, whereupon continued rotation of the lead screw is without effect. The cutting head remains stationary and produces the extra deep finishing groove 62. The fact that groove 122 on the lead screw is wider than the feed lever 108 is without consequence, for the cutting head moves along the carrier arm 20 with a snug engagement and considerable friction, and ceases movement the moment the propulsion by the lead screw stops. In this respect the heavy cutting head with its associated mechanism is quite different from the extremely light-weight and readily moved pick-up arm. The sleeve 50 is smoothly finished and is of the same diameter as the lead screw, so that it readily receives the inner one of the bearings 124 of the cutting head carrier.

I have so far spoken of the utility of the spiralling mechanism for providing a run-out groove at the end of a record. This mechanism may, however, be used for other purposes. For example, referring to Fig. 6, the record 130 is provided not only with a spiral run-out groove 132, but also with a spiral starting groove 134. This permits the record to be started by simply lowering the pick-up stylus on the marginal portion of the record, without attempting to locate it in the first sound groove. In less than one revolution of the turntable, the stylus reaches the starting groove 134 and is thereby carried rapidly inwardly to the sound grooves 136. The method of making the starting groove 134 will be obvious, the cutting head being started near the edge of the record, and the spiralling crank 64 being turned until the cutting head has been moved inwardly an appreciable distance, whereupon normal feed is begun by simply discontinuing rotation of the crank. In Fig. 6 the grooves intermediate the first and last few grooves have been omitted.

The spiralling mechanism may also be used to provide connecting grooves between short recordings. Thus, referring to Fig. 7, the record 140 is provided with a series of short recordings 142, 144 and 146. These are connected by spiral tracks 148 and 150. The recording 146 may also be provided with spiral run-out track 152. The spiral tracks 148, 150 and 152 may each be used as a run-out and tripping groove. It may be mentioned that the automatic stopping mechanisms provided on most phonographs are so arranged that the stopping point may be adjusted anywhere on the face of the record. The short recordings may, for example, be different sound effects, or they may be spot announcements. In such case, the operator simply adjusts the automatic tripping mechanism for whichever recording is to be used. The spiral track at one side of the recording may be used as a starting groove, and that on the opposite side may be used as a run-out and tripping groove.

It should be understood that while the description has so far assumed that the record is cut and played from the outside in, it may also be cut and played from the inside out. The latter procedure is preferred by many. For this purpose, the lead screw is changed from left-hand as shown, to right-hand. One important advantage of the present simplified spiralling mechanism and the manner in which it interchangeably receives any of a number of lead screws, is that the lead screw may be changed from left-hand to right-hand or vice versa, as well as changed in pitch. On this point, it will be observed that the lead screw is always turned in one direction by the turntable, hence the crank is turned in only one direction regardless of whether the recording is from the outside in or from the inside out. More specifically, the turntable turns clockwise as viewed from above, and the lead screw turns clockwise as viewed from the crank end. In this way the crank is turned in the most natural direction, that is, away from the operator at the top of the arc. The same unidirectionally driven clutch is applicable to either type of lead screw.

One further use for the spiralling mechanism may be mentioned. This is the possibility of somewhat increasing the pitch or spacing of the sound grooves when reaching isolated extra-loud points in an otherwise moderately loud recording. The sound grooves are very closely spaced when making the so-called "long-playing" records which may, for example, cover a period of fifteen minutes. With such records, the groove spacing may be inadequate where the cutting stylus vibration is of particularly great amplitude. It has heretofore been necessary to "cue" the recording with the operator, who would cut down the recording volume at the extra-loud points. This, of course, has the disadvantage that when the recording is reproduced, it does not faithfully reproduce the proportional loudness at those points. When using recording apparatus provided with the present spiralling mechanism, the operator may follow his cues by cranking the lead screw somewhat at the loud points, thereby providing a greatly increased spacing between sound grooves in a record which otherwise has closely spaced sound grooves.

It is believed that the construction as well as the method of operation of my improved spiralling mechanism for sound recording apparatus, and the many advantages thereof, will be apparent from the foregoing detailed description thereof. The operator of the machine preliminarily selects and inserts the proper lead screw, this being changed from time to time depending, for example, upon whether the recording is to be on a ten-inch record at 78 R. P. M. with considerable pitch, or is to be a large-diameter long-playing record at 33⅓ R. P. M. with small pitch. For installations where the lead screw is changed frequently, each lead screw preferably carries its own worm gear and clutch. To remove and replace the lead screw, it is then merely necessary to loosen the thumb screw 82; to then draw back the crank disc 66 and with it the center bearing 76, whereupon the lead screw with its gear and clutch is removed and another inserted. No tools are required, and the change may be made very rapidly. In installations where the lead screw is changed only infrequently, a single gear and clutch may be used, this being transferred from

one lead screw to another by loosening the set screw 54. Even with this arrangement, the change may be made quite rapidly, and requires only a screw driver. However, the gear and clutch assembly is inexpensive, and it is no appreciable burden to provide each lead screw with its own gear and clutch.

It will be apparent that while I have shown and described the invention in a preferred form, many changes and modifications may be made in the structure disclosed, without departing from the spirit of the invention defined in the following claims.

I claim:

1. Recording apparatus comprising a turntable, a cutting head, a lead screw for moving the cutting head over the turntable, said lead screw terminating in a portion of reduced diameter for letting the cutting head remain stationary in order to produce a circular track concentric with the record, means gearing the turntable to the lead screw, said means including an overrunning clutch so faced that the lead screw may be driven faster than it is driven by the turntable, and optionally useable means to turn the lead screw at a comparatively rapid rate following the end of a recording until the cutting head is moved to the reduced diameter portion at the end of the lead screw, whereby the record is provided with a spiral run-out groove leading to a circular track.

2. Instantaneous recording apparatus comprising a turntable, a cutting head, a lead screw for moving the cutting head over the turntable, said lead screw terminating in a portion of reduced diameter for keeping the cutting head stationary in order to produce a comparatively deep circular track concentric with the record, means gearing the turntable to the lead screw, said means including pawl and ratchet mechanism so faced that the lead screw may be driven faster than it is driven by the turntable, and a manually rotatable crank to turn the lead screw at a comparatively rapid rate following the end of a recording until the cutting head is moved to the reduced diameter portion at the end of the lead screw, whereby the record is provided with a spiral run-out groove leading to a circular track.

3. Recording apparatus comprising a turntable, a cutting head, a removable and replaceable lead screw for moving the cutting head over the turntable, said lead screw being selected to produce the desired pitch for the sound track, means gearing the turntable to the lead screw, said means including an overrunning clutch so faced that the lead screw may be driven faster than it would normally be driven by the turntable, said clutch detachably receiving one end of the lead screw, and optionally useable drive means detachably receiving the opposite end of the lead screw for turning the lead screw at a comparatively rapid rate.

4. Instantaneous recording apparatus comprising a turntable, a cutting head, a removable and replaceable lead screw for moving the cutting head over the turntable, said lead screw having a pitch selected to produce the desired number of lines per inch on the record, means gearing the turntable to the lead screw, said means including a pawl and ratchet means so faced that the lead screw may be driven faster than it is driven by the turntable, said means detachably receiving one end of the lead screw, and a manually rotatable crank detachably connected to the opposite end of the lead screw in order to turn the lead screw at a comparatively rapid rate.

5. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging the center of a record carried by the turntable, said carrier arm being pivotally mounted at its outer end so that the arm may be swung away from the turntable, a removable and replaceable lead screw mounted on said carrier arm, a cutting head carried by said lead screw, a worm driven by the aforesaid flange, a worm gear meshing with said worm, overrunning clutch mechanism associated with said worm gear, the overrunning part of the clutch detachably receiving the inner end of the lead screw, the outer end of said carrier arm having a bearing receiving a sleeve, releasable means for locking said sleeve within said bearing, a crank shaft rotatable in but not axially movable in said sleeve, a cone bearing at the inner end of said shaft receiving the outer end of the lead screw, means locking said lead screw rotatively to said crank shaft, and a crank at the outer end of said crank shaft.

6. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging the center of a record carried by the turntable, said carrier arm being pivotally mounted at its outer end so that the arm may be swung away from the turntable, a removable and replaceable lead screw mounted on said carrier arm, a cutting head carried by the carrier arm and moved by said lead screw, a worm driven by the turntable, a worm gear meshing with said worm, overrunning clutch mechanism associated with said worm gear, the overrunning part of the clutch mechanism receiving one end of the lead screw, the outer end of said carrier arm having a crank which is also operatively connected to one end of the lead screw.

7. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging the center of a record carried by the turntable, a removable and replaceable lead screw assembly mounted on said carrier arm, said lead screw assembly including a lead screw, rotatable means removably receiving one end of the lead screw, a worm gear and associated overrunning clutch mechanism mounted on said rotatable means and connecting the worm gear to the lead screw, a worm driven by the aforesaid flange and meshing with said worm gear, a crank at the outer end of said carrier arm, and means detachably connecting said crank to said lead screw.

8. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging the center of a record carried by the turntable, a removable and replaceable lead screw assembly mounted on said carrier arm, said lead screw assembly including a lead screw, rotatable means removably receiving one end of the lead screw, a worm gear and associated overrunning clutch mechanism mounted on said rotatable means and connecting the worm gear to the lead screw, a worm driven by the aforesaid flange and meshing with said worm gear, the outer end of said carrier arm having a crank shaft, a crank at the outer end of said shaft, means at the inner end of said shaft receiving the end of the lead screw, and means whereby said shaft is axially movable to release the lead screw.

9. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging

the center of a record carried by the turntable, a removable and replaceable lead screw assembly mounted on said carrier arm, said lead screw assembly including a lead screw having center holes at its ends, a hub removably secured to one end of the lead screw, a worm gear and associated overrunning clutch mechanism mounted on said hub and connecting the worm gear to the lead screw, a worm driven by the aforesaid flange and meshing with said worm gear, center bearings at the ends of said carrier arm receiving said lead screw assembly, one of said center bearings being axially movable for ready removal and replacement of the lead screw assembly, a crank at the outer end of said carrier arm, and means detachably connecting said crank to said lead screw.

10. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging the center of a record carried by the turntable, said carrier arm being pivotally mounted at its outer end so that the arm may be swung away from the turntable, a removable and replaceable lead screw assembly mounted on said carrier arm, said lead screw assembly including a lead screw having center holes at its ends, a hub removably secured to one end of the lead screw, and a worm gear and associated overrunning clutch mechanism mounted on said hub and connecting the worm gear to the lead screw, a worm driven by the aforesaid flange and meshing with said worm gear, the inner end of said carrier arm having a fixed center bearing to receive the inner end of the lead screw assembly, the outer end of said carrier arm having a crank shaft, the inner end of said crank shaft having a center bearing to receive the outer end of the lead screw assembly, and having means to rotate the lead screw with the crank shaft, a crank at the outer end of said crank shaft, a sleeve surrounding said crank shaft, said crank shaft being rotatable in but not axially movable in said sleeve, and means whereby the said sleeve is axially movable to release the lead screw assembly from the center bearings.

11. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging the center of a record carried by the turntable, a removable and replaceable lead screw mounted on said carrier arm, a worm gear rotatably mounted at the inner end of the carrier arm, overrunning clutch mechanism connecting said worm gear to said lead screw, a worm driven by the aforesaid flange and driving said worm gear, the inner end of said carrier arm having bearing means for the worm gear and lead screw assembly, the outer end of said carrier arm having a crank shaft, means detachably connecting the crank shaft to the lead screw, a crank at the outer end of said shaft, said shaft being axially slidable at the outer end of the carrier arm, and a manually releasable means for locking said shaft in desired axial position.

12. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging the center of a record carried by the turntable, a removable and replaceable lead screw assembly mounted on said carrier arm, said lead screw assembly including a lead screw having center holes at its ends, a worm gear rotatably mounted on one end of said lead screw, overrunning clutch mechanism connecting said worm gear to said lead screw, a worm driven by the aforesaid flange and driving said worm gear, a crank at the outer end of said carrier arm, and cone center bearings at the ends of said carrier arm receiving said lead screw assembly, one of said center bearings being axially movable for ready removal and replacement of the lead screw assembly.

13. Recording apparatus comprising a turntable, a cutting head carrier arm having a rotatable flange at its inner end for engaging the center of a record carried by the turntable, a removable and replaceable lead screw assembly mounted on said carrier arm, said lead screw assembly including a lead screw having center holes at its ends, a worm gear rotatably mounted on one end of the lead screw, overrunning clutch mechanism connecting said worm gear to said lead screw, a worm driven by the aforesaid flange and driving said worm gear, the inner end of said carrier arm having a fixed center bearing, the outer end of said carrier arm having an axially movable center bearing, said center bearing being formed at the inner end of a crank shaft, a crank at the outer end of said shaft, a sleeve surrounding said shaft, said shaft being rotatable in but not axially movable in said sleeve, said sleeve being axially slidable in a bearing at the outer end of the carrier arm, and a manually rotatable thumb screw for locking said sleeve in desired axial position.

14. Recording apparatus comprising a turntable, a carrier arm having means at its inner end for engaging the center of the turntable, said carrier arm being pivotally mounted at its outer end so that the arm may be swung away from the turntable, a removable lead screw mounted on said carrier arm, a cutting head mounted on said carrier arm and arranged to be moved by said lead screw, a worm driven by the turntable, a worm gear meshing with said worm, overrunning clutch mechanism associated with said worm gear, the overrunning part of the clutch mechanism receiving one end of the lead screw, for normal slow speed operation of the lead screw, and a crank operatively connected to the lead screw and adapted by convenient manual operation to turn the lead screw faster than its normal drive speed in order to produce a spiral groove of high pitch when desired.

15. Recording apparatus comprising a turntable, a carrier arm, a removable lead screw mounted on said carrier arm, said lead screw having center holes at its ends, a gear at one end of the lead screw so mounted as to be rotatable relatively thereto, overrunning clutch mechanism connecting said gear to said lead screw, means driven by the turntable for driving said gear, an additional independent drive means coupled to said lead screw for rotating the lead screw faster than its normal speed in order to produce a spiral groove of high pitch when desired, and cone center bearings at the ends of said carrier arm for receiving said lead screw, one of said cone center bearings being axially movable for ready removal of the lead screw.

16. Recording apparatus comprising a turntable, a cutting head, a removable and replaceable lead screw for moving the cutting head over the turntable, said lead screw being selected to produce the desired direction and pitch for the sound track, means gearing the turntable to the lead screw for normal drive of the lead screw, said means including a worm and worm gear with the worm being driven by the turntable and operating to drive the worm gear, an additional optionally-usable drive means detachably receiv-

ing the lead screw and adapted to be operated at higher speed than the normal drive for the lead screw, and slip means in the gearing between the worm gear and the lead screw in order to afford overrunning movement of the lead screw relative to the worm gear, said slip means being adequate to feed the cutting head under drive of the turntable, the additional optionally-usable drive means when operated at higher speed as aforesaid functioning to turn the lead screw much faster than it is normally driven by the turntable in order to produce a spiral groove of high pitch.

17. Recording apparatus comprising a turntable, a cutting head, a removable lead screw arranged to be positioned over the turntable for moving the cutting head thereover, means gearing the turntable to the lead screw for normal slow-speed operation of the lead screw, said means including a worm and worm gear with the worm being driven by the turntable and operating to drive the worm gear, optionally usable rotatable means detachably receiving the lead screw, said rotatable means including a manually operable crank which may be readily and conveniently used for turning the lead screw faster than it is normally driven by the turntable in order to produce a spiral groove of high pitch when desired, slip means in the gearing between the worm gear and the lead screw in order to afford overrunning movement of the lead screw relative to the worm gear, said slip means being adequate to feed the cutting head under drive of the turntable, and end bearings receiving said lead screw, at least one of said end bearings being readily axially movable to facilitate removal of the lead screw.

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