Nov. 19, 1940. M. M. GRUBER ET AL 2,221,970

SOUND RECORDER

Filed April 8, 1938 3 Sheets-Sheet 1

FIG. II.

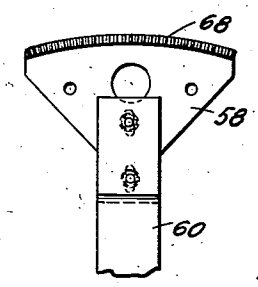

FIG. I.

FIG. 13.

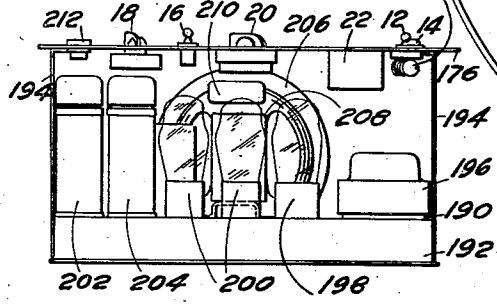

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FIG. 2.

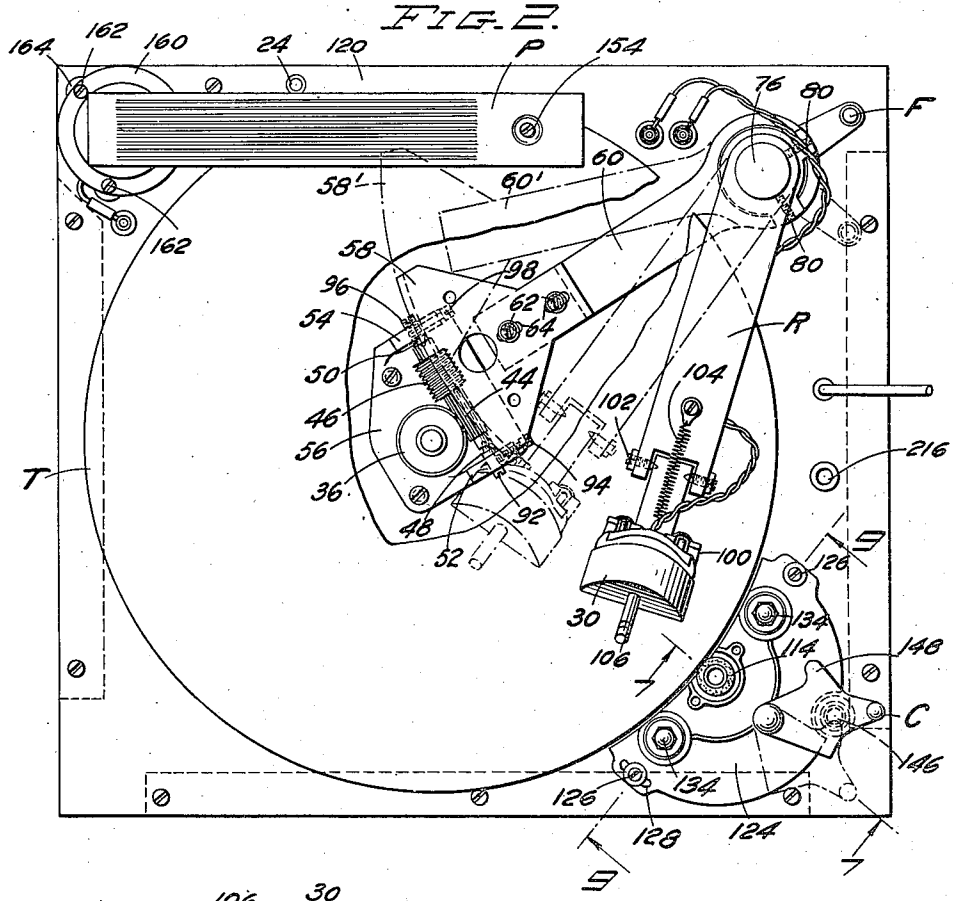

FIG. 3.

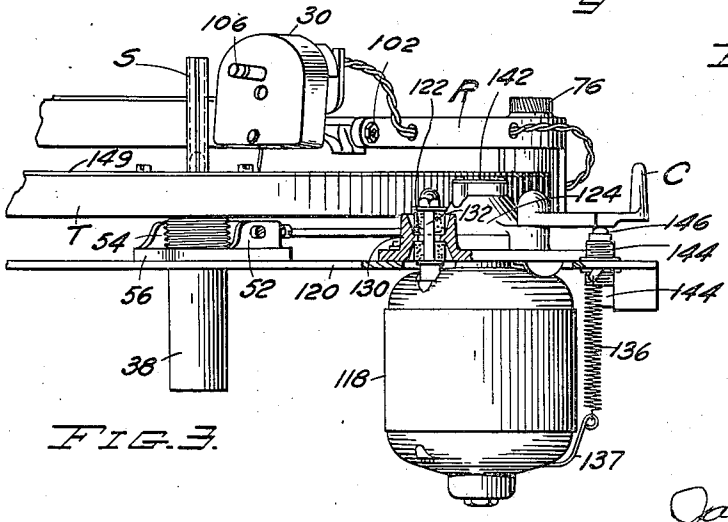

FIG. 4.

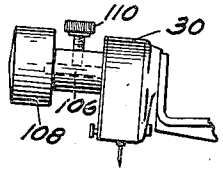

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FIG. 5.

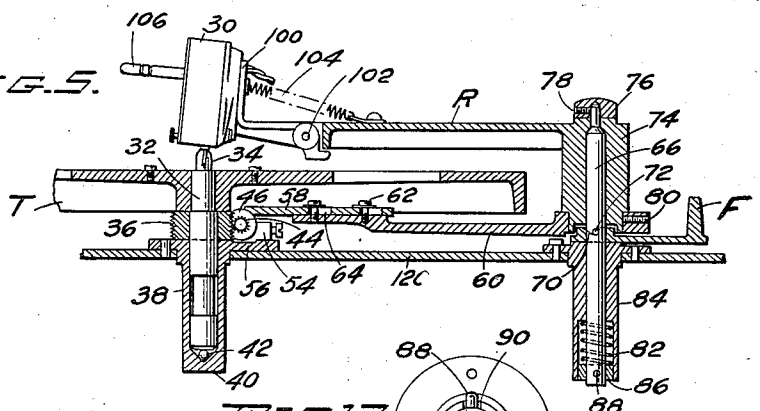


FIG. 12.

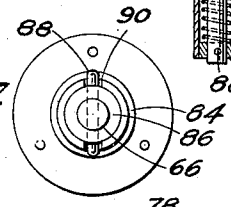


FIG. 6.

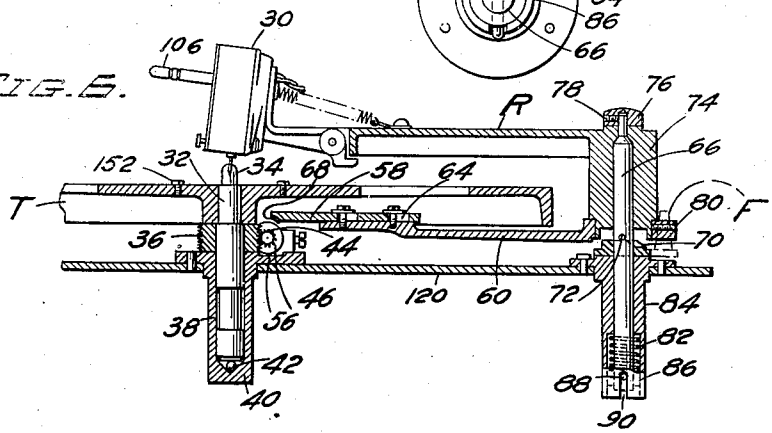


FIG. 7.

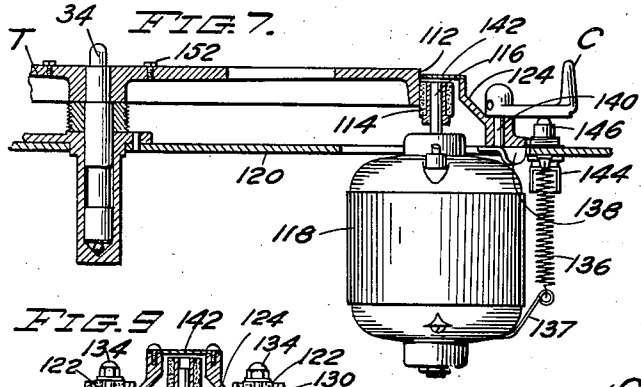


FIG. 8.

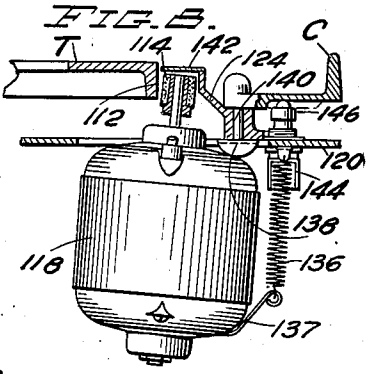


FIG. 9

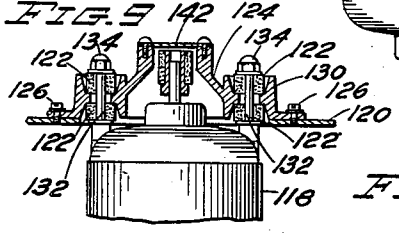
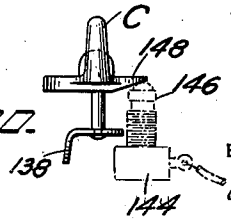


FIG. 10.



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Patented Nov. 19, 1940

2,221,970

UNITED STATES PATENT OFFICE

2,221,970

SOUND RECORDER

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Application April 8, 1938, Serial No. 200,926

11 Claims. (Cl. 274—13)

This invention relates to sound recorders, and more particularly to a compact, portable apparatus for recording and reproducing disc records.

The primary object of the present invention is to generally improve sound recorders of the character specified. More particular objects center about the feed mechanism for feeding the cutting stylus over the surface of the disc being recorded, and are to provide feed mechanism which is comparatively simple, inexpensive, sturdy in construction, and positive in feed; which is readily releasable by the disengagement of parts of the feed gearing so that the cutting head may be moved over the disc to any desired point, thus making it possible to record parts of a disc or to continue a recording which was interrupted part-way through the disc; and which automatically stops feed movement when the useful part of the disc has already been recorded. In accordance with still another object of the invention, the parts of the feed mechanism are all located immediately beneath the turntable and above the plate on which the turntable and associated driving motor are mounted, for this simplifies the necessary feed connections between the turntable and the cutting head. Another and more detailed object of the invention is to provide convenient adjustments for the parts of the feed mechanism to compensate for inaccuracies which may arise in producing the bearings and other parts of the feed mechanism by die-casting methods.

Other objects of the invention center about the control of the driving motor, but this aspect of the invention is not claimed herein, it being claimed in our copending application, Serial No. 243,104, filed November 30, 1938, which is in part a division and in part a continuation of this application.

To the accomplishment of the foregoing, and other more detailed objects, which will hereinafter appear, our invention consists in the recording 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 is a perspective view showing a complete, self-contained, portable recording and reproducing apparatus embodying features of our invention;

Fig. 2 is a plan view of the parts of the apparatus associated with the turntable;

Fig. 3 is a partially sectioned elevation of the same;

Fig. 4 is explanatory of the conversion of the cutting head for use with metal discs;

Fig. 5 is a section taken in elevation through the turntable feed arm and recording arm, with the feed mechanism engaged;

Fig. 6 is a similar view with the feed mechanism disengaged;

Fig. 7 is a section taken in elevation at the driving motor and shows the motor control mechanism in driving position, this section being taken in the plane of the line 7—7 of Fig. 2;

Fig. 8 is a similar section, but with the parts in stopped position;

Fig. 9 is a section taken in the plane of the line 9—9 of Fig. 2, and is explanatory of the mounting for the driving motor;

Fig. 10 is an elevation of the control handle with its associated cams for releasing the motor wheel and controlling the motor switch;

Fig. 11 is a detail of the feed segment;

Fig. 12 is a bottom plan view of the bearing for the recording arm; and

Fig. 13 is a rear elevation of the audio frequency amplifier and loud speaker section of the apparatus.

Referring to the drawings, and more particularly to Fig. 1, the recorder comprises a turntable T, a recording arm R, a shaving collector S, a pick-up arm P, a feed release F, a motor control C, a microphone M, and audio frequency amplifier and loud speaker equipment located generally at the forward end A of the casing for the apparatus. The turntable T is driven by a concealed motor, the said motor being started and stopped and at the same time engaged with or released from the turntable by the control handle C. The recording arm is moved over the surface of the disc D carried by the turntable, by appropriate feed mechanism subsequently described in detail. This feed mechanism is released or made inoperative by oscillation of the handle F, thus permitting the recording arm to be moved freely over the disc D so as to locate the cutting stylus at any desired point on the disc. During the recording operation, a switch 12 is closed, thus energizing the amplifier, as is indicated by lighting of an appropriate pilot light 14, and a change-over switch 16 is thrown to the recording position. There is a volume control 18 and a tone control 20. The volume control 18 may be used to limit the amplitude of the audio frequency wave being impressed on the disc, and for this purpose a meter 22 is provided to indicate the audio frequency amplitude.

After the disc has been recorded, it is merely

necessary to release the feed mechanism at handle F, whereupon the recording arm R may be swung outwardly to a position clear of the turntable. The change-over switch 16 is thrown in opposite direction for phonograph reproduction, and pick-up arm P is lifted from its rest pin 24 and applied to the record. The audio frequency wave, after suitable amplification, is supplied to a loud speaker disposed against the inner side of the end wall 26, and the said wall is cut away as is indicated at 28 to form a grille for sound discharge.

Considering the mechanism in greater detail, and referring now to Figs. 2, 5 and 6 of the drawings, we shall first describe the feed mechanism for feeding the recording arm R and with it the cutting head 30, over the face of the disc. This feed must be properly synchronized with the turntable, and the drive for the feed is therefore preferably taken from the turntable shaft. Briefly, the turntable T turns a worm 36 meshing with a small diameter pinion 44 carrying a larger diameter feed screw 46. This engages the periphery of a toothed segment 58 secured at the end of a feed arm 60, the opposite end of which is connected to the recording arm R so that both oscillate together under the influence of the feed screw 46. The release handle F moves segment 58 out of engagement with the feed screw and thus releases the recording arm from the feed mechanism.

In the present case the turntable T is a die-casting assembled with a force fit onto a turntable shaft 32. The upper end of shaft 32 is shaped and dimensioned to act as a record centering pin 34. Immediately beneath turntable T the shaft 32 carries a worm 36. The shaft then passes into a main bearing 38, the latter being closed at the bottom, as is indicated at 40, and carrying a ball 42 which receives the thrust of the turntable. No leakage of lubricant is possible, and a small amount of lubricant within bearing 38 lasts for many months. This simplified bearing construction is made possible because the drive for the feed mechanism is taken near the top of the shaft above the bearing, and in a sense, from the hub of the turntable itself, although in practice the worm 36 is preferably made as a separate element for convenience in machining the same, and in order that a hard metal may be used in contrast with the soft die-cast metal of the turntable.

Worm 36 meshes with a relatively long, small diameter pinion 44. This rotates with a relatively large diameter feed screw 46. The assembly of pinion 44 and feed screw 46 is carried on bearing pins 48 and 50 which are themselves received in upstanding bearing walls 52 and 54 which are cast integrally with the main bearing 38 and a top plate 56. This bearing assembly may be die-cast, but in such case the soft metal is preferably cast around a thin sleeve of bronze forming a lining for the main bearing 38.

The feed screw engages the periphery of a segment 58. Segment 58 is secured to a feed arm 60 by screws 62 passing through slots 64 in the segment. Feed arm 60 is fixedly secured to recording arm R and they oscillate together about the upright pin 66. The arc of segment 58 is struck about pin 66 as a center, and the periphery of segment 58 is toothed by a series of radial teeth 68 best shown in Figs. 6 and 11, these teeth having a pitch equal to that of the feed screw 46.

In Fig. 5 it will be observed that the end of segment 58 bears against the upper portion of screw 46, and the parts are therefore readily disengaged by elevating the segment slightly above the screw, as is shown in Fig. 6. This is done by oscillating the handle F, the said handle having diametrically opposite camming surfaces, one of which is shown at 70 in Figs. 5 and 6. These camming surfaces bear against a pin 72 passing transversely through the upright shaft 66. Shaft 66 oscillatably carries recording arm R, the shaft being freely received in the hub 74 of the recording arm in a manner which will be clear from inspection of Figs. 5 and 6 of the drawings, and being held against axial movement by a cap 76 locked in position by set screw 78. The feed arm 60 is secured directly to the lower end of hub 74 of the recording arm, and the parts function as a single member although they are cast separately. They are locked together by a pair of perpendicularly related set screws 80 which pass through the end of feed arm 60 and bear against hub 74 of the recording arm. The two parts are, of course, angularly related in proper manner so that the travel of the cutting head 30 will take place over the useful recording area of the disc, while segment 58 is moving in engagement with the feed screw 46. This angular relation is substantially as shown in Fig. 2, and it may be remarked that the section shown in Figs. 5 and 6 is fictional to the extent that the plane of the section through the recording arm R necessarily differs from the plane of the section through the feed arm 60, but these sections have been brought into a single plane for convenience in drawing.

The assembly of feed arm and recording arm is normally urged downwardly not only gravitationally, but also by means of a compression spring 82 (Fig. 5) housed within a bearing 84 and pressing at its lower end on a collar 86 which is secured to upright shaft 66 by a cross pin 88. The cross pin 88 projects beyond collar 86 and is received in slots 90 cut through the wall of bearing 84, as is shown in Fig. 12. This prevents rotation of shaft 66 and consequently holds pin 72 against rotation when the feed release handle F is oscillated about shaft 66. In this way the handle F may be employed to elevate the feed arm 60, as is shown in Fig. 6, at which time the recording arm may be swung freely over the entire surface of the turntable.

It is believed that the significance of the relative arrangement and dimensioning of the parts of the feed mechanism will now be apparent, for the segment 58 oscillates throughout its arc of travel either with or without engaging the feed screw 46, all without striking or interfering with the pinion 44 or worm 36 or bearings 52 and 54. This result is attained by making feed screw 46 larger in diameter than pinion 44, thus permitting the segment to ride freely over the pinion. The segment bears on the upper half of the feed screw so that it may be disengaged by upward movement, but it is preferably confined to the outer portion of the upper half of the feed screw in order that it may freely clear the worm 36. The relatively large diameter of the feed screw 46 together with the top location of the segment 58 causes the segment to ride over and to clear the bearings 52 and 54.

It was previously mentioned that the main bearing assembly together with the top plate 56 and bearings 52 and 54 are preferably die-cast. Because of inaccuracies in the resulting casting, and in order to increase the tolerance in manufacture of the gears, the cone bearings 48

and 60 are preferably made adjustable. The center or cone of bearing 48 is located eccentrically with respect to its shank 92, and by rotation of shank 92 the distance of pinion 44 from worm 36 may be adjusted. The adjustment is locked by a set screw 94. The conical or center bearing 50 is not eccentric, but is formed at the end of a screw 96 which may be turned to adjust the thrust of the bearings or to take up end play. The adjustment is locked by a set screw 98. The position of segment 58 relative to screw 46 may be adjusted by reason of the slots 64, thus compensating for any changes in the position of the pinion and feed screw or in the dimension of the feed arm 60 or even the segment 58. The assembly of pinion 44 and screw 46 is readily accomplished by making pinion 44 long enough to extend all the way between center bearings 48 and 50, while screw 46 is driven over one end of the pinion.

The peripheral length of segment 58 is made such as to correspond to the useful recording area of the disc and the location of the segment relative to the recording arm is such that when the cutting stylus reaches the minimum recording radius, the trailing end of the segment passes screw 46 and is thereupon automatically disengaged from the screw, and no further feed of the stylus takes place. Broken line position 58', 60' in Fig. 2 of the drawings shows the feed segment approaching the end of its range, and it will be understood that after some additional travel, the trailing end of the segment will leave the end of the screw. This presupposes that the feed is from the outside in, but with an oppositely threaded screw, the feed is from the inside out. In such case the automatic disengagement of the feed segment takes place at the opposite end of the screw with the segment moving counterclockwise as viewed in the drawings.

The construction of the feed mechanism of the recorder is simplified by locating all of the parts above top plate 120 of the phonograph casing, yet the feed mechanism is not at all exposed to view, it being fully concealed by the turntable T. The assembly of feed mechanism and turntable is kept compact in vertical dimension by elevating the segment 58 relative to the feed arm 60 so that the segment 58 is located within the hollow flanged turntable, as will be clear from inspection of Figs. 5 and 6. The total elevation of the turntable by reason of the introduction of the feed mechanism is limited to the introduction of the worm 36 between the turntable and the main bearing 38, and this is not enough to in any way affect the desired true rotation of the turntable, particularly so in view of the long and substantial nature of the main bearing 38.

The cutting head 30 may be of conventional character, and requires no detailed description. It is mounted on a suitable bracket 100 pivotally connected to recording arm R at 102. The cutting head 30 is preferably made comparatively light in weight so that it will be suitable for cutting acetate discs with a light cutting pressure. The desired cutting pressure may be obtained even if the cutting head is somewhat too heavy, by the use of a tension spring 104 connected between the cutting head and recording arm R. The tension of this spring may be made adjustable.

For recording on a metal disc such as the known aluminum discs, a different stylus is employed and a heavy stylus pressure is required. For this purpose, we provide the cutting head 30 with a forwardly projecting pin 106, and the machine is equipped with a weight 108 best shown in Fig. 4. This weight is center-bored to receive the pin 106, and may be locked on the pin by means of a thumb screw 110. The mass is so selected and disposed relative to the cutting head 30 that the resulting recording pressure is suitable for recording on aluminum records. To again record on acetate discs, it is merely necessary to remove the weight 108.

The motor control mechanism is next described with reference to Figs. 7 through 10 of the drawings, but this control mechanism is claimed in our copending application previously referred to. The turntable T is given a broad machine-trued periphery 112, and this is frictionally engaged by a comparatively soft rubber motor wheel 114. Wheel 114 is mounted at the upper end of motor shaft 116, the motor 118 being disposed in upright position and being of the alternating current induction type which operates for the present purpose as a synchronous motor. The reduction ratio between the small motor wheel 114 and the large turntable disc, together with the winding of the motor, is so selected as to produce a turntable speed of 78 R. P. M., and no speed regulator or governor mechanism is needed or used. The motor is mounted in rubber cushions 122, as is best shown in Fig. 9, and is suspended from the top plate 120 on which all of the parts so far described are mounted. More specifically, we provide a motor housing 124 best shown in Figs. 2 and 3. This motor housing is secured to top plate 120 by adjusting screws 126, one of which is received in a slot 128 (Fig. 2), thereby affording adjustment of the entire motor housing toward or away from the turntable. This determines the frictional driving pressure between the motor wheel 114 and the turntable. Motor housing 124 is provided with hollow frustroconical cups or seats 130 which receive the rubber sleeves or cushions 122. Motor 118 is provided with upwardly projecting rods 132 which pass through the rubber pads 122 and the upper ends of which receive nuts 134 bearing on appropriate washers. The significant thing about this arrangement is not merely the provision of a soft cushioned mounting for the motor, but even more importantly, the provision of an oscillatable mounting affording bodily oscillation of the motor between the driving position shown in Fig. 7 and the disengaged or released position shown in Fig. 8. The motor is substantially upright in the driving position of Fig. 7, and thus the desired driving force is obtained by reason of gravitational attraction on the body of the motor itself. This driving pressure may be increased by the use of a tension spring 136 connected between the lower end of the motor at 137 and any convenient point of connection on the plate 120.

The motor may be oscillated to the position of Fig. 8 by means of a motor release cam 138. Cam 138 is secured at the lower end of a pin 140 to the upper end of which the motor control handle C is connected. Pin 140 passes through a suitable bearing in the motor housing 124 previously referred to. It will be manifest that by swinging the control handle C from the solid line position to the broken line position shown in Fig. 2, the cam 138 will be shifted from the position shown in Fig. 7 to the position shown in Fig. 8, thus causing the same to bear against a cooperating part of the motor housing acting as a cam follower, and thereby tilting the motor to the position shown in Fig. 8, at which time the

motor wheel 114 is disengaged from the turntable T.

The motor housing 124 is made of a single piece of metal except for a small cover plate 142 which is secured in place by two small screws as is clearly shown in Fig. 9. This cover plate has been removed in Fig. 2 in order to expose the motor wheel 114.

The control handle C also controls the energization of motor 118. For this purpose we provide an electric switch 144 mounted on plate 120 by means of the conventional threaded bushing and nut construction, the body of the switch and the electric wires leading thereto being disposed beneath plate 120, while a plunger 146 for operating the switch projects upwardly through the threaded bushing above plate 120. This switch is so designed that it is normally open, and is provided with resilient means to keep it so. When plunger 146 is depressed and held in depressed condition, the switch is closed. In accordance with the present invention, this is done by the control handle C, and more particularly, by a camming projection 148 at one side of the control handle, as is best shown in Figs. 2 and 10. In Fig. 10 the switch is open, and the same applies to Fig. 8. In Fig. 7 the switch is closed, and the same applies to Fig. 2. In Fig. 2, however, when the control handle is moved to the broken line position, the switch is opened. A momert's reflection will show that as the control handle C is moved from the "stop" position shown in dotted lines, toward the starting position shown in solid lines, the switch is closed, thus starting the motor. As the movement of the control handle C is continued, the switch remains closed, and the motor release cam 138 is moved away from the motor far enough to permit the motor wheel to engage the periphery of the turntable. Because of this sequence of operation, the motor starts without any load and is already spinning when it frictionally engages the turntable. In stopping the machine, the motor is released from the turntable and there is no wear on the motor wheel if the turntable is stopped quickly with the hand. Most importantly, it is impossible to neglect to release the motor wheel from the turntable when stopping the machine, and this prevents the motor wheel from being left pressing against the turntable over long periods of non-use with resulting production of a flat side on the periphery of the motor wheel.

The shaving collector S is particularly simple in character. Broadly, we provide means to wind up the shaving which is being cut from the disc. This means is mounted at the center of the turntable, and more specifically, consists of a tube S which is frictionally slid over the centering pin 34 of the turntable. The tube S is preferably made by rolling a strip of metal to tubular configuration with a slot or space between the edges of the metal, this being one way to obtain the desired frictional engagement between the tube and the centering pin. The manner in which the shaving collector operates will be understood if it is kept in mind that the shaving cut from the disc gathers in convolutions about the disc, but these convolutions tend to remain stationary rather than to rotate with the disc, because the cutting point or cutting stylus is stationary. When the shaving reaches the shaving collector S, either in annular form or because of deformation and flattening of the ring of shaving, it is wound up about the shaving collector because the latter is rotating with the turntable, and winds the shaving relative to the fixed starting point at the cutting stylus. In this way the shaving is drawn into a bunch at the center, where it does not interfere with proper functioning of the recording stylus. The feed mechanism may be designed to cut from the outside toward the center of the disc, or from the center toward the outside of the disc, depending upon which way the thread of the feed screw is cut. We recommend the latter cut, because then the cutting head is constantly moving away from the previously cut shaving.

The turntable is desirably provided with a layer of sheet rubber of frictional character, indicated at 149 in Fig. 3, but omitted in Figs. 5 through 8 of the drawings.

The blank discs are provided with a center hole to receive the centering pin 34, and are provided with one or more additional holes 150 (Fig. 1) to receive drive pins 152 (Figs. 5–7). Ordinary commercial phonograph records do not have the additional holes 150, and it is therefore desirable to make the pins 152 removable so as to make it possible to play ordinary records. In the present case this is done in very simple fashion by providing the pins 152 with threaded shanks which are received in mating threaded holes in the turntable. When it is desired to play ordinary records, it is merely necessary to unscrew the driving pins or screws 152 from the turntable. Only one such screw need be used at any one time during the making of records, and this single screw may be expeditiously removed. When playing records which have been made on the machine, it is, of course, unnecessary to remove the screw, for the discs are provided with the extra holes 150.

The pick-up arm P may be conventional in character, and requires no detailed description. It is a channel-shaped arm formed of heavy gauge sheet metal. The magnetic pick-up head is received within the channel-shaped arm, and is secured in place by means of a screw 154 (Fig. 2). The stylus 156 (Fig. 1) may be changed by releasing a conventional knurled thumb screw 158. The opposite end of the arm is pivotally mounted on a post 160 which in turn is secured to the top plate 120 by screws 162 preferably passing through substantial rubber pads or bushings 164. When not in use, the arm rests on a stationary rest pin 24, the lower end of which is secured to the top plate 120 of the machine, and the upper end of which is received within the side walls of the channel-shaped arm. This holds the arm elevated above the turntable and swung outside the turntable, as is shown in Fig. 1. When the pick-up arm is raised over the rest pin 24 and moved just inside the rest pin, the stylus may be placed substantially at the edge of the turntable, as will be evident from examination of Fig. 2. The turntable in the present case is a twelve-inch turntable, and the pick-up is thus positioned to reproduce records up to twelve inches in diameter. The recording arm R and its associated feed mechanism is similarly adapted to handle discs up to twelve inches in diameter.

Referring to Fig. 1, the casing comprises a bottom wall, not shown, side walls 170, a rear end wall 172, a front end wall 174, a relatively large top plate 120, and a relatively small top plate 176, the large top plate being positioned substantially lower than the small top plate 176. The turntable and associated recording and pick-

up arms are mounted on the large plate 120, and the sides 170 and rear wall 172 of the casing are preferably cut away at plate 120 to afford free sideward access to these parts. The small plate 176 is located at substantially higher elevation to make room therebeneath for the audio frequency amplifier and loud speaker equipment. The small plate 176 also functions as a panel on which the associated instruments and controls are mounted. The case is completed by a cover 178 provided with a narrow peripheral wall. This wall is widened at 180 and 182 to compensate for the cutting away of the side walls 170 and rear wall 172 at the large top plate 120. The hinges of the cover are of the open type which permit complete removal of the cover when it is turned all the way back, and this leaves the lower part of the case well open for use. It is not essential, however, to remove the cover 178, and the apparatus may be used with the parts in the position shown in Fig. 1. When the cover is closed, it may be locked at 184, and dowels 186 are used to insure proper fit of the cover over the lower part of the case. The complete unit is portable, and may be carried by means of handle 188. The mounting of the controls on top panel 176 is especially convenient because these controls are fully enclosed and protectively housed when the case is closed by the cover 178. If the controls were mounted on the front wall 174, they would be exposed, or it would be necessary to provide an additional protective wall outside the control handles, and this would increase the size of the unit.

It has already been mentioned that the audio frequency amplifier and loud speaker equipment is located in the forward end section A of the case, and this will be further clarified by reference to Fig. 13, which is a rear view of this section looking in the plane of the line 13—13 of Fig. 1, but with the chassis removed from the case. No attempt will be made to describe the same in detail, but it may be briefly pointed out that the chassis comprises a bottom plate 190 with the usual downwardly bent side walls 192 forming a bottom space beneath which the wiring between tube sockets and various elements is disposed, as well as fixed resistors, capacitors, and the like. The top plate or panel 176 is spaced above bottom plate 190 by appropriate vertical walls 194. The power transformer is indicated at 196, and the rectifier tube for power supply, at 198. In the present case this is the type known commercially as "No. 80" rectifier tube. The tubes 200 are power amplifier tubes used in push-pull, and in the present case are of the type known commercially as "No. 45" power tube. Voltage amplification is provided ahead of power tubes 200 by means of tubes carried within the shields 202 and 204. In the present case these are of the type known commercially as "6C8G," which include elements making possible two stages of amplification in each tube. The change-over switch was previously referred to, and is indicated at 16. When this is thrown to the recording position, the microphone feeds into tube 202, then tube 204, then the power tubes 200, and then into the cutting head, the tube 204 having its second section used as a phase inverter for feed into the push-pull power amplification stage. When the change-over switch 16 is thrown to the phonograph or playback position, less amplification is needed, and the pick-up is connected to the second section of tube 202, the output of which is fed to the tube 204, and thence to the power amplifier tube 200 as previously described, and thence to the voice coil of the loud speaker.

The loud speaker is located in front of the tubes 198, 200, and is shown at 206. It is preferably of the electro-dynamic type, its field coil being indicated at 208, and the transformer for the voice coil being shown at 210. The remaining elements visible in Fig. 13 have already been referred to, these being the power switch 12 with associated pilot lamp 14' visible in ruby lens 14, the volume indicator meter 22, the tone control 20, the volume control 18, and the receptacle 212 for the microphone connection.

It will be understood that the audio amplifier and loud speaker section described in connection with Fig. 13 is employed only because the present unit is a completely self-contained portable unit, to operate which it is merely necessary to insert the plug 214 (Fig. 1) into any convenient wall outlet. Many features of the invention may be used, however, with recording and reproducing apparatus employed in association with a regular cabinet phonograph or radio receiver. In such case the audio amplifier and loud speaker of the radio receiver may be used, and the parts shown in Fig. 13 are unnecessary. More specifically, from the standpoint of the manufacturer of such a combination radio receiver, it is merely necessary to provide room at the top or somewhere in the cabinet for the large mounting plate 120, for this includes the turntable, the recording arm with associated feed mechanism, the pick-up arm and the driving motor with associated motor control mechanism, all as is best shown in Fig. 2. Incidentally, in speaking of radio receivers, it may be pointed out that it is possible to make a recording of a received radio broadcast feature. This may be done by simply locating the microphone in front of the radio speaker, but may be done with greater fidelity by connecting the audio output of the radio receiver, which would normally be supplied to the voice coil of the speaker, directly to the cutting head of the recorder. For this purpose, we provide a jack 216 (Figs. 1 and 2) adapted to receive a plug which is connected to the voice coil of the radio receiver.

It is believed that the construction and operation, as well as the many advantages of our improved recording apparatus, and more particularly the improved portable recording and reproducing apparatus, will be apparent from the foregoing detailed description thereof. The feed mechanism is simple, inexpensive, sturdy and positive in action. The segment is readily disengaged from the screw and the cutting stylus may be positioned at any desired point on the disc. The segment is automatically disengaged from the screw at the end of the useful recording area of the disc. The parts of the feed mechanism are all located above the mounting plate and close to and are concealed by the turntable. The turntable is carried in a simple main bearing and may be removed by simply lifting the same upwardly, at which time the feed mechanism is fully exposed and accessible for service. The recording arm is located above the mounting plate and is readily removable from the upright pin, and the cutting head is readily removable from the recording arm for servicing. The same applies to the pick-up arm, and in fact, even the electrical connections to both arms are made above the mounting plate 120 so that the cut-

ting head or pick-up may be completely removed from the apparatus for examination or replacement without having to open up the top plate 120 of the case. Most of the parts may be made comparatively inexpensively by die-casting, which has the additional advantage of permitting the use of very light-weight metals. The manufacturing tolerance is large because appropriate adjustments of the parts are provided for.

The motor control is especially convenient, and by simply oscillating a single lever, two different controls are caused to function in best time sequence. The soft rubber motor wheel is normally disengaged from the turntable, and there is no danger of it sticking to the turntable or acquiring a "flat." The motor is started before the motor wheel is brought into frictional engagement with the turntable. It is impossible to stop the motor without disengaging the motor wheel from the turntable because the motor switch is opened at the end of the movement of the control handle. The motor is suspended and cushioned in rubber, and the rubber mounting itself functions to permit the desired movement of the motor wheel. This is preferably accompanied by bodily movement of the motor itself, and the weight of the motor is used to provide the desired engaging force between the motor wheel and the turntable although this may be supplemented, if desired, by a tension spring.

An exceedingly simple and inexpensive means is provided which functions effectively to collect the shaving when operating on an acetate or like composition disc from which a continuous thread-like shaving is cut. The same cutting head may be used to record on an aluminum or like metallic disc, and the necessary increase in cutting pressure is provided for in a convenient and inexpensive manner. Driving pins in addition to the centering pin are provided on the turntable in order to insure positive rotation of the disc with the turntable during the recording operation. These driving pins may be left in place during play-back of records made in the apparatus, and are readily removable in order not to interfere with reproduction of ordinary commercially manufactured phonograph records.

By the addition of audio amplifier and loud speaker equipment, the apparatus may be made completely self-contained and portable. The resulting unit is kept compact by disposing the electrical equipment at the forward end of the case, and making that end higher than the remainder of the case above which the turntable is mounted. The elevated top plate above the audio equipment is preferably made to function as a panel on which the associated instruments and controls are mounted, because in this way they may be protectively enclosed and locked against tampering when the main cover of the case is closed. There is no loss of accessibility to the turntable and recording and pick-up arms, because the side and rear walls of the lower part of the case preferably are cut away, and this is compensated for by increasing the depth of the cover at the cut-away portions.

It will be apparent that while we have shown and described our 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.

We claim:

1. Apparatus for recording sound, said apparatus comprising a turntable, a cutting head, an arm extending rearwardly from the same and oscillatably mounted at its rear end on a vertical pivot for movement across the turntable, and feed mechanism all located immediately beneath the turntable, said feed mechanism including a screw, gearing connecting said turntable and screw for rotating the screw, a segment extending rearwardly from and moved by said screw, said segment being in the form of a sector of a circle having the pivot of the arm as its center, said segment having teeth at the bottom of the periphery thereof engaging the top of said screw, the rear end of said segment being rigidly connected directly to the rear end of said arm for simultaneous bodily movement therewith, said arm and segment being vertically movable on said pivot, a feed release handle at said pivot, and cam means operated thereby to raise the arm and segment in order to disengage the segment from the screw.

2. Apparatus for recording sound, said apparatus comprising a horizontal panel, a main turntable bearing beneath said panel, a top bearing plate above said panel, a turntable above said panel having a turntable shaft projecting downwardly into said main bearing, a short worm on said shaft between said turntable and said main bearing, said plate having spaced bearing ears carrying a small-diameter pinion meshing with said worm, a short large-diameter screw secured at one end of said pinion, a recording arm bearing secured to said panel outside said turntable, a recording arm having a hub mounted on said recording arm bearing, a feed arm rigidly secured to said hub and extending between the turntable and the panel, a toothed sector carried by said feed arm and adapted to rest on said screw and to clear said pinion and worm, cam means and an operating handle therefor disposed above said panel and beneath said recording arm hub for raising or lowering the hub and with it the feed arm and sector in order to disengage or engage the sector and screw, said worm and pinion and screw and sector all being concealed by said turntable but exposed on lifting the turntable from the main bearing.

3. Apparatus for recording sound, said apparatus comprising a main turntable bearing, a bearing plate localized at the main bearing, a turntable having a turntable shaft in said main bearing, a worm on said shaft, said bearing plate having spaced bearing ears, a small-diameter pinion meshing with said worm, a short large-diameter screw at one end of said pinion between said bearing ears, conical center bearings carried in said bearing ears and receiving the ends of said pinion and screw assembly, one of said cone bearings being eccentrically mounted in its bearing ear for adjustment of the pinion toward or away from the worm, the other of said cone bearings being carried on a screw for axial adjustment of the center-to-center distance between bearings, a recording arm above the turntable, a feed arm below the turntable connected to said recording arm, and a toothed sector on the feed arm adapted to mesh with the large-diameter screw and at the same time to clear the pinion and the worm.

4. Apparatus for recording sound, said apparatus comprising a horizontal panel, a main turntable bearing carried by said panel, a turntable above said panel having a turntable shaft projecting downwardly into said main bearing, feed mechanism including a feed arm located between the turntable and the panel and adapted to be

moved in response to rotation of the turntable shaft, a recording arm bearing carried by said panel outside said turntable, a recording arm having a hub oscillatably mounted on a vertical shaft carried in said recording arm bearing, means to prevent rotation of the shaft but to afford vertical movement thereof, the aforesaid feed arm being rigidly secured to the hub of the recording arm, helical cam means and an operating handle therefor disposed above said panel and beneath said hub, said cam means and handle being oscillatable about the vertical shaft and functioning to raise or lower the shaft, and with it the hub and recording arm and feed arm.

5. Apparatus for recording sound, said apparatus comprising a horizontal panel, a main turntable bearing carried beneath said panel, a turntable above said panel having a turntable shaft projecting downwardly into said main bearing, feed mechanism including a feed arm located between the turntable and the panel and adapted to be driven by the turntable shaft, a recording arm bearing carried by said panel outside said turntable, a recording arm having a hub oscillatably mounted on a vertical shaft carried in said recording arm bearing, said shaft being provided with a transverse pin at its lower end to prevent rotation of the shaft, said pin being received in vertical slots in the bearing to afford vertical movement of the shaft, the aforesaid feed arm being rigidly secured to the hub of the recording arm, helical cam means and an operating handle therefor disposed above said panel and beneath said recording arm hub for raising or lowering the recording arm and with it the feed arm, said cam means and handle being oscillatable about the vertical shaft, and said vertical shaft having a pin extending transversely therethrough and resting on said helical cam means for raising and lowering the shaft upon oscillation of the handle.

6. Apparatus for recording sound, said apparatus including a turntable having a shaft thereon, a cutting head, a pivoted arm supporting the same for movement over the turntable, and feed mechanism compactly localized at the axis of the turntable, said mechanism comprising a worm gear mounted on the turntable shaft for rotation therewith, a pinion of small diameter meshing with said worm gear, a screw of substantially larger diameter than the pinion rotatable with said pinion, said screw being short in axial dimension and being located closely adjacent the worm gear, a segment driven by said screw and secured to said arm for oscillation therewith, the periphery of said segment being provided with teeth meshing with said screw, the large diameter of the screw relative to the small diameter of the pinion causing the segment to clear the worm gear and pinion while meshing with the screw, the central location of the screw near the axis of the turntable localizing the driving engagement between the segment and screw closely adjacent the axis of the turntable.

7. Apparatus for recording sound on a disk, said apparatus including a turntable having a shaft thereon, and feed mechanism for feeding a cutting head over the turntable, said feed mechanism comprising a worm gear mounted on the turntable shaft for rotation therewith, a pinion of small diameter meshing with said worm gear, a screw of substantially larger diameter than the pinion rotatable with said pinion, said screw being short in axial dimension and being located closely adjacent the worm gear, a segment driven by said screw and secured to said cutting head for oscillation therewith, the periphery of said segment being provided with teeth meshing with said screw, said segment being of such arcuate length that it passes out of mesh with the screw when the cutting head reaches the limit of useful recording area on the disc, the central location of the screw near the axis of the turntable affording ample range of movement of the segment while keeping said segment at all times concealed beneath said turntable and localizing the driving engagement between the segment and screw closely adjacent the axis of the turntable, the large diameter of the screw relative to the small diameter of the pinion causing the segment to clear the worm and pinion while meshing with the screw.

8. Apparatus for recording sound, said apparatus comprising a panel, a main turntable bearing beneath said panel, a turntable above said panel having a turntable shaft projecting downwardly into said main bearing, a worm gear on said shaft between said turntable and said main bearing, a small diameter pinion above said panel and meshing with said worm gear, a screw of substantially larger diameter than the pinion rotatable with said pinion, said screw being short in axial dimension and being located closely adjacent the worm gear, a recording arm oscillatably mounted on said panel outside said turntable, a feed arm connected to said recording arm above the panel and extending between the turntable and the panel, a toothed segment carried by said feed arm and adapted to engage said screw, the large diameter of the screw relative to the small diameter of the pinion causing the segment to clear the worm and pinion while meshing with the screw, the central location of the screw near the axis of the turntable localizing the driving engagement between the segment and screw closely adjacent the axis of the turntable, said turntable being downwardly flanged at its periphery to rigidify the same, said segment being received in the hollow space within the turntable flange thereby reducing the necessary elevation of the turntable above the panel while keeping the feed mechanism above the panel.

9. Apparatus for recording sound, said apparatus comprising a support panel, a main turntable bearing carried by and disposed beneath said panel, the lower end of said bearing being closed and provided with a thrust ball, a turntable above said panel having a turntable shaft projecting downwardly into said main bearing and resting on said thrust ball, a worm gear mounted on said shaft above the panel between said turntable and the main bearing and rotatable therewith, a small-diameter pinion above said panel and meshing with said worm gear, a large-diameter screw rotatable with said pinion, said screw being short in axial dimension and being located closely adjacent the worm gear, bearings carrying said pinion and screw, said bearings being carried on a plate localized at and so fixed in location by the main bearing as to maintain the desired center to center spacing of the worm gear and the pinion, a recording arm above the turntable, a feed arm between the turntable and the panel and connected to said recording arm, a toothed segment carried by the feed arm and meshing with the screw, the large diameter of the screw relative to the small diameter of the pinion causing the segment to clear the worm gear and pinion while meshing with the screw, the central location of the screw near the axis of the turn-

table localizing the driving engagement between the segment and screw closely adjacent the axis of the turntable.

10. Apparatus for recording sound, said apparatus including a turntable having a shaft thereon, a cutting head, a feed arm therefor, and feed mechanism compactly localized at the axis of the turntable, said mechanism comprising a worm gear mounted on the turntable shaft for rotation therewith, a pinion of small diameter meshing with said worm gear, a screw of substantially larger diameter than the pinion rotatable with said pinion, said screw being short in axial dimension and being located closely adjacent the worm gear, spaced bearings for said pinion and screw assembly, one of said bearings being adjustable with the pinion toward or away from the worm gear, a segment mounted on the feed arm and provided with teeth adapted to mesh with said screw, said segment being adjustably secured to said feed arm for movement toward or away from the screw, screws to fixedly lock the segment in adjusted position, the large diameter of the screw relative to the small diameter of the pinion causing the segment to clear the worm gear and pinion and bearings while meshing with the screw, the central location of the screw near the axis of the turntable localizing the driving engagement between the segment and screw closely adjacent the axis of the turntable.

11. Apparatus for recording sound, said apparatus comprising a main turntable bearing, a bearing plate localized at the main bearing, a turntable having a turntable shaft in said main bearing, a worm gear on said shaft rotatable therewith, said bearing plate having spaced bearing ears, a small-diameter pinion carried by said bearing ears and meshing with said worm gear, a short large-diameter screw at one end of said pinion between said bearing ears and located closely adjacent the worm gear, said pinion extending through the screw and said screw being hollow to receive the pinion with a force-fit, a recording arm above the turntable, a feed arm below the turntable connected to said recording arm, and a toothed segment on the feed arm adapted to mesh with the screw, the large diameter of the screw relative to the small diameter of the pinion causing the segment to clear the worm gear and pinion while meshing with the screw, the central location of the screw near the axis of the turntable localizing the driving engagement between the segment and screw closely adjacent the axis of the turntable.

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