July 22, 1952 R. M. CAIN 2,603,977

TURNTABLE SPEED COMPENSATOR

Filed Feb. 27, 1947 3 Sheets-Sheet 1

Fig. 1

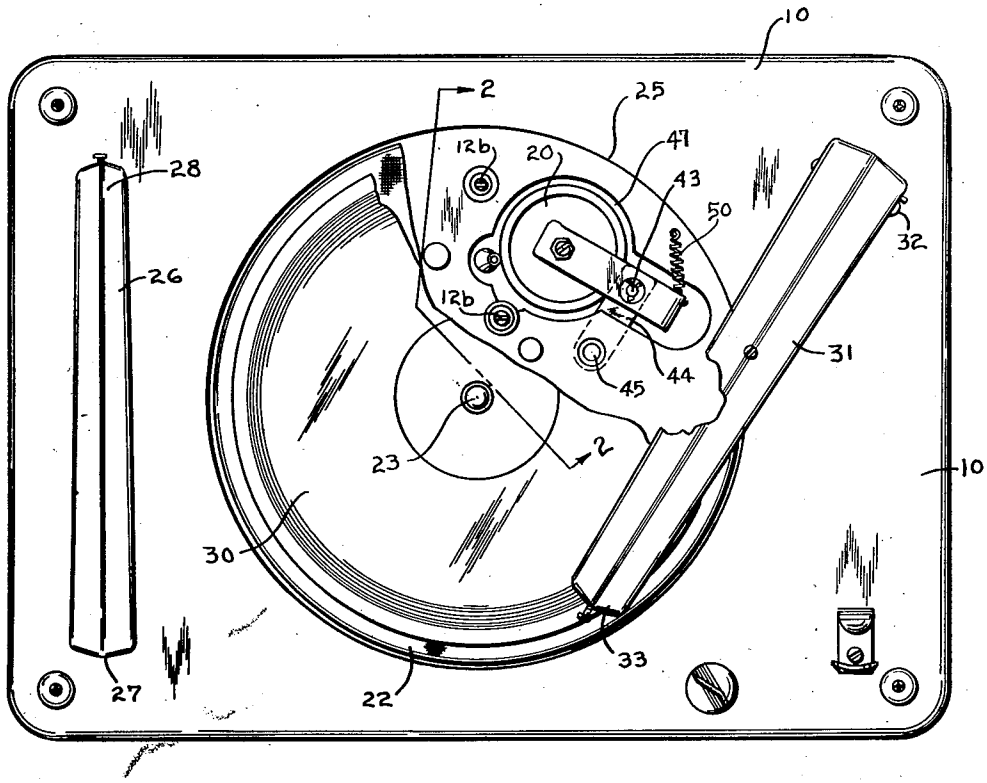
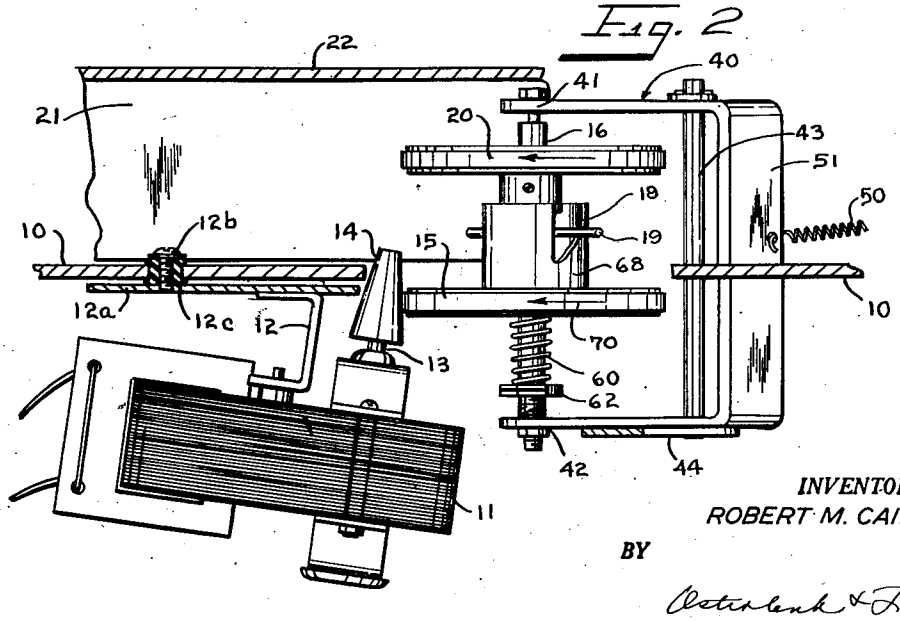


Fig. 2



INVENTOR.
ROBERT M. CAIN
BY
Osterlenk & Faber
ATTORNEYS

July 22, 1952 R. M. CAIN. 2,603,977

TURNTABLE SPEED COMPENSATOR

Filed Feb. 27, 1947 3 Sheets-Sheet 2

Fig. 3

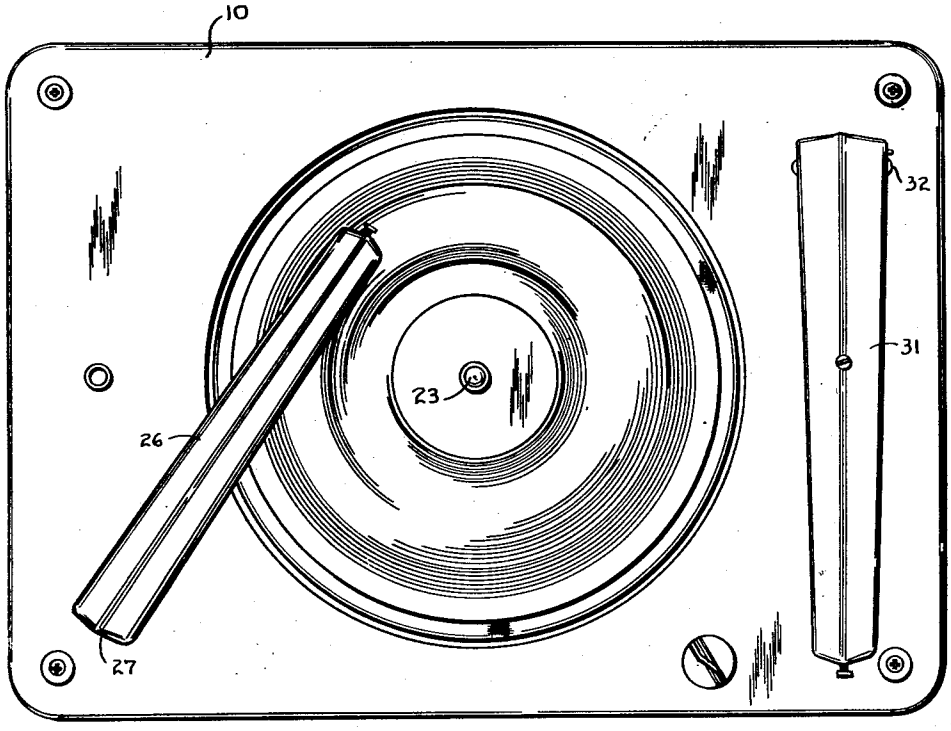
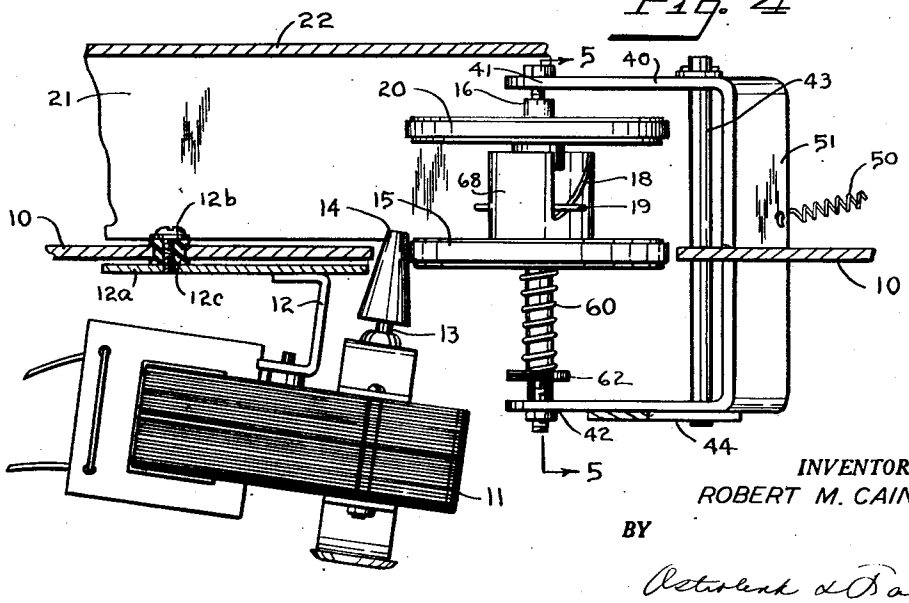


Fig. 4



INVENTOR.
ROBERT M. CAIN

BY

Acton Lenk & Baker

ATTORNEYS

July 22, 1952 R. M. CAIN 2,603,977

TURNTABLE SPEED COMPENSATOR

Filed Feb. 27, 1947 3 Sheets-Sheet 3

Fig. 5

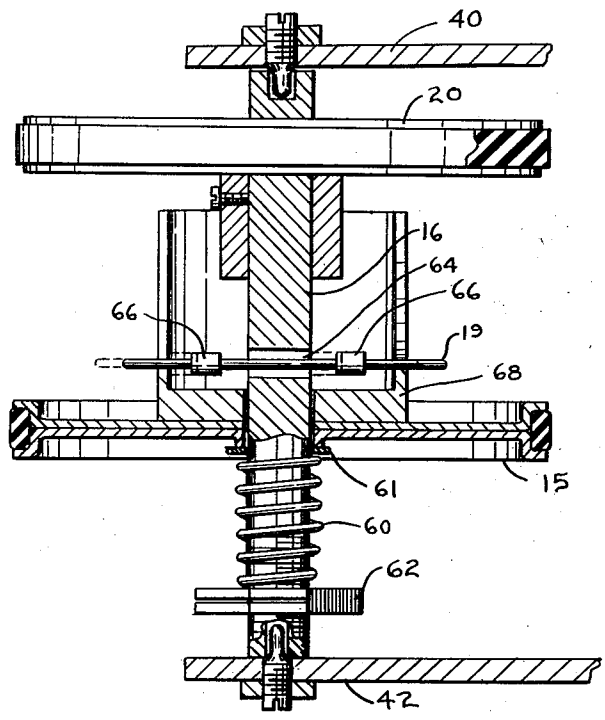
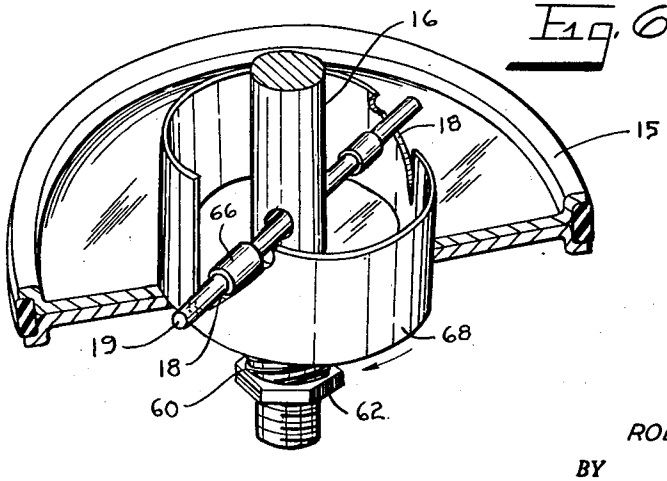


Fig. 6



INVENTOR.
ROBERT M. CAIN
BY
Cistiland & Parker
ATTORNEYS

Patented July 22, 1952 2,603,977

UNITED STATES PATENT OFFICE

2,603,977

TURNTABLE SPEED COMPENSATOR

Robert M. Cain, Charlotte, Mich., assignor to Wilcox-Gay Corporation, Charlotte, Mich., a corporation of Michigan

Application February 27, 1947, Serial No. 731,319

3 Claims. (Cl. 74—190.5)

1

My present invention relates to sound recording and play-back devices, and more particularly to speed compensating means specifically to adapted to sound recording and play-back devices and utilized in connection therewith to maintain the turntable speed at a constant rate irrespective of variations in load.

My invention is primarily an improvement over the device set forth in Patent No. 2,351,948 in which a single unitary, substantially inexpensive unit is described which can be used by the unskilled home user both to make records and to play them back.

In the said Patent No. 2,351,948 many compensating elements are described for the purposes of making it possible to use light-weight and inexpensive parts, thus bringing the device within the reach of the home user. Such compensating devices which include the resilient mounting of the motor and the resilient mounting of the cutting and the pick-up elements as well as other compensating means therein described, made it possible to make a home record with a very light turntable and even with records which are not truly flat. However, where light-weight parts are used so that no substantial fly-wheel effect occurs, there does result a slight speed variation in the operation of the turntable for play-back and recording.

In a combined record making and play-back unit, more power is required during the cutting operation than during the play-back operation because during cutting some of the material of the record is being removed. This results in more work being done during cutting than during play-back in which latter case, the needle need merely follow the groove.

With the commercial device made in accordance with Patent No. 2,351,948, it was found that the braking load during cutting of a record was of the order of 14 inch ounces adjacent the periphery of a 10 inch record, decreasing to about 3½ inch ounces at the inner portion of the record.

The play-back load as above pointed out, however, was measured in fractions of an inch ounce. The speed variation is of a two-fold nature. It is primarily a slippage factor and to a lesser extent a variation in motor speed. In the drive from the motor shaft to the turntable flange, there exists a changing phenomenon of transmission efficiency which is a function of the load on the turntable. As the load on the turntable increases, the efficiency of the drive drops; this is termed "slippage."

2

If the slippage were to remain constant, then allowance would be made in pulley sizes and other permanent adjustments. But the slippage is greater with a heavy load, as in cutting the outside diameter of a record, than it is during play-back.

The use of my novel compensator, in addition to compensating for slippage, can and does compensate for variation in motor speed. It thus becomes possible to use a motor about one-fourth the size and weight of the motor previously used without the compensator at a saving of half the cost of the motor, thus more than paying for the addition of the compensator.

It was found that the difference in speed between record cutting and play-back was such that the play-back operation occurred at a sufficiently higher speed to create a noticeable change in pitch. This was particularly so at the periphary of a record where the cutting load was greatest. The only method previously available was to apply a synthetic load during play-back in an attempt to make up for the load difference between cutting and play-back. Of course, by making the parts extremely heavy with relation to the load, the variations in the load might be reduced, but the recorder would no longer be a simple home unit.

Applying an additional load during play-back simply amounted to decreasing the efficiency of operation; and also arranging speed shift mechanism to change from one fixed gear ratio to another fixed gear ratio when shifting from cutting to play back would tend to add unnecessary complexity, increase the expense of the device.

Neither the additional synthetic load nor the change-over between two gear ratios would compensate for the varying load during cutting; but would compensate only for an average cutting load.

My invention is directed toward the incorporation in the drive between the motor and the turntable of an automatic speed compensator responsive to the torque on the turntable automatically to control the final speed of the turntable.

Essentially my speed compensator is so ar-

ranged that on an increase in torque demand tending to slow down the turntable, the driving ratio between the motor and the turntable is changed in accordance with the torque to increase the relative speed of the turntable with respect to the motor and thus compensate for the tendency to go at a slower speed owing to increased torque demand.

Similarly, my device is so arranged that when there is a decrease in torque on the turntable tending to permit the motor to drive the turntable more rapidly, the ratio of the drive from the motor to the turntable is automatically changed to a degree exactly corresponding to the decrease in torque so that the speed of the turntable relative to the motor is decreased. Thus changes in slippage as above defined and changes in motor speed are automatically compensated to produce a constant speed.

Essentially the motor armature carries a conical shaft which drives an idler wheel, which in turn is vertically slidable on a shaft which carries another idler keyed thereto. The conical shaft drives the first idler and the first idler drives the shaft of the second idler which in turn drives the turntable. The first idler is supported on the shaft of the second idler by a compression spring at a position where it registers with the smallest diameter of the cone and thus where the driving ratio is such as to produce the basic no-load turntable speed or the exact speed required for both cutting and play-back.

As the torque on the turntable increases, the first idler is correspondingly driven down against the compression of the spring to a point where the increased compression of the spring counterbalances the increased torque. The spring is selected so that, for the height of the conical drive shaft, the driving ratio between the motor shaft and the turntable when the idler is in equilibrium produces a constant turntable speed, compensating for the drive slippage and slowing of the motor under the load.

Thus, as the torque varies, the first idler shifts up and down always reaching a point of equilibrium between torque and spring at a point where its contact with the cone changes the gear ratio to maintain the constant basic speed.

The variations which must be compensated for are relatively small. Thus, where the turntable is designed to rotate at 78 R. P. M. a variation plus or minus 1 or 2 R. P. M. will produce a noticeable change in pitch. It has been found that without any compensator, the variation in load between the extreme 14 inch ounce load at the outer periphery of a record being cut and no load at all did not produce a difference of much more than 2 to 4 R. P. M. in a turntable designed to rotate at 78 R. P. M. This, however, was more than sufficient to produce a noticeable change in pitch and tone quality.

Consequently, while the variation involved is one from slightly more than zero load to a 14 inch ounce drag, the speed compensation necessary is only that needed to prevent the turntable from varying in speed more than 2 to 4 R. P. M.

Accordingly an object of my invention is to provide a novel speed compensating means for a turntable in a recording device so that the turntable will rotate at the same speed when a record is being cut as when the record is being played back.

Another object of my invention is a provision of novel speed compensating means for the turntable of a sound recording device wherein the torque on the turntable automatically varies the driving ratios between the motor and the turntable in accordance with the load on the turntable in order to maintain constant speed.

The foregoing and many other objects of my invention will become apparent in the following description and drawings in which

Figure 1 is a top view, partially broken away, showing my recorder and its compensating device.

Figure 2 is a cross-sectional view taken on line 2—2 of Figure 1 looking in the direction of the arrows.

Figure 3 is a top view of the recorder of Figure 1.

Figure 4 is a cross-sectional view corresponding to that of Figure 2 showing another position of the compensating device.

Figure 5 is a cross-sectional view taken on line 5—5 of Figure 4 looking in the direction of the arrows.

Figure 6 is a fragmentary view in perspective showing a detail of the device.

Referring now to Figures 1, 2 and 3, my novel home recording device and compensator comprises a base plate 10, to the underside of which is secured the motor 11 by means of the bracket 12 on plate 12*a*. Plate 12*a* is secured by bolts 12*b* and grommets 12*c* to base plate 10. The grommet mount for the motor permits the motor itself to yield as a whole in the event of any power surge and thereby avoid a "wow;" this mounting follows the principles of Patent No. 2,351,948. Motor shaft 13 is provided with a conical pulley 14. Pulley 14 drives the first idler 15. Idler 15 is slidable on shaft 16 and is rotatably mounted with respect thereto; but idler 15 drives the shaft 16 by the cam surfaces 18 thereof which engage the pin 19 which extends through the shaft 16.

Shaft 16 carries the idler 20 keyed thereto. Idler 20 is in engagement with and drives the flange 21 of turntable 22. Turntable 22 is rotatably mounted on the spindle 23 which is carried by the base plate 10, said turntable 22 and spindle 23 being preferably recessed in a well 25 formed in the mounting plate 10.

The pick-up arm 26 is pivotally mounted at 27 on base plate 10 and carries a stylus at the end 28 which may engage a record 30 mounted on the turntable 22. Cutting arm 31 is pivotally mounted at the end 32 and is provided with a stylus at the end 33 which may also engage the record 30.

As shown in Patent No. 2,351,948, the cutting arm 31 is driven from the spindle 23 in accordance with the rotation of the turntable 22. The specific operation of the cutting arm 31 need not be described here since it is the same as that shown in the said Patent No. 2,351,948. The shaft 16 is rotatably supported in bearings 41, 42 in the U-shaped bracket 40. Bracket 40 is in turn pivotally mounted on the post 43 which passes through appropriate openings in the top and bottom of the bracket 40, said post 43 being carried by the arm 44 which in turn is carried by bolt 45 secured to the underside of the base plate 10.

The bracket 40 is pivotal on the post 43. Arm 44 is pivotally mounted on bolt 45 to permit the tension spring 50 hereinafter described to move the idlers into engagement with the cone 14 and turntable flange 21.

The bracket 40 and the idlers 20 and 15 operate in the keyhole slot 47 in the base plate.

Tension spring 50 is secured to the vertical portion 51 of the bracket 40 and biases the bracket 40 and hence the idlers 15 and 20 into engagement respectively with the cone 14 and the turntable flange 21.

As will be seen, especially from Figures 2 and 4, in order to maintain the idler shaft 16 vertically, the cone 14 must be tipped so that the side thereof facing the idler may be vertical. In order to obtain this result the entire motor mounting bracket 12 is so arranged that the whole motor 11, together with the cone 14, is mounted at an angle to the vertical so that the side of the cone adjacent the idler 15 may always be vertical.

Thus idler 15 may move up and down on the vertical shaft 16 and still remain in contact with the cone 14 at every position of idler 15. The vertical position of idler 15 with respect to the cone 14 will of course, determine the ratio between cone 14 and idler 15.

When now the phonograph is operated, motor 11 drives the cone 14 which drives idler 15. Idler 15 which is freely rotatable and slidable on shaft 16 drives the pin 19 through cammed surfaces 18 on collar 68 of idler 15. Pin 19 thus turns the shaft 16 which carries the idler 20 in engagement with the turntable flanges 21 and drives the turntable 22. The pin 19 as shown in Figure 5 passes through a hole 64 in the shaft 16, the hole 64 being sufficiently large to permit pin 19 to wobble a bit without binding. Pin 19 is also prevented from slipping out of the hole 64 by the bushings 66 mounted on either side thereof.

The cammed surface 18 on each side of idler 15 is provided in the collar 68 of idler 15 and the driving direction is indicated by the arrow 70 of Figure 2. It will thus be seen that as the cone 14 drives idler 15, there is a tendency for the cammed surfaces 18 to slip down under the pin 19, moving idler 15 down. This is resisted by the compression spring 60.

As the torque increases, however, the spring 60 permits the cammed surfaces 18 to slip down somewhat under the pin 19 to the position shown in Figure 2. This has caused idler 15 to be pushed down and this downward force is counterbalanced by the compression of the spring 60.

As the load increases resulting in added torque, the increased slippage in the driving elements above described results in a relatively slower movement of the turntable with respect to the motor so that the turntable speed tends to drop from the constant desired speed. This is compensated for immediately by the shifting of the idler 15 down the slope of cone 14 to a different driving ratio producing a greater relative speed between the turntable and motor in order to maintain the constant turntable speed. Also, the other effect of increased torque is to tend to slow down the motor itself which tends to slow down the operation of the entire system, including the turntable, thus tending to cause the turntable to rotate at the speed which is less than the required constant speed. This too is compensated for by the changed position of idler 15 with respect to cone 14 to produce a greater relative speed between idler 15 and cone 14 for the sole purpose of maintaining the constant speed of the turntable. Likewise, when the load decreases reducing the torque and hence reducing the degree to which the motor is slowed down, the turntable first would tend to rotate relatively more rapidly

with respect to the drive mechanism because of the decreased slippage and the entire system, including the motor, will tend to rotate more rapidly due to the decreased torque on the motor, both of these elements tending to cause increased speed of the turntable and of the entire system are immediately compensated for by the shifting of idler 15 to a point where the changed torque is again counterbalanced by the spring 60 to maintain the constant speed. Lock nut 62 (Figures 5 and 6) holds the spring 60 at the proper adjustment. After the machine is built, by the use of a stroboscopic disc, the free speed can be set at the precise level by turning the nut up or down on the shaft.

Thus my novel device operates as a speed compensator rather than a speed governor, being immediately responsive to variations in torque to adjust the relative speed of the turntable and motor so as to maintain the turntable speed constant even though the motor speed varies.

I have tested my novel device with a stroboscopic disc in order to determine that the turntable speed is maintained constant even though the load may vary and have actually found that this is so. Thus, in one experiment I placed a 10 inch record disc on the turntable and placed a 6 inch stroboscopic disc over the record disc. All of the elements were adjusted so that with no load on the turntable other than the record disc and the stroboscopic disc above it, the stroboscopic disc was apparently stationary at the 78.26 R. P. M. ring. I then placed the cutting arm at the outer periphery of the 10 inch record disc. For from one to two seconds after the cutting arm was placed on the outer edge of the 10 inch disc, there was slight movement of the 78.26 R. P. M. ring, but this movement halted within two seconds. With the turntable rotating and a record being cut, the 78.26 R. P. M. ring of the stroboscopic disc remained stationary. Then at the end of slightly more than one minute with approximately one inch of the record having been cut, the cutting arm was lifted. Again there was a slight movement of the 78.26 R. P. M. ring on the disc and this ring again became apparently stationary within two seconds. I then placed the play-back arm on the cut groove. This resulted in no perceptible movement of the 78.26 R. P. M. ring; nor did the removal of the play-back arm.

This contrasts with prior experiments where no speed compensator was used wherein the placement of the cutting arm on the outer periphery of the record disc caused the originally apparently stationary ring of the stroboscopic disc to begin to move in a regular unchanging manner until the cutting arm was removed.

The one or two seconds required for the turntable to adjust itself during this experiment was due to the fact that the load was shifted from zero load to 14 ounce drag without any intermediate shifting. Accordingly it was necessary for the idler 15 to move from the top of cone 14 all the way down to the bottom of the cone 14 and this required a second or two.

The principal point is that during the recording itself, the speed remained constant and did not vary from the no load speed or from the speed of play back.

Actually during a home recording operation, the cutting arm is placed on the record disc and the record disc is rotated for from one to three revolutions before actual voice recording begins. Similarly at the end of the record when the cutting arm is lifted, the play-back arm is cus-

tomarily not put in place until many seconds afterwards since it is necessary for the cutting arm to be removed and a switch to be operated to de-energize the cutting arm and energize the pick-up. Consequently the few seconds required for automatic adjustment from no load to full load and back again does not at all interfere with operation.

In actual operation the grommeted mounting of the motor as described in Patent No. 2,351,948 will take care of instantaneous loads which would otherwise result in wows. The resilient mounting of the cutting stylus and the playback stylus will permit momentary irregularities in the record to be compensated for.

My novel device compensates primarily for the continuous difference in load between cutting and play back and also compensates for the steadily changing difference in load between cutting at the outer periphery of the record and cutting at the inner portion of the record.

Accordingly my novel compensator maintains predetermined correct speed of the turntable, and the record cut on a home recorder embodying my novel device can be played back thereon at the same speed without an intervention by the operator and without any intervention by the operator and without any adjustment of any elements by him.

Accordingly the naturalness and clarity of the recording is preserved and the entire recording operation is balanced and effective so that the same result may be achieved with the simple inexpensive home recording device as has heretofore been possible only on heavy and expensive commercial record making outfits.

In the foregoing I have described my invention solely in connection with a preferred illustrative embodiment thereof. Since many variations and modifications of my invention should now be obvious to those skilled in the art, I prefer to be bound not by the specific disclosures herein but by the appended claims.

I claim:

1. In a sound recording unit arranged to cut and play back records; a motor, a turntable, a positive driving connection between said motor and turntable; speed compensating means in said positive driving connection responsive to variations in torque for maintaining the turntable at constant speed when idling, when subject to the play-back load and when subject to the cutting load; said speed compensating means comprising a conical driving member; a driven member engaging the surface of said conical driving member; means biasing said driven member to a position where it engages a smaller diameter of the conical driving member and means responsive to increase in torque for moving said driven member to engage a larger diameter of the cone, said driven member being moved by said last mentioned means against said biasing means to a point of equilibrium between the torque and the biasing means; said biasing means being enabled on decrease of torque to move said driven member to engage a smaller diameter of said conical driving means at another point of equilibrium between the torque and said biasing means; said driven member being freely mounted on a shaft in driving relation with said turntable; said before mentioned means responsive to increase in torque comprising a cam connection between said shaft and said driven member; said biasing means maintaining said driven member in engagement with said cam connection; said cam connection moving said driven member against the force of said biasing means on increase in torque.

2. In a sound recording unit arranged to cut and play back records; a motor, a turntable, a positive driving connection between said motor and turntable; speed compensating means in said positive driving connection responsive to variations in torque for maintaining the turntable at constant speed when idling, when subject to the play-back load and when subject to the cutting load; said speed compensating means comprising a conical driving member; a driven member engaging the surface of said conical driving member; means biasing said driven member to a position where it engages a smaller diameter of the conical driving member and means responsive to increase in torque for moving said driven member to engage a larger diameter of the cone, said driven member being moved by said last mentioned means against said biasing means to a point of equilibrium between the torque and the biasing means; said biasing means being enabled on decrease of torque to move said driven member to engage a smaller diameter of said conical driving means at another point of equilibrium between the torque and said biasing means; said driven member being freely mounted on a shaft in driving relation with said turntable; said before mentioned means responsive to increase in torque comprising a cam connection between said shaft and said driven member; said biasing means maintaining said driven member in engagement with said cam connection; said cam connection moving said driven member against the force of said biasing means on increase in torque; said biasing means moving said driven member to change its position on its shaft and with respect to its cam connection on decrease in torque, the axis of said conical driving means being inclined to that of the shaft at an angle equal to half the apical angle of the cone; the side of said cone in engagement with the driven member being parallel to the axis of the shaft.

3. In a sound recording unit arranged to cut and play back records; a motor, a turntable, a driving connection between said motor turntable; speed compensating means in said driving connection responsive to variations in torque for maintaining the turntable at constant speed when idling, when subject to the play-back load and when subject to the cutting load; said speed compensating means comprising a conical driving member rigidly connected to said motor; a driven member engaging the surface of said conical driving member; means biasing said driven member to a position where it engages a smaller diameter of the conical driving member and means responsive to increase in torque for moving said driven member to engage a larger diameter of the cone, said driven member being moved by said last mentioned means against said biasing means to a point of equilibrium between the torque and the biasing means; said biasing means being enabled on decrease of torque to move said driven member to engage a smaller diameter of said conical driving means at another point of equilibrium between the torque and said biasing means; said driven member being freely mounted on a shaft in positive driving relation with said turntable; said before mentioned means responsive to increase in torque comprising a cam connection between said shaft and said driven member; said biasing means maintaining said driven member in engagement with said cam

connection; said cam connection moving said driven member against the force of said biasing means on increase in torque; said biasing means moving said driven member to change its position on its shaft and with respect to its cam connection on decrease in torque, said cam connection comprising a collar carried by said driven member surrounding said shaft; a cam surface on said collar extending at an acute angle to the axis of said shaft; a transverse pin on said shaft engaging said cam surface.

ROBERT M. CAIN.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
942,910	Keller	Dec. 14, 1909
1,391,707	Viviand	Sept. 27, 1921
2,244,120	Schneider	June 3, 1941
2,312,798	Carrington	Mar. 2, 1943