

March 2, 1948.

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2,437,128

VARIABLE SPEED TRANSMISSION

Filed May 28, 1945

3 Sheets-Sheet.1

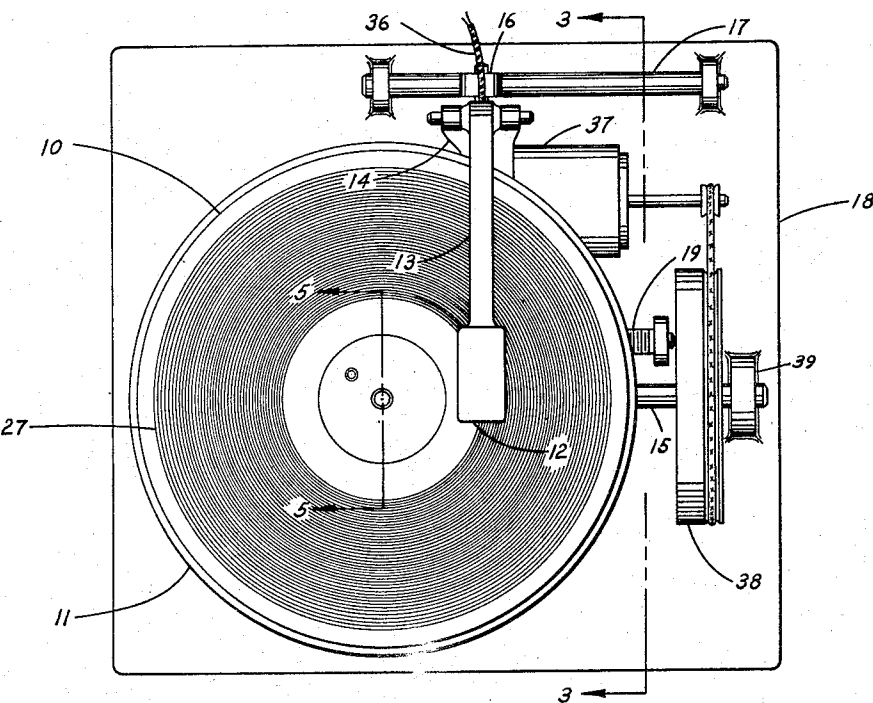


Fig. 1.

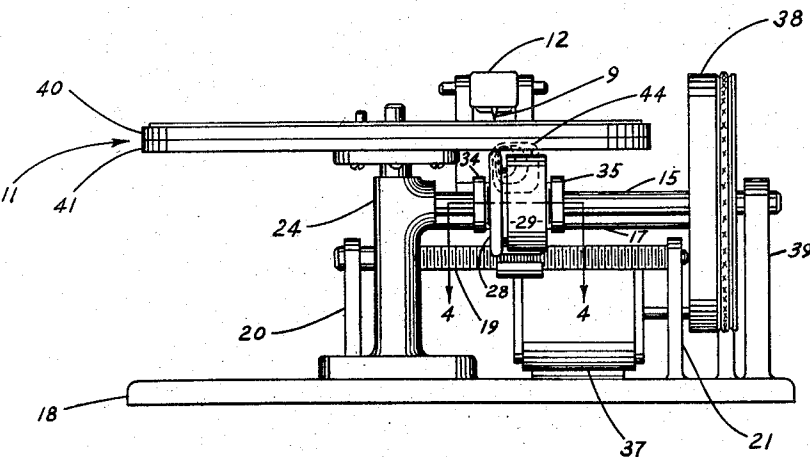


Fig. 2.

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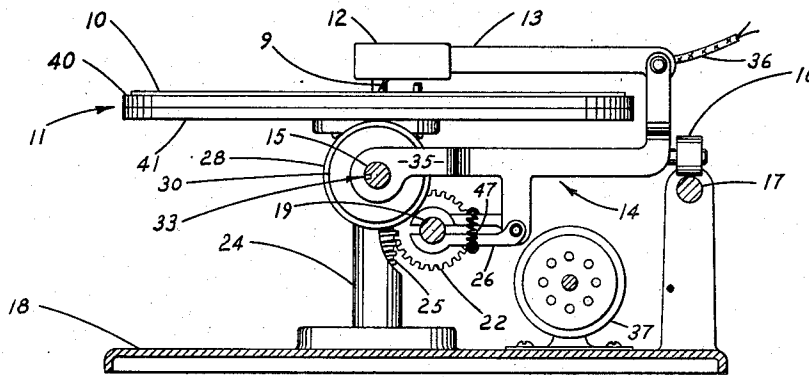


Fig. 3.

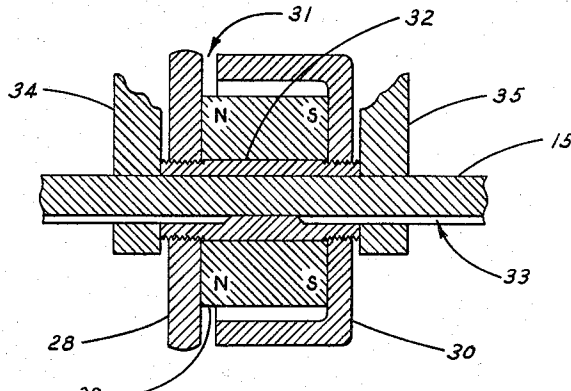


Fig. 4

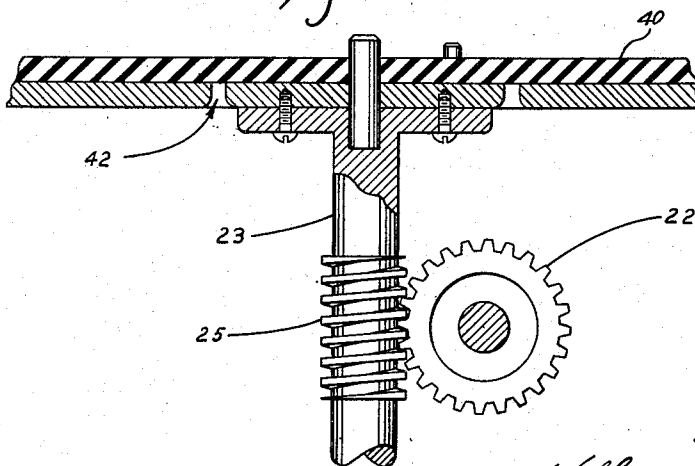


Fig. 5.

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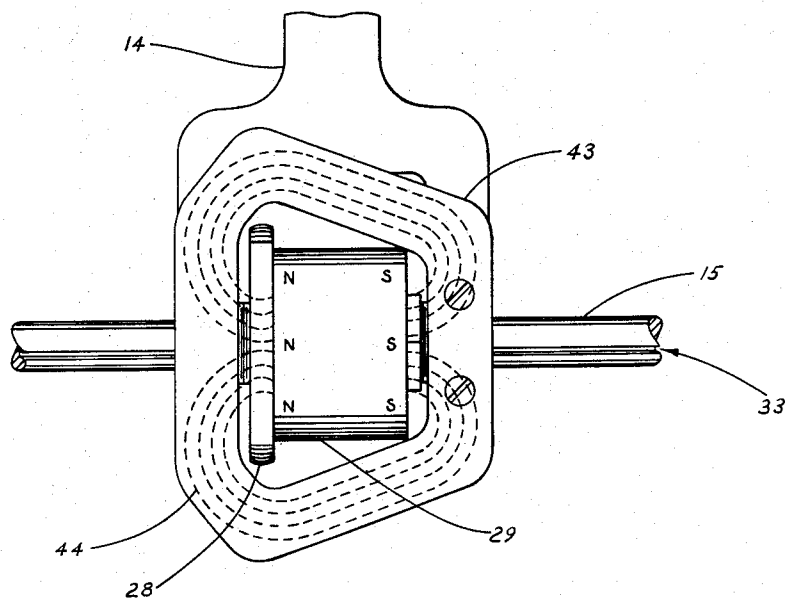


Fig. 6.

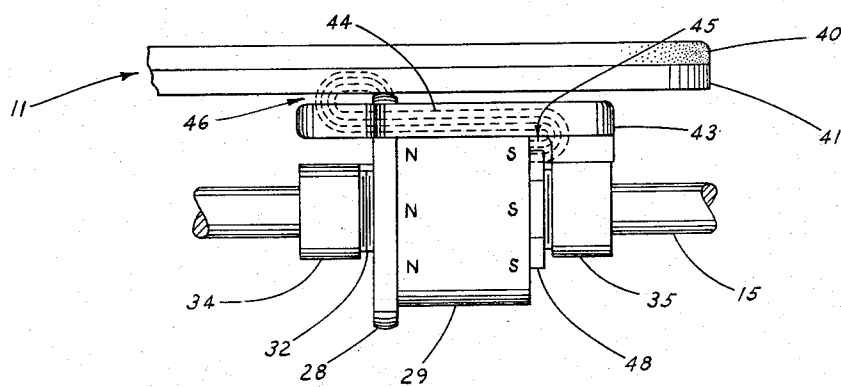


Fig. 7.

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VARIABLE-SPEED TRANSMISSION

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7 Claims. (Cl. 74-194)

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My invention relates generally to variable speed transmissions in which the speed variation is achieved by means of a friction drive wheel, which may be engaged with a driven disc at various radial distances from the center of such disc.

My invention relates more particularly to a method of driving the turntable of sound recorders of the type known as constant groove speed recorders. In this type of recording apparatus the sound record is produced in the form of an undulating spiral groove engraved or embossed by a vibrating stylus in the surface of a disc shaped record. The type is further characterized by the fact that the angular velocity of the rotating record is varied during the process of recording in such a manner that the tangential velocity of the groove past the stylus producing it is constant throughout the record. The purpose in maintaining this constant tangential velocity or constant groove speed, as it is known in the art, is the saving of record material. This saving is achieved by virtue of the fact that while a minimum groove speed is necessary to enable the recording of sound therein, the conventional phonographs of the constant radial speed class attain this minimum groove speed near the center portion of the record only, the groove speed at all other portions of the record being greater than the minimum necessary for sound recording. Hence, in a record having a given total length of the spiral groove and using a minimum groove speed at which adequate sound recording can be produced in said groove, a substantially longer playing time can be achieved by the constant groove speed method than by the constant tangential velocity method. In the constant groove speed class of recorder the angular speed variation is obtained by incorporating in the record drive system a variable speed transmission.

Conventional variable speed transmissions of the class described generally achieve an optimum frictional engagement between two driving members by constructing at least one of these two members—i. e., a disc and a wheel, of a material having a high coefficient of friction, and further by so mounting the members that the maximum pressure of contact consistent with bearing friction is maintained between them, the pressure being produced either by spring or gravity loading.

This procedure has several disadvantages which restrict the use of transmissions of this type.

One disadvantage lies in the fact that materials having a high coefficient of friction, such as

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cork, rubber, leather, and the like also possess to some degree poor wearing qualities. This results in one or both of the members becoming eccentric or a-planar and introduces irregularities of motion into the system.

Another disadvantage lies in the fact that if the driving wheel is constructed of a material of the class just described, and if sufficient pressure is used to secure adequate frictional engagement, the wheel is often temporarily deformed, introducing inaccuracy in the transmitted motion.

A further disadvantage is that the forces applied to achieve frictional engagement must be counteracted by resultant forces in the bearings of the disc and wheel. Such forces often result in excessive bearing friction, which robs power from the drive system.

In phonographic recorders and in many other applications in instruments and recording devices wherein precise uniform motion is desired, all of the above disadvantages are handicaps. My invention seeks to overcome these handicaps. Additional advantages will appear from the following disclosure.

While my invention may be employed in various ways, I have shown herein an embodiment as part of the drive transmission in a constant groove speed phonograph, such as I have just described. In this phonograph the constant groove speed is accomplished by frictionally driving the record bearing turntable with a drive wheel the periphery of which engages its under surface. As the recording or reproducing of sound proceeds, the drive wheel is moved radially along the under side of the turntable. During such radial motion the drive wheel remains in frictional engagement with the turntable, the point of engagement being directly beneath the point at which a recording or reproducing stylus engages the record. The drive wheel turns at a constant velocity and since it is always engaged with the turntable at a radius equal to the radius of the stylus engaging point, the groove speed is at all times equal to the peripheral velocity of the driving wheel.

The foregoing mechanism is old in the art and it is the novel means for securing engagement between the drive wheel and the turntable with which my invention deals. The following description will disclose these features.

Reference should now be made to the attached drawings in which:

Fig. 1 is a plan view of phonographic apparatus embodying my invention;

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Fig. 2 is a front elevational view of the same apparatus;

Fig. 3 is a side elevational view of said apparatus with portions of the mechanism sectioned along line 3—3 in Fig. 1;

Fig. 4 is a sectional view of the drive wheel and its supporting members taken along the line 4—4 as indicated in Fig. 2;

Fig. 5 is a partially sectioned elevational view of the central portion of the turntable, taken along line 5—5 as indicated in Fig. 1;

Fig. 6 is a partial view of an alternate means for embodying my invention in the same phonographic apparatus. In this view the turntable 11 has been removed to show underlying parts; and

Fig. 7 is a front elevational view of the device shown in Fig. 6 with the turntable in place.

In the apparatus illustrated a record disc 10 rests on and is rotated by a turntable 11. Above the turntable and record is an electrical-mechanical transducer 12, such as is used to convert electrical impulses into mechanical vibrations, or vice-versa. Projecting downward from the transducer 12 and engaging the surface of the record 10 on a radius thereof is a stylus 9. This stylus is part of the moving element of the transducer 12 and serves either to emboss an undulating groove 27 in the surface of the record 10, for the purpose of making a sound recording therein, or to reproduce sound from the groove in an already recorded record. These two functions may be selectively performed by connecting the transducer electrically through leads 36 either to the output of an amplifier for recording, or to the input of an amplifier for reproducing. Means for selectively making these connections are well known in the art.

The transducer 12 is mounted to the forward end of an arm 13 which is pivotally supported at its rearward end for vertical swinging motion in a yoke-shaped and upwardly projecting portion of a carriage 14. The carriage is slidably supported by eye-shaped members 34 and 35 at its forward end, which slide along a shaft 15, and by a roller 16 at its rearward end. The roller 16 is adapted to roll along a track rod 17 which is fixedly mounted to a base 18, said track rod being parallel to the surface of the record, and also parallel to the shaft 15. It will be seen that in this manner the carriage 14, arm 13, and transducer 12 may move radially in such a manner that, as the turntable 11 rotates and the carriage 14 moves, a spiral groove is produced in the surface of the record 10. Uniform radial motion is achieved by means of a lead screw 19, which is journaled at its ends in two pillars 20 and 21, which project upwardly from the base 18.

Near its left end the lead screw 19 has mounted on it a worm gear 22, which meshes with a worm portion of a vertical spindle 23. Said spindle 23 is flanged, fixedly mounted thereby to the center portion of the turntable 11, and journally supported in a columnar portion 24 of the base 18. The worm portion 25 of spindle 24 meshes with the worm gear 22, as described above, hence, rotating the lead screw 19. Pivotally mounted to the carriage 14 is a split lead nut 26, which is adapted to engage the lead screw 19 in scissors fashion. The lead nut 26 is urged into engagement with the screw 19 by a closing spring 47. Thus, it will be seen that as the turntable 11 rotates, the transducer 12 and its stylus 9 are moved radially along above the surface of the record 10, in such a manner that the stylus embosses a spiral groove in the record, or may reproduce

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sound from a spiral groove recording in the record.

Slidably mounted on the shaft 15 is a disc-shaped drive wheel 28, the purpose of which is to engage and rotate the turntable 11. This drive wheel has in the instant embodiment several attached parts, which rotate with it about a common axis, as seen best in Fig. 4.

The drive wheel 28 is constructed of ferro-magnetic material, and its periphery is slightly crowned, thus adapting it to engage the under surface of the turntable 11 at substantially a single point. A cylindrical magnet 29 is mounted integrally with the drive wheel 28 and is so magnetized as to produce a magnetic pole at each of its circular ends, as indicated by the letters "N" and "S" in Fig. 4. A cup-shaped soft iron pole piece 30 serves to conduct the magnetic flux from the right end of the magnet 29 towards a toroidal gap 31, thus producing a strong magnetic field therein. The outside diameter of the pole piece 30 is slightly less than that of the wheel 28. The drive wheel, magnet and pole piece are mounted on a tubular core 32 of non-magnetic material having formed on its inner surface an inwardly projecting key, which engages a keyway 33 in the shaft 15. The outer ends of the core 32 are threaded to engage concentrically threaded holes in the wheel 28 and the pole piece 30.

Thus, it will be seen that the magnet 29, the core 32, and the drive wheel 28 operate as a unit. This unit may slide longitudinally along shaft 15, but by virtue of the key portion of the core 32, it may rotate only with the shaft. The shaft 15 is rotated at a constant speed by a motor 37, which is belted to a flywheel 38, which in turn is concentrically keyed to the outer end of the shaft 15 and rotates therewith. Said shaft 15 is journaled at its outer end in a pillar 39, which projects upwardly from the base 18 and at its inner end in a side of the column 24.

The forward end of the carriage 14 is bifurcated into two eye-shaped portions 34 and 35, which pass over the shaft 15 and are slidable thereon. The core 32 is retained between the two eye-shaped members 34 and 35, in such a manner as to be moved longitudinally along the shaft 15 by the carriage 14. The carriage 14 is so shaped that the periphery of the drive wheel 28 engages the under surface of the turntable 11 at a point immediately below the stylus 9, which relative position is maintained regardless of the radial position of the carriage 14.

The turntable 11 is of laminar construction, the upper laminum 40 being of rubber, or a similar flexible material, and the lower laminum 41 being of a ferro-magnetic substance. Since this lower portion of the turntable is ferro-magnetic, it will be attracted by the drive wheel 28. In order to permit the turntable to be urged into engagement with the drive wheel a portion of the lower laminum 41 is cut away near its center forming an annular gap 42. The turntable, therefore, is supported across said gap 42 by the upper flexible laminum and by virtue of the flexibility mentioned, the turntable is free to tilt slightly in any direction.

The magnetic attraction of the drive wheel 28 causes the turntable to tilt slightly downward to the right (as viewed in Fig. 2) until the lower laminum 41 strikes and engages frictionally with the periphery of the drive wheel 28. Since the diameter of the wheel 28 is slightly greater than the diameter of the pole piece 30, the pole piece

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does not touch the turntable, thus the drive wheel 28 and the turntable are engaged at substantially a single point. The gap between the pole piece 30 and the turntable 11 is, however, quite small. Because of the smallness of this gap and because the drive wheel 28 actually contacts the ferro-magnetic portion of the turntable, the magnetic attraction between the turntable and the drive wheel is relatively great with no significant resultant forces being developed, however, either in the journal bearings of the horizontal shaft 15, or in the bearings of the vertical spindle 23. The magnetic flux path produced in the system is shown in Fig. 2 by flux lines 44. By making use of magnetic attraction in the manner described, very much greater force can be applied to frictionally engage the drive wheel and the turntable than can be applied practically through the bearings of friction driven element of conventional design. Because of this greater engaging force, only a relatively low coefficient of friction need exist between the drive wheel and the turntable. Since the coefficient of friction need not be great, materials of good wearing quality, such as iron and steel, may be used in the construction of the friction drive elements, thus resulting in a great uniformity of speed transmission and long life of the mechanical elements.

Another method and means by which my invention can be embodied in the phonographic apparatus described is illustrated in Figs. 6 and 7. In this instance, a pole piece 43, which serves to concentrate the magnetic flux adjacent to the point of frictional engagement, is fixedly mounted to the carriage 14. It is so mounted on this carriage that it moves with it, and hence, the drive wheel 28 and the magnet 29 have at all times the same spatial relationship with the pole piece. Since the cup-shaped pole piece 30 is omitted in this alternate method, it is necessary to make use of the nut 48 to retain the magnet 29 and wheel 28 on core 32.

The magnetic flux path produced by this alternate method is shown in Figs. 6 and 7 by flux lines 44, which start from the end of the magnet marked "S," cross the small vertical gap 45, passing into the pole piece 43; hence, through the pole piece to a horizontal gap 46 and into the lower lamination 41 of the turntable 11. From the turntable they pass into the frictionally engaged drive wheel 28 and hence, back through the magnet 29. The effect of the concentrated flux in the horizontal gap 46 and at the point of engagement of the drive wheel 28 and the turntable lamination 41 results in a comparatively high degree of frictional engagement pressure.

While I have described only one embodiment of and use for my invention, others will become apparent. For instance, in clock drives for telescopes and astronomical instruments a speed reduction is often required of such a ratio as to be unattainable with spur or worm gear reductions. The extreme accuracy of speed reduction attainable in systems employing my invention renders them useful in this latter application. Many modifications and uses of this system will become apparent to those skilled in the art and I do not mean to be limited to the embodiments shown herein, but rather to the scope of the appended claims.

I claim:

1. In phonographic apparatus of the class described and employing a record bearing turntable frictionally driven by the periphery of a drive

wheel mounted in adjustable relationship to the said turntable, a magnetic means for maintaining frictional engagement pressure between said turntable and drive wheel, which means consists of the combination of: a turntable constructed of ferro-magnetic material; a drive wheel magnetized with one magnetic pole at the engaged periphery thereof; a non-rotating, ferro-magnetic pole piece mounted in fixed relationship with the axis of the drive wheel, but in adjustable relationship with the turntable, so that it moves with said drive wheel and forms a magnetic flux conducting path, which serves to lead a substantial portion of the flux to an area adjacent to the point of frictional engagement between the drive wheel and turntable.

2. In a variable speed transmission for constant groove speed recording-transcription equipment, the combination of: a driven disc of ferro-magnetic material mounted for rotation and adapted to serve as a record supporting turntable; a driving roller mounted for rotation with its periphery engaged substantially at a point with a face of said driven disc; a permanent magnet mounted for rotation with said roller and with one pole face thereof in contact therewith; and a generally cylindrical pole piece mounted for coaxial rotation with said roller, spaced therefrom, and in contact with the other pole face of said magnet whereby to produce a concentration of magnetic flux in a toroidal shaped space adjacent the periphery of said roller.

3. In a variable speed transmission for constant groove speed recording-transcription equipment, the combination of: a driven disc of ferro-magnetic material mounted for rotation and adapted to serve as a record supporting turntable; a driving roller mounted for rotation with its periphery engaged substantially at a point with a face of said driven disc; a permanent magnet mounted for rotation with said roller and with one pole face thereof in contact therewith; a generally cylindrical pole piece mounted for coaxial rotation with said roller, spaced therefrom, and in contact with the other pole face of said magnet whereby to produce a concentration of magnetic flux in a toroidal shaped space adjacent the periphery of said roller; and flexible supporting means for said driven disc whereby the same is adapted for tilting motion in response to said magnetic attraction of said roller and pole piece.

4. In a variable speed transmission for constant groove speed recording-transcription equipment, the combination of: a driven disc of ferro-magnetic material mounted for rotation and adapted to serve as a record supporting turntable; a driving roller mounted for rotation with its periphery engaged substantially at a point with a face of said driven disc; a permanent magnet mounted for rotation with said roller and with one pole face thereof in contact with said roller; and a flux conducting member mounted in fixed spaced relationship with said roller and magnet and shaped and adapted to conduct flux from the periphery of said roller adjacent said engaged point thereof, to the other pole face of said magnet.

5. In a variable speed transmission for constant groove speed recording-transcription equipment, the combination of: a driven disc of ferro-magnetic material mounted for rotation and adapted to serve as a record supporting turntable; a driving roller mounted for rotation with its periphery engaged substantially at a point with

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a face of said driven disc; a permanent magnet mounted for rotation with said roller and with one pole face thereof in contact with said roller; a flux conducting member mounted in fixed spaced relationship with said roller and magnet and shaped and adapted to conduct flux from the periphery of said roller adjacent said engaged point thereof, to the other pole face of said magnet; and flexible supporting means for said driven disc whereby the same is adapted for tilting motion in response to magnetic attraction of said roller and flux conducting member.

6. In phonographic apparatus of the class described and employing a record bearing turntable frictionally driven by the periphery of a drive wheel engaged therewith, magnetic means for maintaining frictional engagement pressure between said turntable and drive wheel, which means consists of the combination of: a turntable having a portion thereof constructed of ferro-magnetic material; a drive wheel magnetized with one magnetic pole at the engaged periphery thereof; and a generally cylindrical pole piece mounted for coaxial rotation with said drive wheel in flux conducting connection therewith whereby to produce a concentration of magnetic flux in a toroidal shaped space adjacent the periphery of said roller.

7. In phonographic apparatus of the class described and employing a record bearing turntable frictionally driven by the periphery of a drive

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wheel engaged therewith, magnetic means for maintaining frictional engagement pressure between said turntable and drive wheel, which means consists of the combination of: a turntable having a portion thereof constructed of ferro-magnetic material; a drive wheel magnetized with one magnetic pole at the engaged periphery thereof; and a flux conducting member mounted in fixed spaced relationship with said drive wheel and adapted to conduct flux from the periphery of said drive wheel at the point of said engagement thereof to the other pole face of said drive wheel.

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