

Nov. 3, 1942.

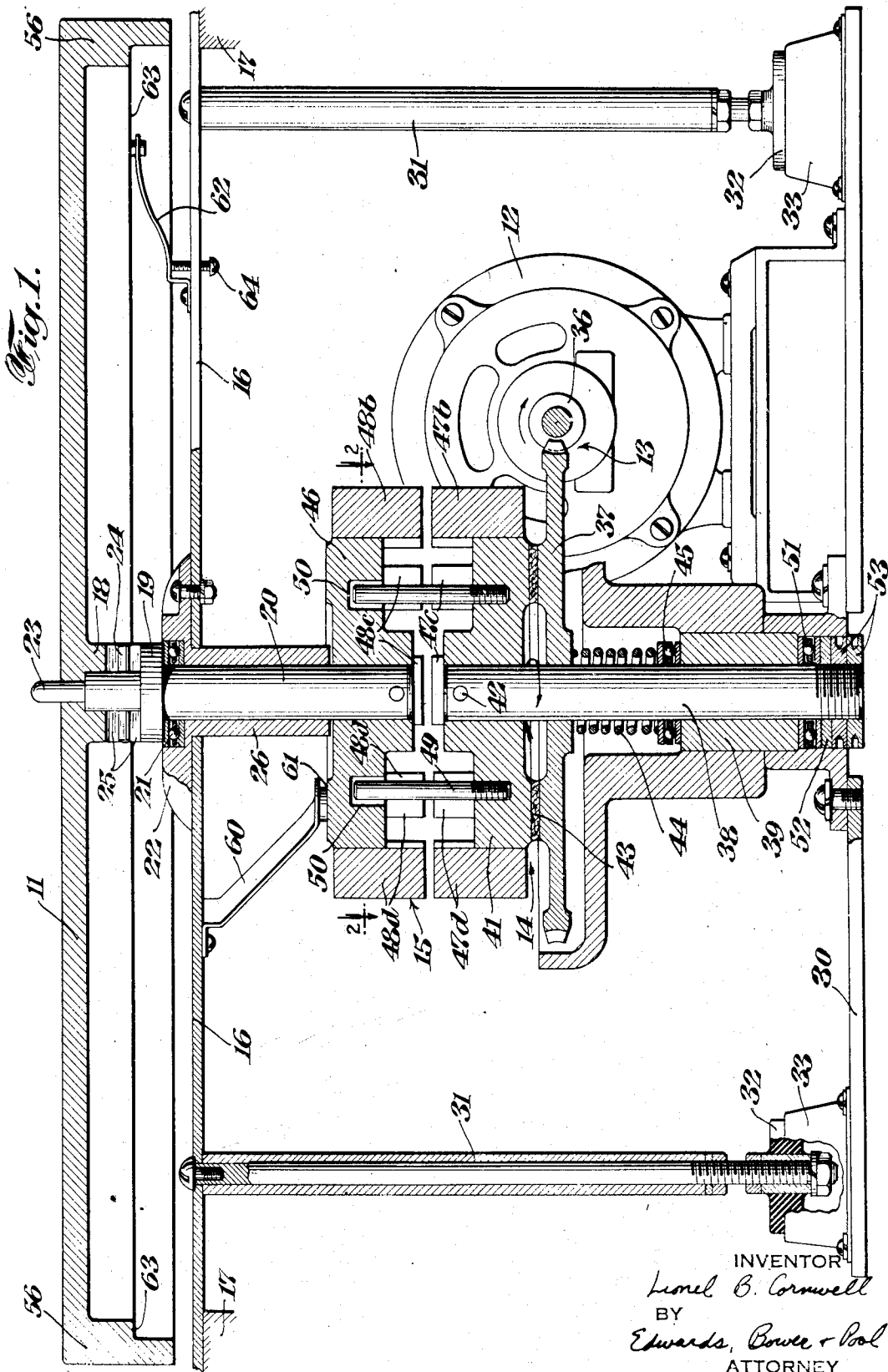
L. B. CORNWELL

2,300,778

SOUND REPRODUCER DRIVE

Filed Nov. 22, 1939

2 Sheets-Sheet 1



Nov. 3, 1942.

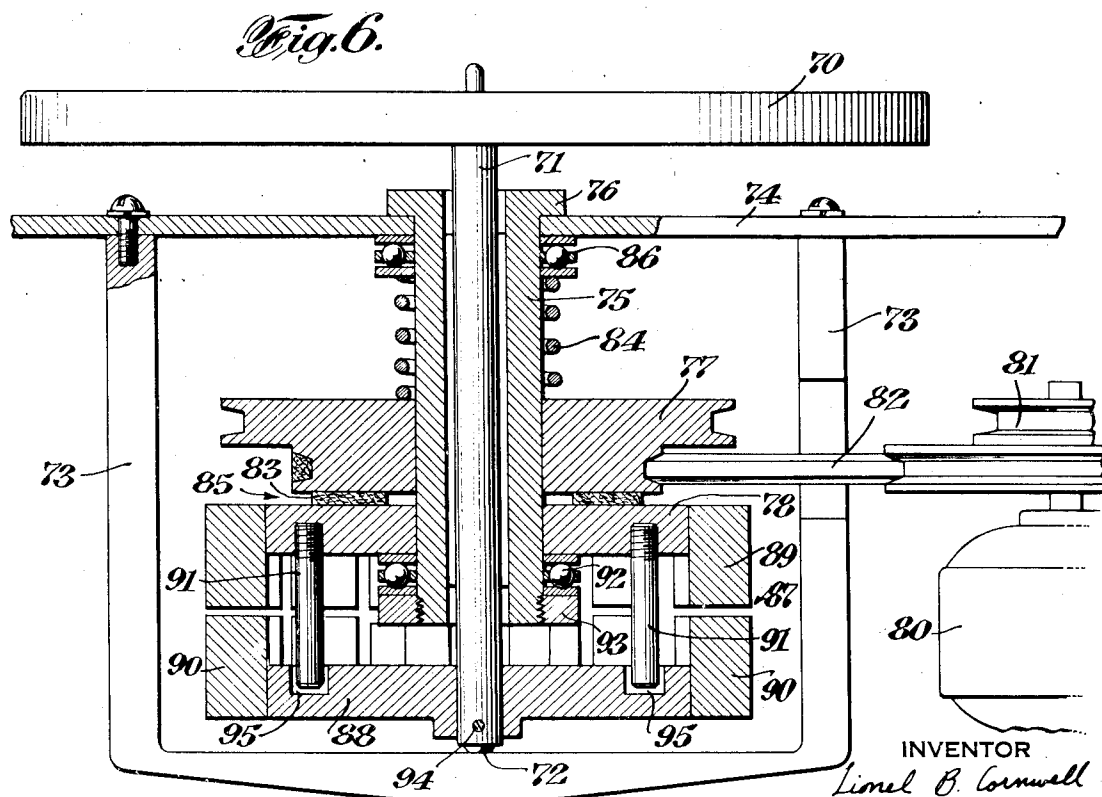
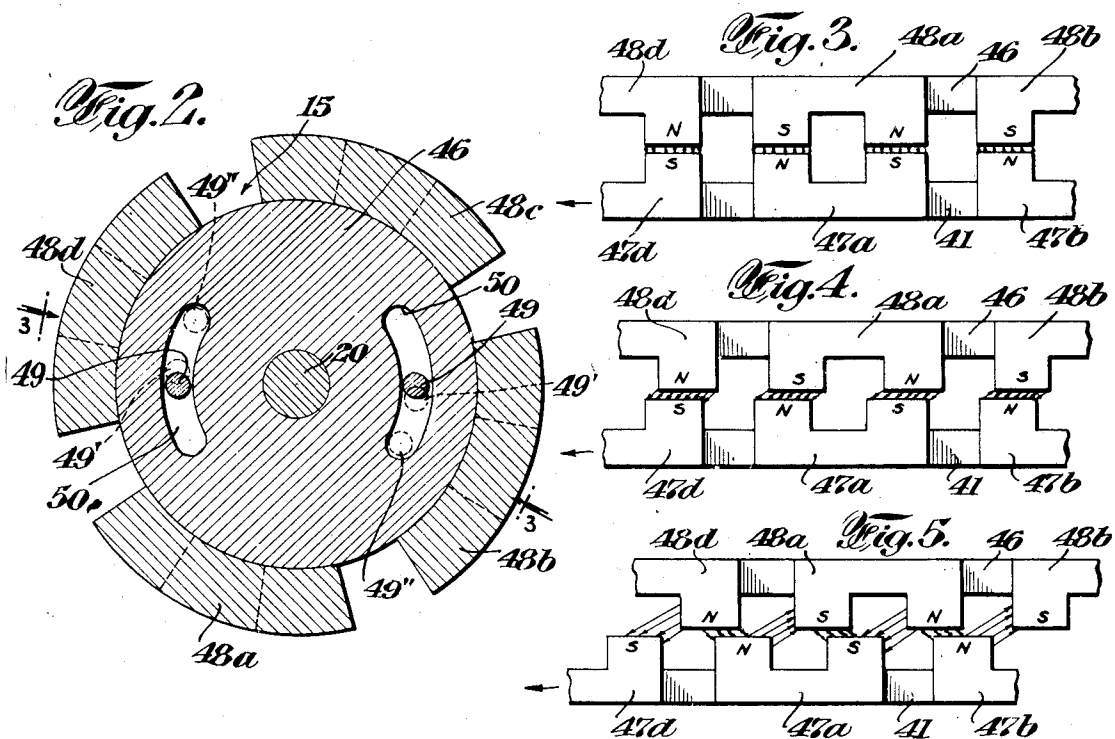
L. B. CORNWELL

2,300,778

SOUND REPRODUCER DRIVE

Filed Nov. 22, 1939

2 Sheets-Sheet 2



INVENTOR
Lionel B. Cornwell
BY
Edwards, Bruce & Pool
ATTORNEYS

UNITED STATES PATENT OFFICE

2,300,778

SOUND REPRODUCER DRIVE

Lionel B. Cornwell, Stamford, Conn., assignor to
Cinaudagraph Corporation, Stamford, Conn., a
corporation of Delaware

Application November 22, 1939, Serial No. 305,590

2 Claims. (CL 172-284)

This invention relates to apparatus for driving a rotating element and maintaining its speed closely constant.

The principal feature of the invention is the provision of such an apparatus which is simple and inexpensive in construction and effective in operation.

The invention is shown and described as applied to a turntable of a phonograph or other device for rotating a record in the recording or reproduction of sound. In such devices, particularly for those used where high fidelity sound recording and reproduction are required, as in radio broadcast and motion picture work, it is essential that there be no variation in the speed of the turntable.

Other features of the invention, and its advantages, will become apparent from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a vertical section through the center of the apparatus;

Fig. 2 is a horizontal section of a portion of the apparatus shown in Fig. 1, the section being taken along the line 2-2 thereof;

Fig. 3 is a diagrammatic view of the portion of the apparatus shown in Fig. 1, the view being a development of a vertical elevation about the portion of the periphery indicated by the line 3-3 of Fig. 2;

Figs. 4 and 5 are diagrammatic views similar to Fig. 3 showing other relative positions of the parts; and

Fig. 6 is a vertical section through the center of an alternate construction.

Referring to Fig. 1, the disc or turntable 11 is mounted to rotate about a vertical axis and is driven by the motor 12 through the reduction gearing 13, friction clutch 14 and coupling device 15.

The turntable 11 is positioned above the plate 16, the plate being suitably supported around its edge by the cabinet 17 which houses the apparatus, and the turntable being rotatably supported upon the plate 16. In the construction shown, the hub 18 of turntable 11 rests upon the top of enlarged head 19 of the vertical shaft 20, the under side of head 19 resting upon the supporting bearing 21, the bearing 21 resting in a recess in the head of a member 22, and the latter being in engagement with and supported by the plate 16. The shaft 20 extends upwardly into the hub 18 and has a portion 23 projecting above the top of the turntable for centering the record thereon. A pin 24 extends radially from 55

shaft 20 and engages the walls of slots 25 in hub 18 for preventing relative rotation between the shaft 20 and the turntable 11. Member 22 is formed with a sleeve 26 which extends downwardly through the aperture in plate 16 and serves to guide the shaft 20 which is positioned within it.

The motor 12, gearing 13 and friction clutch 14 are positioned below plate 16 and are supported upon a chassis 36. This chassis is suspended from plate 16 by the rods 31, the lower end of each such rod being secured to the center of a sponge rubber cushion 32, with the cushion secured to the chassis by the mounting ring 33 which engages a peripheral shoulder on the cushion 32. The motor, gearing and friction clutch are thus mounted upon the cabinet 17 in such a manner that the mechanical vibrations developed therein are not transmitted by the supports therefor to the turntable 11.

The gearing 13 consists of a worm 36 and worm wheel 37, the former being secured to the shaft of the motor 12 and the latter being rotatably mounted upon a vertical shaft 38 which is coaxial with shaft 20. The shaft 38 is rotatably mounted in a sleeve 39 which is suitably secured to the chassis 36.

The friction clutch 14 consists of the top surface of worm wheel 37, the bottom surface of a disc 41 which is secured to the shaft 38 by the pin 42, a friction ring 43 positioned between and in engagement with these two surfaces, and the helical compression spring 44. The helical compression spring 44 is positioned about shaft 38 and urges the worm wheel 37 upward toward the disc 41 and thus furnishes the friction-creating pressure for the clutch. The lower end of the spring presses against a bearing 45 which rests upon a radial shoulder formed on sleeve 39.

The coupling device 15, coupling shaft 38 with shaft 20, consists (referring also to Fig. 2), of the disc 41 secured to shaft 38, a disc 46 secured to the shaft 20, a number of permanent magnets 47a, 47b, 47c and 47d secured around the periphery of disc 41, a corresponding number of similar permanent magnets 48a, 48b, 48c and 48d secured around the periphery of disc 46, and one or more pins 49 each having one end thereof mounted in the disc 41 and having the other end thereof positioned in an arcuate slot 50 in disc 46. Each of the permanent magnets 47 and 48 is formed with two oppositely magnetized poles N and S joined by a yoke, with magnets 47 on the lower disc 41 mounted so that the poles thereof extend upwardly, with magnets 48 on the upper disc 46 mounted so that the poles thereof extend

downwardly, and with substantial clearance between the ends of the upper and lower sets of poles. To maintain this clearance the shaft 38 is provided with thrust bearing 51 positioned between the lower surface of sleeve 39 and a washer 52, the latter being suitably secured to shaft 38 as by lock nuts 53. Magnets 47 and 48 are correspondingly spaced on their respective discs 41 and 46, with alternate poles on each disc having the same polarity and with corresponding upper and lower poles having opposite polarity. Thus, when the discs 41 and 46 are positioned relative to each other so that the corresponding magnets 47 and 48 are opposite each other, as shown in Fig. 3, the magnetic force between the several poles tend to keep the discs in this relative position. For convenience this relative position is referred to as the "static" position of the coupling device 15.

In considering the operation of the apparatus, assume initially that all the parts are stationary and that the coupling device 15 is in the "static" position (i. e. the position shown in Fig. 3) and that motor 12, when in operation, rotates worm 36 clockwise, as viewed in Fig. 1. Thus, upon the starting of motor 12, worm wheel 37 is rotated clockwise, as viewed from above, or forward as this direction of rotation is for convenience hereinafter termed. Likewise, disc 41 rotates forward since at first there is no slipping of the friction clutch 14.

As soon as lower disc 41 rotates forward relative to upper disc 46, as shown in Fig. 4, the magnetic forces between magnets 47 and 48 tend to rotate upper disc forward (see Fig. 4). However, opposing this starting movement of upper disc 46 is its inertia and the inertia of the turntable 11, the inertia of the latter having been made large by constructing the turntable of heavy material and with an oversize flange 56 at its perimeter to obtain a fly-wheel action. As a consequence the magnetic forces of coupling device 15 are insufficient to overcome all this inertia so that the lower disc 41 advances relative to the upper disc 46 until pins 49 on the lower disc engage the forward ends of slots 50 in the upper disc 46. The lower disc 41 is then unable to advance any further relative to the upper disc 46 and for the time being the two discs are mechanically coupled for joint forward motion. The positions of the magnets at this time are shown in Fig. 5, the positions of the pins 49 being indicated by the dotted outlines 49' in Fig. 2.

Thereupon the inertia of the turntable 11 and disc 46 is mechanically applied to the lower disc 41, and as the friction clutch 14 is unable to transmit, without slipping, sufficient force to overcome this inertia, the friction clutch 14 commences to slip.

However, the force that is transmitted by the friction clutch 14 gradually overcomes the inertia of the turntable 11 and disc 46 and eventually brings the speed of the turntable 11 substantially up to that of lower disc 41. Thereupon the magnetic forces between the magnets 47 and 48 bring the upper set of magnets into substantial alignment with the lower set of magnets and thereby substantially eliminate the advance of the lower disc 41 with respect to the upper disc 46. During further operation the coupling between the discs is solely by means of the magnetic forces, so the drive thereupon becomes exclusively magnetic. To overcome the friction and other losses attendant upon the rotation of turntable 11, a small rotative force must be applied to the upper

disc 46. This is supplied by the slight advance of the lower disc 41 with respect to the upper disc 46, as shown in Fig. 4. Fig. 4 thus illustrates the positions of the parts under normal full speed running conditions, while Fig. 5 represents the positions of the parts during their acceleration up to normal full speed running condition. The position of the pins 49 under the conditions illustrated in Fig. 4 is shown by the dotted pin outlines 49' in Fig. 2; similarly, the position of pins 49 under the conditions illustrated in Fig. 5 is shown by the dotted pin outlines 49'' in Fig. 5.

After the turntable has been brought up to full speed, none of the vibrations of the motor 12 or of the gearing 13 is transmitted to the turntable. Also, momentary variations in the speed of disc 41 due to any cause, (such as to a change in the line voltage of the motor, or to irregularities in gear teeth or to back lash in the gearing), are not transmitted to the turntable as these momentary speed variations are absorbed by momentary movements of the lower disc 41 relative to the upper disc 46. If the speed variation and thus the relative displacement of the discs, becomes more than momentary, the magnetic forces between the magnets 47 and 48 gradually change the speed of the turntable, against the inertia of the turntable, until the parts are restored to their normal positions. In other words, momentary speed variations of the motor and gearing are not transmitted to the turntable, but any permanent change in speed of the motor and gearing results in a very gradual change in speed of the turntable.

To insure that under normally full speed running conditions under very light driven loads the lower disc 41 is slightly in advance of the upper disc 46, a small frictional load, preferably adjustable, may be applied either to the upper disc 46 or to the turntable 11. Such a load may be applied by a leaf spring 60 secured at one end to plate 16 and having its other end engaging an annular surface 61 on the top of disc 46. Alternatively, such a load may be applied by a leaf spring 62 secured at one end to plate 16 and having its other end engaging an annular surface 63 on the underside of turntable 11, preferably near the rim. In either case the leaf spring is preferably provided with some means, such as screw 64, to regulate the engaging pressure of the spring and thus the friction which is thereby created. While the amount of friction created is small, it should be substantially larger than the torque otherwise required to drive the turntable so that any incidental variations in such torque are relatively insignificant in comparison to the total torque required to drive the turntable. Thus the drag of the turntable upon the coupling device 15 is substantially constant and of sufficient quantity to insure that the upper disc 46 lags enough behind the lower disc 41 to avoid "hunting."

Fig. 6 shows an alternate construction. The turntable 70 is mounted on the upper end of a vertical shaft 71, the lower end of which is supported, through the bearing 72, upon the frame 73, the latter being secured to and positioned below plate 74. Surrounding shaft 71 is a sleeve 75, the upper end of which is formed with a collar 76 engaging the upper surface of plate 74. This sleeve is preferably stationary. Rotatably mounted upon sleeve 75 is a pulley 77 and a disc 78, pulley 77 being positioned above disc 78. The motor 80 for driving the turntable is at one side of the apparatus and is supported from plate

74 through cushions such as 32, 33 of Fig. 1, or by any other suitable means, which does not transmit the motor vibrations to the plate 74. A pulley 81 is secured to the shaft of motor 80, and pulleys 81 and 77 are connected by a belt 82. In the construction illustrated each pulley 81 and 77 has two surfaces of different diameter so that by shifting belt 82 from one surface to the other the pulley may be driven at either of two different speeds without changing the motor speed.

Between pulley 77 and disc 78, and engaging the lower and upper surfaces thereof respectively, is the annular friction disc 83. This, in conjunction with the surfaces which it engages and in conjunction with the helical spring 84, serves as a friction clutch 85 between pulley 77 and disc 78. Helical compression spring 84 surrounds sleeve 75, has its lower end engaging pulley 77 and has its upper end engaging a bearing 86 which abuts against the plate 74.

Disc 78 is coupled to shaft 71 by the coupling device 87 positioned below the pulley 77 and friction clutch 85. This coupling device 87 is similar to the coupling device 15 of Fig. 1, and consists of the disc 78 driven by pulley 77 through the friction clutch 85, of the disc 88 positioned below disc 78 and secured to shaft 71 (as by the pin 94), of the permanent magnets 89 and 90 secured along the perimeters of discs 78 and 88 respectively, and of pins 91 secured to disc 78 and extending into slots 95 in disc 88. To maintain the separation between magnets 89 and 90, and to support disc 78 and pulley 77 upon sleeve 75, a thrust bearing 92 is provided at the lower end of sleeve 75, the lower surface of this bearing engaging a collar 93 removably secured to sleeve 75, and the upper surface of this bearing engaging disc 78.

The turntable 70 has substantial inertia, as with the turntable 11 of Fig. 1 and, as in Fig. 1, a small frictional load is applied to the turntable.

The detailed description of the operation of the apparatus of Fig. 1 also is applicable to the operation of the alternate construction shown in Fig. 6. It is believed sufficient to note further that pulley 77, friction clutch 85 and coupling device 87 of Fig. 6 correspond respectively to worm wheel 37, friction clutch 14 and coupling device 15 of Fig. 1. An advantage of the construction of Fig. 6 is that vibrations and speed variations due to imperfect gears are avoided by dispensing with their cause—the gearing. Another advantage is that with the same apparatus

the turntable may be driven at either of two speeds, such as at 33.3 or 78 revolutions per minute.

In the system of this invention the turntable 11, 70 with its magnet is rotatable around a vertical axis independently of the cooperating drive magnet and its motor or belt. In normal operation only the attraction and repulsion between the magnets deliver the driving torque for the turntable. Structurally the parts are separate so that any vibrations of the driving motor, belts or gearing will not be mechanically transmitted to the turntable. The magnetic coupling effectively smooths out all irregularities in the drive and maintains an even torque on the turntable and completely protects it from mechanical shocks or vibrations originating in the driving mechanism.

Although the invention has been shown and described as applied to a turntable for a phonograph or other device, the invention is applicable to other rotating elements which are to be driven and maintained at a uniform speed, for example, the sprocket controlling the passage of sound film past the light beam of a sound recording or reproducing apparatus.

I claim:

1. A magnetic coupling comprising a rotatable driving rotor, a series of separate closely spaced U-shaped magnets carried by said rotor, each magnet having axially directed north and south poles with a connecting yoke, a driven rotor coaxial with said driving rotor, a series of separate spaced U-shaped magnets each having an axially directed north and south pole with a connecting yoke carried by said driven rotor, the south poles of the driving magnets facing the north poles of the driven magnets and vice versa and said poles being so closely spaced around the peripheries of the rotors that relative rotary motion between said rotors develops substantial repulsion between like poles of all the magnets while attraction between opposite poles of all the magnets is still maintained, and means rotatably supporting said rotors to drive the driven rotor from the driving rotor through the combined attraction and repulsion of the poles of said magnets.

2. A coupling as set forth in claim 1 in which the distance between successive magnets is less than the length of each magnet measured peripherally around the rotor.

LIONEL B. CORNWELL.