Dec. 25, 1962 A. C. IPPOLITO 3,070,660

ROTARY ELECTRICAL APPARATUS

Filed May 29, 1961 2 Sheets-Sheet 1

Fig. 1.

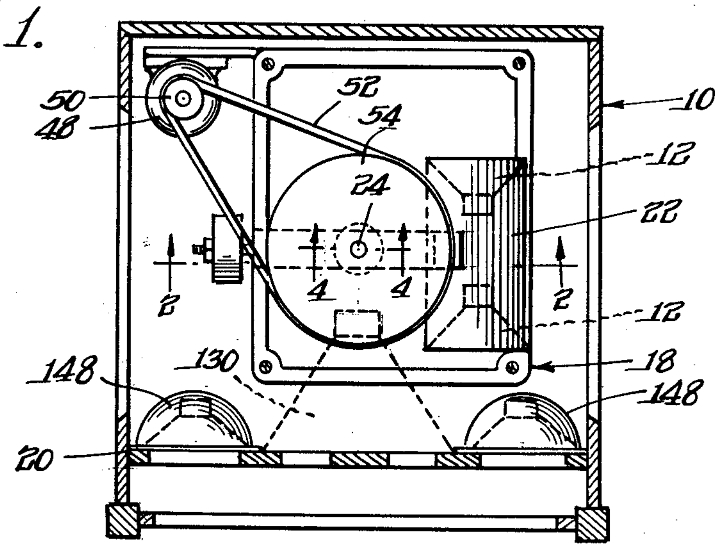

Fig. 2.

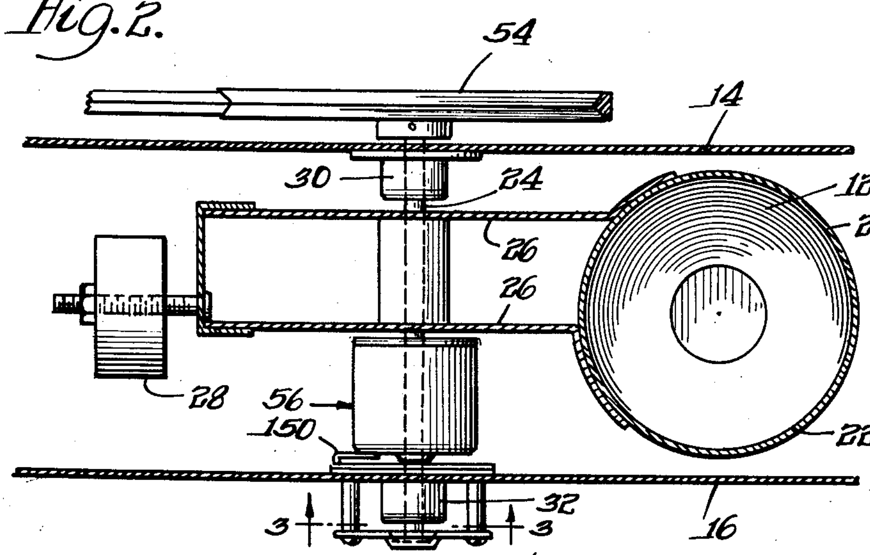

Fig. 3.

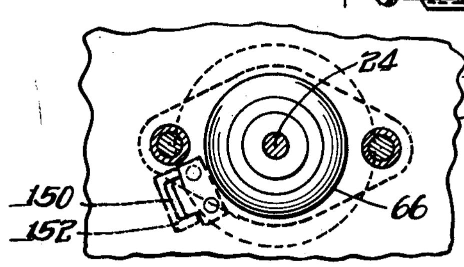

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Fig. 4.

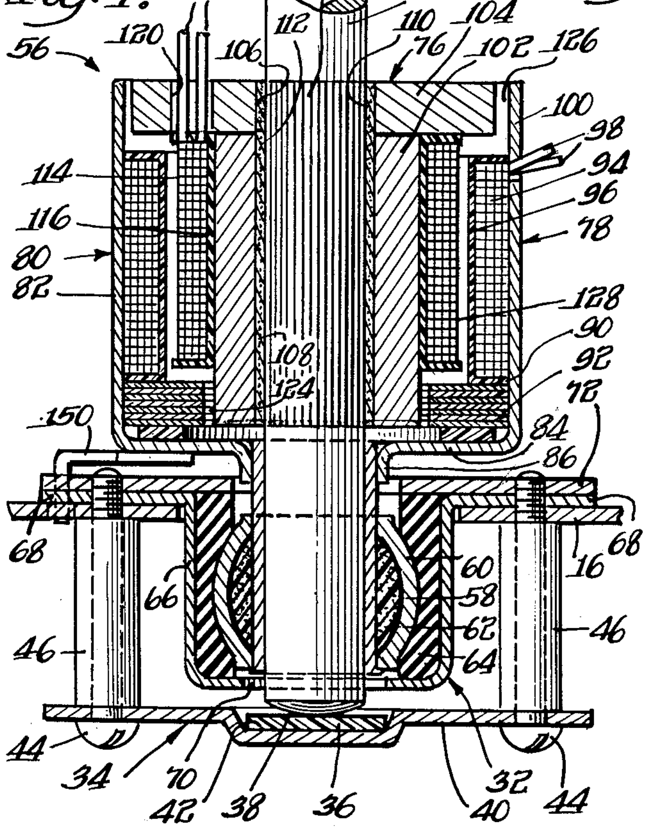


Fig. 5.

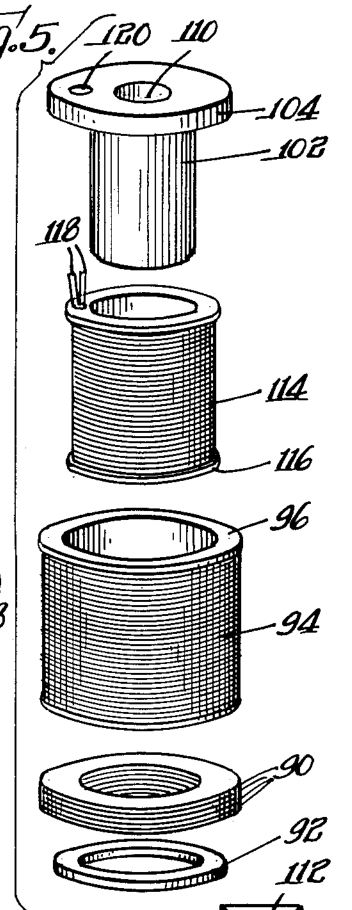
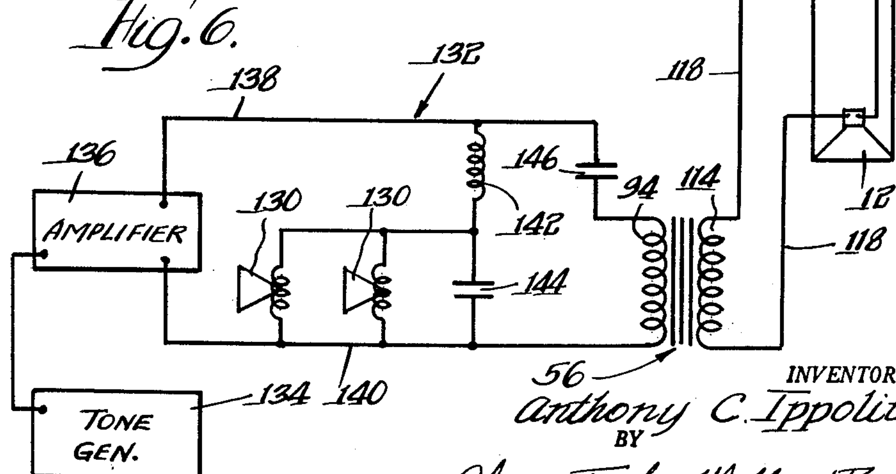


Fig. 6.



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ROTARY ELECTRICAL APPARATUS

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14 Claims. (Cl. 179—1)

The present invention relates to electrical sound generating apparatus in which rotating speakers are used to produce musical sound with vibrato effects from electrical sound signals.

Electrical sound generating apparatus of the above character is manufactured on a mass production basis for use in homes and in other places where it is operated without benefit of servicing or maintenance procedures. The purpose and intended usage of this equipment places great significance not only on its operational capabilities, but also on its adaptability to be manufactured economically and sold at an acceptably low price. The ability of the apparatus to operate silently and to generate sound without extraneous noises is of paramount importance.

Prior sound generating apparatus of this character has not been satisfactory in all respects. The shortcomings of such prior sound producing apparatus have included tendencies toward noisy operation, either due to the electrical introduction of noise into the speaker circuit or to mechanically produced noise occurring after prolonged usage. In some instances the connections between the driving amplifiers and the rotating speaker means have been imperfect and subject to deterioration through corrosion and wear on coacting parts.

One object of the invention is to provide vibrato sound generating apparatus of the above character having a new and improved construction well adapted for economical manufacture on a mass production basis and having the inherent capability of operating silently without maintenance over a long service life to effect noiseless energization of rotating speaker means.

Another object is to provide improved vibrato sound generating apparatus as recited in the preceding object which is not subject to deterioration through usage or age.

Another object is to provide vibrato sound generating apparatus of the character recited in which electrical driving energy is supplied to rotating speakers through a rotary transformer having a new and improved construction well adapted for economical manufacture and providing an optimum positional relationship of significant components rotatable with respect to each other, which positional relationship is, by virtue of the improved construction, in herently easy to establish and maintain.

Another object is to provide in vibrato sound generating apparatus of the above character sound signal transmitting means capable of transmitting electrical energizing signals to rotating speaker means without generating noise and having an economical yet inherently rugged construction which is not subject to damage by shock or rough handling.

Another object is to provide in vibrato sound generating apparatus rotary transformer means having an improved construction which, by virtue of its inherent character effects and maintains an optimum positional relationship of electrically coacting parts which rotate with respect to each other while at the same time providing a highly satisfactory electrical coupling through the transformer for driving the rotating speaker means.

Other objects and advantages will become apparent from the following description of the exemplary form of the invention illustrated in the drawings, in which:

FIGURE 1 is a horizontal sectional view of a tone cabinet incorporating the exemplary embodiment of the invention illustrated;

FIG. 2 is a vertical sectional view taken with reference to the line 2—2 of FIG. 1;

FIG. 3 is a sectional view looking upwardly from line 3—3 of FIG. 2;

FIG. 4 is a vertical sectional view on a greatly enlarged scale taken along the line 4—4 of FIG. 1;

FIG. 5 is an exploded perspective view showing concentric internal elements of the rotary transformer; and

FIG. 6 is a simplified diagrammatic illustration of electrical circuits used to energize speakers in the tone cabinet.

Referring to the drawings in greater detail, the tone cabinet **10** forming the exemplary embodiment of the invention illustrated generates sound with vibrato effects by means of two high frequency speakers **12** mounted back-to-back, as illustrated in FIGS. 1 and 2, and rotated in an annular path about a vertical axis of rotation. The rotatable speakers **12** are disposed, as shown in FIG. 2, between upper and lower horizontal plates **14**, **16** of a rotating speaker support frame **18**, FIG. 1, disposed within the housing or casing **20** of the tone cabinet **10**.

Preferably, the two speakers **12** are axially spaced from each other, as shown, and connected together by a cylindrical shroud or shell **22** encircling the two speakers and extending between the speakers to form with the speakers a plenum chamber which acoustically isolates the two adjacent sides of the speakers from the external environment.

The two speakers **12** are supported and rotated through an annular path by means of a vertical shaft **24**. Two vertically spaced support arms **26** are medially mounted on the shaft **24**, FIG. 2, for rotation with the shaft and extend into embracing attached relation to the speaker supporting shell **22**. The opposite ends of the arms **26** project from the shaft **24** in a direction opposite from the speakers **12** and support an adjustable counterweight **28** which provides dynamic balance for the rotating structure.

The vertical shaft **24** is journalled in two self-alining bearing assemblies **30**, **32** mounted on the upper and lower support plates **14**, **16**, respectively, and having a construction which will be presently described in detail.

The weight of the shaft **24** and structure supported by the shaft is supported by a simple thrust bearing **34** suspended below the lower self-alined bearing **32**, as shown. The weight supporting thrust bearing **34** comprises a small bearing disk **36** supported in a horizontal position in which it is engaged by the crowned lower end **38**, FIG. 4, of the shaft **24**. While other bearing materials can be used, the thrust disk **36** is preferably formed from a plastic material commercially available under the trade name "Nylatron." Support for the disk is provided by a support plate **40** defining a pocket **42** for the disk and being supported at opposite ends by screws **44** and spaced from the overlying plate **16** by spacers **46**.

The shaft **24** is rotated by an electric motor **48**, FIG. 1, having a small pulley **50** connected by a belt **52** to a much larger pulley **54** mounted on the upper end of the shaft **24** above the support plate **14**. The motor **48** rotates the speakers **12** at a speed which provides the optimum vibrato effects in the sound emitted by the speakers.

Electrical driving energy is supplied to the rotatable speakers **12** through a rotatable electrical coupling **56** having a novel construction combined with the roller bearing **32** and affording significant advantages in the construction of the apparatus and in the generation of sound.

The lower shaft bearing **32**, which is constructed as an integral part of the electrical coupling **56**, comprises a porous bronze bearing sleeve 58 journalling the shaft 24 and extending along a rather extensive axial segment of the shaft just above the lower end of the shaft, as shown in FIG. 4.

The bearing sleeve 58 is supported on the lower plate 16 by means which allows the bearing sleeve to swivel somewhat in relation to the support plate 16 to seek a position of concentric coaxial alinement with the shaft 24.

Thus, as shown in FIG. 4, the bearing sleeve 58 is encircled from its lower end along a major portion of the axial length of the sleeve by an annular steel jacket 60 shaped externally, as shown, in the form of a portion of a sphere intervening between two truncating planes. The center of the external spherical surface of the jacket 60 lies on the axis of the sleeve 58. Opposite ends of the jacket 60 fit tightly around the sleeve 58 to hold the jacket in a fixed position on the sleeve. The annular space between the sleeve 58 and and the jacket 60 is filled with a long-lasting lubricant which will exude through the bronze sleeve 58 to lubricate the shaft 24 over a virtually unlimited service life of the apparatus. A plastic or somewhat "solid" type of lubricant is used for this purpose. A lubricant known commercially as "Plastic E" is preferred for this use. The lubricant within the jacket 60 is identified by the number 62.

The steel jacket 60 is supported by an encircling bushing or annular cushion 64 formed of rubber. The radially inward surface of the annular rubber cushion or mount 64 is shaped to conform to the spherical external surface of the jacket 60. The rubber mount 64 has a cylindrical external form and is supported within a deep-drawn steel cup 66 having support flanges 68 overlying the plate 16. A central opening 70 in the cup 66 provides clearance for the shaft 24. A centrally open plate 72 is disposed in covering relation to the mount 64 and cup 66 and receives the threaded upper ends of the screws 44 which extend up through the plate 16 to support the thrust bearing 34, as described.

As a bearing, the upper bearing 30 is essentially similar to the bearing 32 described.

The electrical coupling 56 comprises a rotary assembly 76 mounted on the shaft 24, as will be described, in a stationary assembly 78 supported in a manner which assures a concentric properly spaced relationship of the rotary assembly in the stationary assembly with respect to each other.

The stationary assembly 78 is fixedly mounted on the bearing sleeve 58 of the self-alining bearing 32 to have a stable concentric relationship to the shaft 24 journalled in the sleeve 58.

The stationary assembly 78 comprises a deep-drawn steel cup 80 of cylindrical shape. The cup 80 is open at its upper end and comprises a cylindrical wall 82 merging at its lower end with a flat annular bottom 84 of the cup which extends radially inward to a downwardly protruding cylindrical spud integrally formed by extruding or swaging on the inner periphery of the cup bottom. The cylindrical spud or flange 82 is dimensioned to fit tightly around the upper end of the porous bronze bearing sleeve 58 to have a fixed relationship to the sleeve which positively assures a coaxial relationship of the bearing sleeve and cup wall 80 which extends upwardly beyond the bearing sleeve.

Thus, upon assembly of the shaft 24 to the bearing sleeve 58, the bearing sleeve 58 swivels within its mount as necessary to accommodate the shaft, thus causing the axis of the bearing sleeve and the axis of the cup wall 82 to coincide with the axis of the shaft.

The steel wall 82 of the cup 80 forms a component part of a magnetic circuit formed by coacting magnetic elements of the rotary and stationary assembly 76, 78, as will presently appear. A plurality of annular ferrite disks 90 are stacked together in the lower portion of the cup 80 on an annular, non-magnetic spacer 92 which rests on the cup bottom 84. The outer periphery of each of the flat annular ferrite disks 90 has a close circumferential fit with the cup wall 82.

A cylindrical primary coil or winding 94 wound on a plastic bobbin 96 is fitted into the cup 80 to engage the uppermost ferrite disk 90 in close proximity to the cup wall 82. The coil 94 and bobbin 96 are secured in place in the cup by a suitable cement. Lead wires 98 extend out through a slot 100 in the upper edge of the wall 82.

The rotatable assembly 76 comprises a ferrite core formed in two sections, one of which is a centrally bored ferrite element 102 having a cylindrical shape. The ferrite element 102 has a length somewhat exceeding the combined length of the primary coil 94 and the stack of ferrite disks 92. A second element of the ferrite core includes a thick ferrite disk 104 adapted to fit within the upper end of the cup 80 and having a central opening 106 substantially equal in diameter to the central bore 108 in the cylindrical element 102. The fixed disk 104 and the cylindrical element 102 are disposed in concentric relation to each other with the bore space of the disk 104 disposed in flat covering relation to the upper end of the element 102.

These two elements of the rotary core are cemented together by filling the opening 106 with an epoxy resin, while these elements are held in concentric abutting relation to each other.

Subsequently, the epoxy resin filling in the disk opening 106 and cylindrical element bore 108 is bored out to form an axial bore 110, coaxial with the element 102 and disk 104 and being dimensioned diametrically to receive the shaft 24 with a tight fit.

The opening 106 in the disk 104 and bore 108 and the element 102 have diameters exceeding that of the bore 110 in the epoxy filling 112 so that boring of the filling may use an epoxy sleeve of substantial radial thickness (also denoted by the number 112) bonded to the element 102 and disk 104 and forming a rigid connection between these parts.

A secondary winding or coil 114 of cylindrical shape is wound on a cylindrical bobbin 116 which is fitted around the core element 102 in underlying abutting relation to the disk 104 where the bobbin 116 is secured in place on the element 102 by a suitable cement. Lead wires 118 from the coil 114 extend upwardly through a hole 120 in the disk 104.

The shaft 24 is fitted axially into the bore 110 of the epoxy resin sleeve 112 which tightly encircles longitudinal knurling 122 on the shaft for rotation with the shaft.

The coacting elements of the couplings 56 are dimensioned in relation to each other so that the lower end of the cylindrical ferrite element 102 extends down to the bottom of he stack of ferrite disks 90 so that a radially thin air gap of cylindrical shape 124 is defined between the cylindrical surface of the element 102 and the inner periphery of the disks 90 spaced radially outward from the element 102. The longitudinal dimension of the cylindrical element 102 is such that the ferrite disk 104 fits within and is encircled by the upper end of the cup wall 82 to define a thin radial air gap 126 of cylindrical shape between the periphery of the disk 104 and the wall 82.

The primary coil 94 extends longitudinally from the uppermost ferrite disk 90 substantially to the thick rotary ferrite disk 104. Similarly, the secondary coil 114 extends longitudinally from the thick rotary disk 104 substantially to the uppermost ferrite disk 90.

The two cylindrical coils 94 and 114 extend radially toward each other to define therebetween a radially thin air gap 128 of cylindrical shape.

The parts thus assembled in relation to each other provide a magnetic circuit including the steel wall 82, the stacked ferrite disks 90, the thick cylindrical ferrite element 102 and the thick ferrite disk 104. This magnetic circuit is interrupted only by the radial air gap 126 and the radial air gap 124, both of which are concentric with the axis of the shaft 24. In this connection, it is also noteworthy that the coils 94 and 114 are radially spaced from each other.

The three critical air gaps or radial spacings in the assembly, that is, the radial air gaps 126, 124 in the magnetic circuit and the radial air gap 128 between the coils, are all accurately established and accurately maintained by the precise coaxial relationship of the cup wall 82 and the shaft 24 which is established by the fixed coaxial mounting of the cup 80 on the bearing sleeve 58.

Highly efficient magnetic coupling of the primary coil 94 with the secondary coil 114 is provided to the magnetic circuit of high permeability achieved through the extensive use of ferrite structural elements, including the stacked disks 90, the cylindrical element 102 and fixed disk 104. The steel cup 80 provides an adequate magnetic path between the disk 104 and disk 90, while at the same time affording powerful protective support to the assembly.

As illustrated diagrammatically in FIG. 6, the two rotary speakers 12 are connected in series with each other and connected through the leads 118 for energization by the secondary coil 104 of the coupling 56. The rotary speakers 12 generate sounds of relatively high frequencies, the generation of high frequency sound by the rotating speakers serving to produce the desired vibrato effects.

The lower frequency components of the sound generated in the tone cabinet 10 are produced by stationary bass speakers 130, FIGS. 1 and 6, mounted in stationary positions within the cabinet 10. The coupling 56 which transmits driving energy to the rotating speaker 12 is incorporated into a cross-over network 132, as illustrated in FIG. 6, to effect a selective discrimination between the frequency of the sound signals transmitted to the speakers 12 and the frequency transmitted to the bass speakers 130. As shown, a tone generator 134 drives an amplifier 136 having two output conductors 138, 140, an inductance 142 and a capacitor 144 connected in series between the conductors 138, 140 of electrical values which provide proper energization to two bass speakers 130 connected in parallel across the capacitor 144. The primary winding 94 of the coupling 56 is connected in series with a capacitor 146 between the conductors 138, 140 to energize the coupling 156 with high frequency sound signals which are transmitted to the speakers 12.

Stationary high frequency speakers 148 mounted in the tone cabinet 10 can be used in conjunction with the rotating speakers 12 to produce sounds with a "chorus" effect or to produce sound without a vibrato effect. The speakers 148 form no part of the invention.

A lug 150 secured to the lower end of the cup 80 extends down into an aperture 152 in the plate 16, as shown in FIGS. 2 and 3, to positively preclude rotation of the stationary assembly 78 of the coupling.

The invention is claimed as follows:

1. Electrical sound generating means comprising, in combination, a tone cabinet, a generally vertical shaft, sleeve bearing means mounted in said cabinet and journalling said shaft for rotation, thrust bearing means mounted on said cabinet and engaging the lower end of said shaft to support the shaft for rotation, drive means connected to rotate said shaft, loudspeaker means, means supporting said loud speaker on said shaft for rotation by the shaft through an annular path, a steel cup mounted in a stationary position encircling said shaft and including a cylindrical wall concentric with the shaft, a centrally bored ferrite core of cylindrical shape mounted on said shaft in concentric encircling relation thereto for rotation therewith and being disposed axially within said cylindrical cup wall, a plurality of thin annular ferrite disks stacked within said cup in stationary positions encircling one end of said core in close proximity to said core and having outer peripheries circumferentially engaging said cylindrical wall, a thick annular ferrite disk element encircling said shaft in contiguous engagement with substantially the entire end area of the end of said core opposite from said thin ferrite disks, said disk element being disposed axially within said cylindrical wall and extending radially outward into close proximity to said cylindrical wall, a cylindrical primary coil mounted in a stationary position within said cup means between said ferrite disks and said ferrite disk element in contiguous engagement with the inner surface of said cylindrical wall, a cylindrical secondary coil connected electrically to said speaker means and being mounted between said ferrite disks and said disk element in closely encircling relation to said ferrite core and in axially telescoped relation to said primary coil, and said primary and secondary coils extending radially toward each other into closely spaced relation to each other.

2. Electrical sound generating means comprising, in combination, a tone cabinet, a shaft, bearing means mounted in said cabinet and journaling said shaft for rotation, drive means connected to rotate said shaft loudspeaker means, means supporting said loud speaker means on said shaft for rotation therewith, a steel cup mounted in a stationary position encircling said shaft and including a cylindrical wall concentric with the shaft, a centrally bored ferrite core of cylindrical shape mounted on said shaft in concentric encircling relation thereto for rotation therewith and being disposed axially within said cylindrical cup wall, first ferrite disk means disposed within said cup in a stationary position encircling one end of said core in close proximity to said core and extending radially into circumferential engagement with said cylindrical wall, second ferrite disk means encircling said shaft in contiguous engagement with substantially the entire end area of the end of said core opposite from said first ferrite disk means, said second ferrite disk means being disposed axially within said cylindrical wall and extending radially outward into close proximity to said cylindrical wall, a cylindrical primary coil mounted in a stationary position within said cup between said first and second ferrite disk means in contiguous engagement with the inner surface of said cylindrical wall, a generally cylindrical secondary coil connected electrically to said speaker means and being mounted between said first and second ferrite disk means in closely encircling relation to said ferrite core and in axially telescoped relation to said primary coil, and said primary and secondary windings extending radially toward each other into closely spaced relation to each other.

3. Apparatus for generating sound with vibrato effects, comprising a shaft, bearing means journalling said shaft for rotation, drive means connected to rotate said shaft, loudspeaker means mounted for rotation with said shaft, means forming a cylindrical wall of magnetic material encircling said shaft in concentric relation thereto, a centrally bored core of cylindrical shape formed of a magnetic material and being mounted on said shaft in concentric encircling relation thereto for rotation therewith within said cylindrical wall, first and second annular disk means formed of a magnetic material, said first disk means closely encircling said core and extending radially into circumferential engagement with said wall, said second disk means encircling said shaft in contiguous engagement with the end of said core opposite from said first disk means, said second disk means being disposed axially within said wall and extending radially outward into close proximity to said cylindrical wall, a cylindrical primary coil mounted in a stationary position between said first and second disk means in contiguous engagement with the inner surface of said cylindrical wall and a generally cylindrical secondary coil connected electrically to said speaker means and being mounted between said first and second disk means in closely encircling relation to said core and in axially telescoped relation to said primary coil.

4. Electrical sound producing means comprising, in combination, a rotatable shaft, thrust bearing means supporting said shaft in a vertical position for rotation, sleeve

bearing means journalling said shaft for rotation, drive means connected to rotate said shaft, loudspeaker means supported on said shaft for rotation thereby, a cylindrical cup formed of a magnetic material mounted in a stationary position concentric with said shaft, a cylindrical magnetic core element mounted on said shaft in concentric encircling relation thereto and extending axially into said cup, a primary transformer coil supported in a stationary position within said cup in concentric relation thereto, a secondary transformer winding mounted on said transformer core in concentric encircling relation thereto and in telescoped relationship to said primary transformer winding, a plurality of annular disks formed of a magnetic material and seated within said cup in peripheral engagement with the cylindrical wall of the cup and in encircling relation to one end of said core, said disks extending radially inward into close radial proximity to said core, a thick annular disk formed of a magnetic material mounted on said shaft in concentric relation thereto for rotation therewith and having one face in contact with the entire radial end area of the end of said cylindrical core opposite from said plurality of disks, said thick rotary disk being disposed axially within said cup and extending radially outward into close proximity to said cylindrical cup wall.

5. Electrical sound producing means comprising, in combination, a rotatable shaft, thrust bearing means supporting said shaft in a vertical position for rotation, sleeve bearing means journalling said shaft for rotation, drive means connected to rotate said shaft, loudspeaker means supported on said shaft for rotation thereby, a cylindrical cup formed of a magnetic material mounted in a stationary position concentric with said shaft, a cylindrical magnetic core element mounted on said shaft in concentric encircling relation thereto and extending axially into said cup, a primary transformer coil supported in a stationary position within said cup in concentric relation thereto, a secondary transformer winding mounted on said transformer core in concentric encircling relation thereto and in telescoped relationship to said primary transformer winding, first annular disk means formed of a magnetic material and seated within said cup in peripheral engagement with the cylindrical wall of the cup and in encircling relation to one end of said core, said disk means extending radially inward into close radial proximity to said core, second annular disk means formed of a magnetic material mounted on said shaft in concentric relation thereto for rotation therewith and having one face in contact with the entire radial end area of the end of said cylindrical core opposite from said first annular disk means, said second annular disk means being disposed axially within said cup and extending radially outward into close proximity to said cylindrical cup wall.

6. Electrical sound producing means comprising, in combination, a rotatable shaft, thrust bearing means supporting said shaft in a vertical position for rotation, sleeve bearing means journalling said shaft for rotation, drive means connected to rotate said shaft, loudspeaker means supported on said shaft for rotation thereby, a cup comprising an end wall and a clyindrical wall fixed thereto formed of a magnetic material mounted in a stationary position concentric with said shaft, said cup being open at one end and a cylindrical magnetic core element mounted on said shaft in concentric encircling relation thereto and extending axially into said cup, a primary transformer coil supported in a stationary position within said cup in concentric relation thereto, a secondary transformer winding mounted on said transformer core in concentric encircling relation thereto and in telescoped relationship to said primary transformer winding, first annular disk means formed of a magnetic material and seated within said cup in peripheral engagement with the cylindrical wall of the cup adjacent one end of said primary coil and in encircling relation to one end of said core, said disk means extending radially inward into close radial proximity to said core, second annular disk means formed of a magnetic material mounted on said shaft in concentric relation thereto for rotation therewith and having one face in contact with the entire radial end area of the end of said cylindrical core opposite from said first disk means and adjacent the secondary winding, said second disk means being disposed axially within said cup and extending radially outward into close proximity to said cylindrical cup wall substantially closing the open end of the cup.

7. A rotary transformer comprising a cylindrical core of magnetic material adapted to be fixed on a shaft, a first transformer coil winding concentrically disposed about said core and relatively toward one end thereof, annular flange means of magnetic material extending radially from the end of said core toward which said coil winding is disposed, a cup adapted to be mounted independently of the shaft on which the core is mounted and comprising an end wall and a cylindrical side wall fixed thereto, said cup being open at the opposite end and being coaxially disposed with regard to said core and flange means, said flange means substantially closing said open cup end but terminating radially short of said cylindrical wall, and a second transformer coil winding fixed in said cup adjacent said cylindrical side wall concentric with and in inductive relation to said first transformer coil winding, said annular flange means radially overlapping said second transformer coil winding.

8. A rotary transformer as set forth in claim 7 wherein the cup is made of magnetic material.

9. A rotary transformer comprising a cylindrical core of magnetic material adapted to be fixed on a shaft, a first transformer coil winding concentrically disposed about said core and relatively toward one end thereof, annular flange means of magnetic material extending radially from the end of said core toward which said core winding is disposed, a cup adapted to be mounted independently of the shaft on which the core is mounted and comprising an end wall and a cylindrical side wall secured thereto, said cup being open at the opposite end and being coaxially disposed with regard to said core and flange means, said flange means substantially closing said open cup end but terminating radially short of said cylindrical wall, ring means of magnetic material fixed in said cup adjacent the end wall thereof concentric with said core and spaced radially therefrom in radially overlapping relation with said first transformer coil winding, and a second transformer coil winding fixed in said cup adjacent said cylindrical side wall and adjacent said ring means concentric with and in inductive relation to said first transformer coil winding, said annular flange means radially overlapping said second transformer coil winding.

10. A rotary transformer as set forth in claim 9 and further including non-magnetic spacer means spacing said ring means from the end wall of said cup.

11. A rotary transformer comprising a cylindrical core of magnetic material adapted to be fixed on a shaft, a first transformer coil winding concentrically disposed about said core and relatively toward one end thereof, first disk means of magnetic material disposed coaxially of said core and contacting substantially the entire radial extent of the adjacent end of said core, said first disk means extending radially out beyond said core, a housing adapted to be mounted independently of the shaft on which the core is mounted and comprising an end wall and a cylindrical side wall secured thereto, said housing being opened at the opposite end and being coaxially disposed with regard to said core and said first disk means, said first disk means substantially closing said opening housing end and terminating radially short of said cylindrical wall, a second transformer coil winding fixed in said cup adjacent said cylindrical side wall concentric with and in inductive relation to said first transformer coil winding, said annular flange means radially overlapping said sec-

ond transformer coil winding, and second disk means of magnetic material fixed in said housing adjacent the end wall thereof and peripherally engaging the side wall thereof, said second disk means radially overlapping said first transformer coil winding.

12. A rotary transformer as set forth in claim 11 wherein the core and the first disk means comprise ferrites and the second disk means comprises a plurality of stacked laminations.

13. A rotary transformer as set forth in claim 11 and further including a sleeve extending through said cylindrical core and said first disk means and securing said core and first disk means together.

14. A rotary transformer comprising a cylindrical core of magnetic material adapted to be fixed on a shaft, a first transformer coil winding unsymmetrically disposed about said core, annular flange means of magnetic material extending radially from one end of said core, a cup comprising an end wall and a cylindrical side wall fixed thereto, said end wall having an opening therein, bearing means received in said opening, mounting means secured to said bearing for mounting said bearing and said cup independently of the shaft on which the core is mounted, said cup being open at the end opposite the end wall and being coaxially disposed with regard to said core and flange means, said flange means substantially closing said open cup end but terminating radially short of said cylindrical wall, and a second transformer coil winding fixed in said cup adjacent said cylindrical side wall concentric with and in inductive relation to said first transformer coil winding, said annular flange means radially overlapping said second transformer coil winding.

No references cited.