Feb. 14, 1933. C. D. BOCK 1,897,835

LOUD SPEAKER

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Fig. 2.

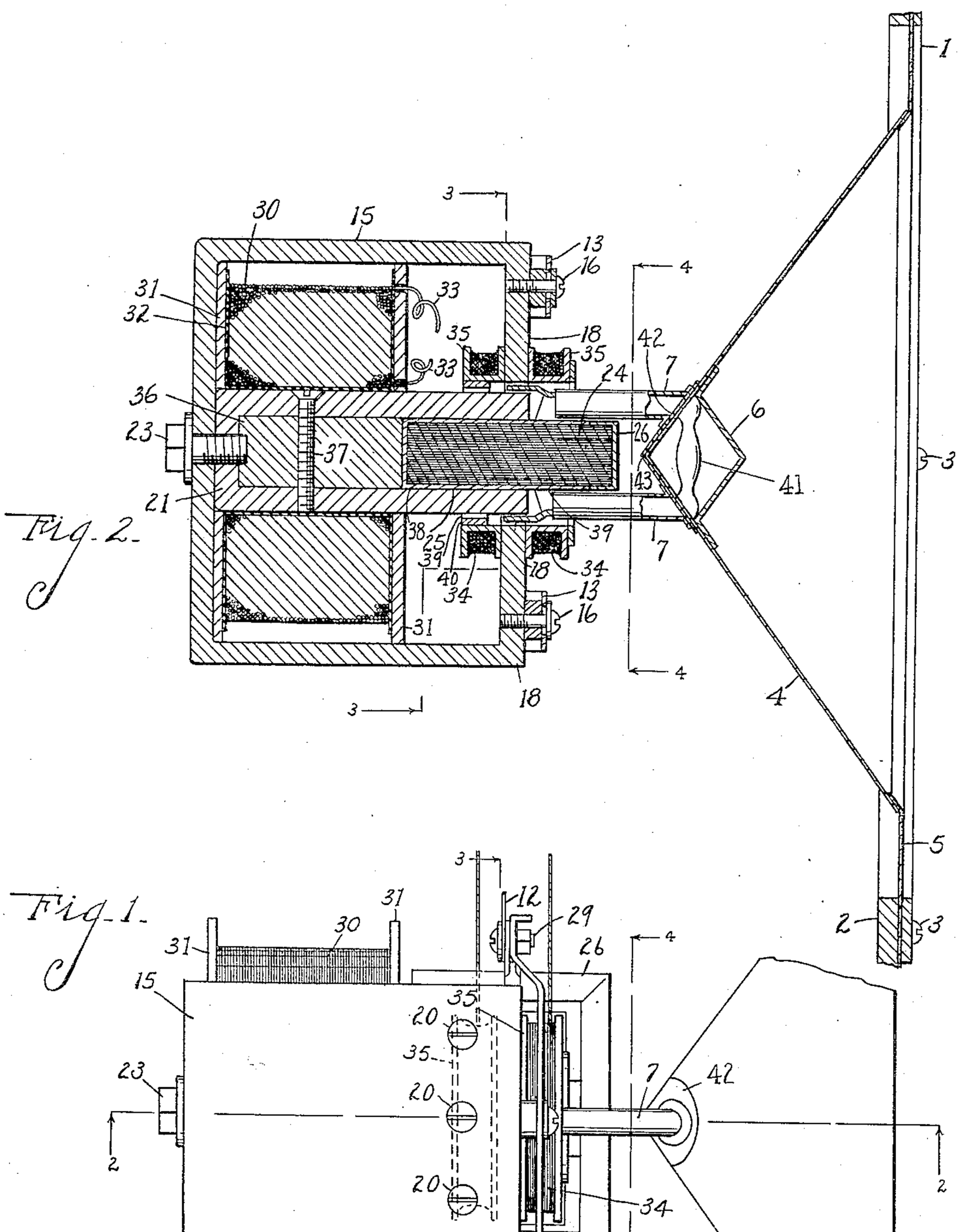

Fig. 1.

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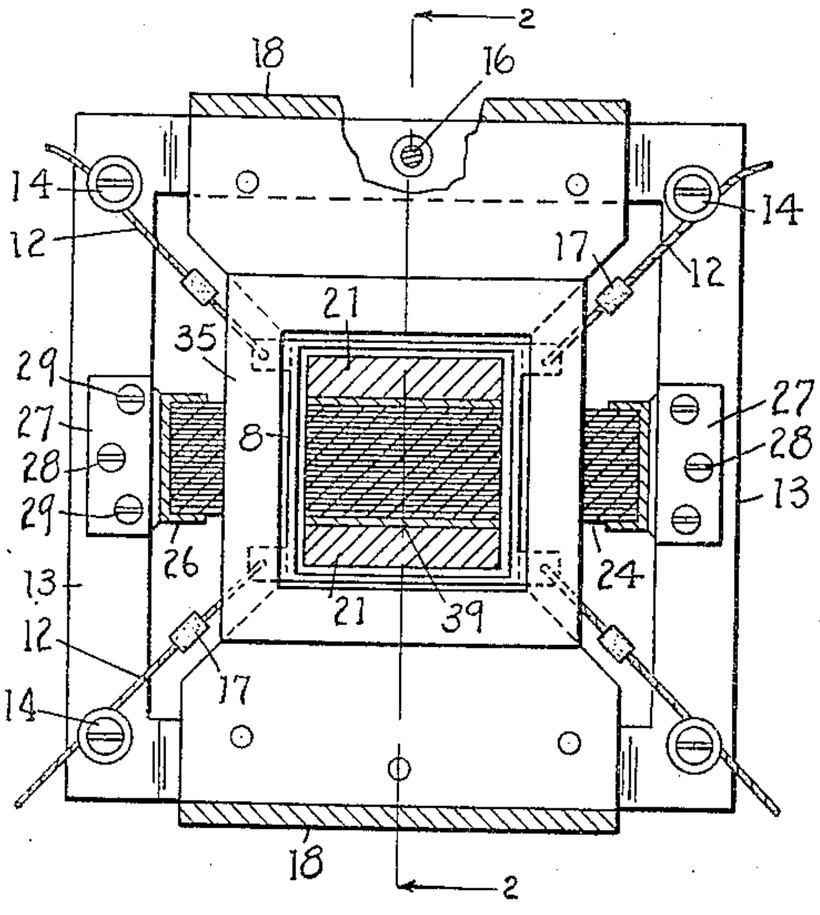

Fig. 3.

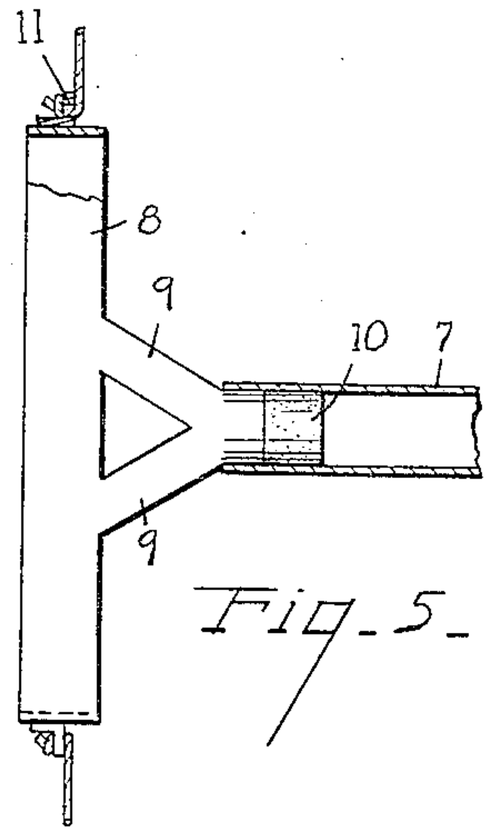

Fig. 5.

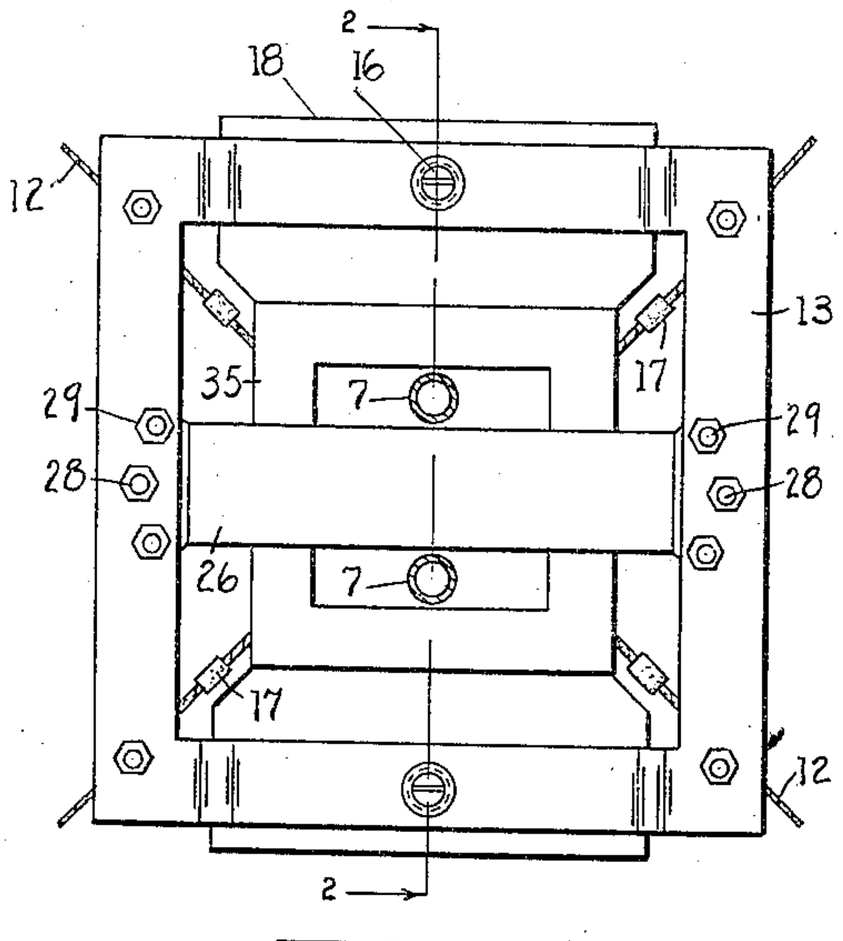

Fig. 4.

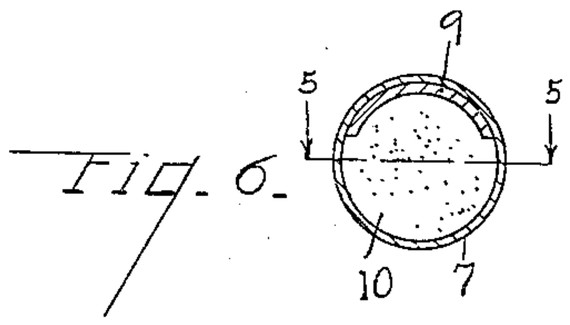

Fig. 6.

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UNITED STATES PATENT OFFICE

CHARLES D. BOCK, OF KALAMAZOO, MICHIGAN, ASSIGNOR OF ONE-HALF TO WILLIAM SHAKESPEARE, JR., OF KALAMAZOO, MICHIGAN

LOUD SPEAKER

Application filed September 2, 1931. Serial No. 560,739.

My invention relates to loud speakers and has for an object to provide a loud speaker that will operate efficiently and will be comparatively simple to construct and economical in cost.

With this and other objects in view, the invention consists in the construction and novel combination and arrangement of parts hereinafter fully described, illustrated in the accompanying drawings and pointed out in the claims appended hereto, it being understood that various changes in the form, proportions and minor details of construction, within the scope of the claims may be resorted to without departing from the spirit of the invention or sacrificing any of the advantages thereof.

In the drawings, Fig. 1 is a plan view of a preferred embodiment of the loud speaker of my invention having portions of the diaphragm broken away;

Fig. 2 is a cross sectional view of the loud speaker taken on line 2—2 of Fig. 1;

Fig. 3 is a view partially in cross section and partially in elevation of the loud speaker taken on line 3—3 of Fig. 2;

Fig. 4 is a view partially in front elevation and partially in cross section taken on line 4—4 of Fig. 1;

Fig. 5 is a greatly enlarged view partially in elevation and partly in cross section of the armature of the loud speaker; and

Fig. 6 is a cross sectional view taken on line 6—6 of Fig. 5.

Referring to the drawings, the numeral 1 indicates a rim that is secured to a supporting panel 2 by means of spaced screws 3. Secured between the rim 1 and the panel 2 is a conical diaphragm 4, to the outer edges of which is glued a border 5 of cloth, fabric, textile material, soft leather, or the like for flexibly suspending the diaphragm 4 in the supporting panel 2.

The conical diaphragm is made of relatively soft paper, preferably of a long, crossed fibre texture, chosen for its advantageous combination of high internal damping and mechanical stiffness. The damping is greatly increased by two layers of lacquer, one on each side. They bind the fibres at the ends and increase the viscosity of the material.

A reinforcing cone 6 of relatively stiff material, such as stiff paper, is mounted on the inner walls of the diaphragm 4 facing the apex 43 thereof, as indicated by Fig. 2 of the drawings. The edges of the reinforcing cone 6 are preferably cut and the flaps are glued or cemented to the diaphragm. Another reinforcing cone 42 is mounted concentric with the apex 43.

The cone 42 is made separately and of a hard material, paper, fibre, metal, or the like. To prevent distortional vibration of the little cone which forms the apex, a bar 41 is cemented, riveted, screwed, or otherwise secured across this apex behind the reinforcing cone 6. This reinforcing bar may be made of wood, or if the apex is of metal (as aluminum), it may be drawn or stamped into the small cone. In any case, care must be taken to keep natural periods outside the audible range.

A pair of tubular posts or pillars 7 of metal, fibre, or paper are mounted near the apex of the diaphragm opposite the ends of the reinforcing bar 41. The posts 7 preferably extend parallel to each other and parallel with and equi-distant from the center line of the conical diaphragm. The inner ends of the posts 7 are cut and the resulting flaps are glued or cemented to the conical diaphragm so that a comparatively integral structure is made between the diaphragm and the posts.

A rectangular armature ring 8 of copper or other good conducting material is secured to the outer ends of the posts 7 by means of a pair of projections 9 that terminate within the posts 7 and are bound to the walls

thereof by means of wooden inserts 10. The details of this construction are illustrated by Figs. 2, 5, and 6. It will be understood that any material having characteristics similar to wood may be used for the inserts 10.

Furthermore, while I prefer to make the posts 7 hollow and of metal, such as aluminum, any stiff material may be used, that is, either hollow or solid, without materially affecting the advantages of the construction.

The ring 8 is provided with holes 11 located in its sides for accommodating supporting strings 12. These strings may be of any suitable material such as wire or fabric, but I prefer to use soft enameled silk thread or varnished braided bronze. I prefer to use a four-point suspension as indicated, the ends of the strings 12 being secured to a rectangular frame 13 of non-conducting magnetic material, such as brass, by means of screws 14 threaded thereto. The rectangular frame 14 is in turn secured to a field frame 15 by means of screws 16.

The openings in the frame 13 through which the screws 16 pass are made larger than the screws for the purpose of adjusting the position of the frame 13 relative to the magnetic frame 15. The frame 13 may be termed a centering frame for the armature ring 8. Mounted on the strings 12 between the armature ring 8 and the securing screws 14 are damping members 17 of chamois skin or the like that check the vibration of the strings 12.

The field frame 15 is preferably of U shape and is provided with pole pieces 18 of V shape that terminate in a central square opening around the periphery of the armature ring 8. A core 21 of magnetic material is secured to the center of the vertical portion of the field frame by means of a screw bolt 23. The core 21 extends forwardly within the field frame and terminates in the plane of the outside of the pole pieces 18. The core 21 is provided with a horizontal slot near its end for the accommodation of a rectangular laminated magnetic core 24.

The laminated core 24 is of rectangular shell shape, having a central portion 25 that is fitted snugly within the opening formed in the end of the core 21. The central portion 25 is preferably disposed in line with the opening in the core 21 and is held in place by a casing 26 which terminates in projections 27 that are secured to the rectangular centering frame 13 by means of screws 28. Screws 29 are provided for securing the ends of the casing 26 together.

The opening in the rectangular frame 13 through which the screws 28 pass is cut somewhat larger than the size of the screws to provide room for adjusting the position of the ring 8 by means of the frame 13. The central core 21 and the inner ends of the pole pieces 18 are spaced apart so as to form an air gap in which the rectangular armature ring 8 is adapted to operate.

A coil 30 of insulated copper wire is carried by and surrounds the hollow core 21 of the field frame. The coil 30 is preferably wound between brass end plates 31 and insulated therefrom by means of a layer of insulation 32 of paper, bakelite or the like. The terminals 33 of the coil 30 are adapted to be connected to a suitable direct current source of electrical supply for energizing them.

A split coil 34 is mounted on the central portion of the laminated core 24 so that half of the coil is on one side of the pole pieces 18 and the other half of the coil is on the other side of the pole pieces. The two parts of the coil 34 are wound in forms 35 of channel shape made of any suitable insulating material such as paper. The coil 34 forms the primary of a transformer whose secondary is the armature ring 8 and whose core is the laminated iron core 24. The terminals of the coil 34 are preferably connected to an insulating panel (not shown). These terminals are adapted to be connected to the audio frequency tube of the radio set.

A magnetic spacing member 36 is provided within the hollow core 21 for the purpose of reducing the flux density in the inner part of the core. The member 36 is preferably held in place by means of a screw 37 that passes through the walls of the core 21 as indicated by Fig. 2.

I have found that a preferable air gap between the central core 21 and the ends of the pole pieces 18 is .040 inches. This gap may be decreased in size to around .035 inches without making the clearance uncomfortably small.

The cross section of the iron of the field frame 15 is of great importance because it serves as a path for the magnetic flux. The spacing bracket 36 serves to reduce the flux density in that part of the central split pole piece and should extend as near the rear end thereof as possible. In constructing the field frame, it is essential that neither the magnetic forces nor any external forces shall seriously change the air gap clearance.

I have found that the iron of the magnetic field frame 15 should be approximately one-quarter of an inch in thickness but this may be varied to around three-sixteenths of an inch without seriously affecting the field at the air gap. The other portions of the field should be approximately the same thickness as the iron of the field frame. Additional mechanical stiffness may be provided by a supporting frame (not shown) which preferably is of steel and of any convenient form, provided only that it clears the transformer laminations of any iron in

contact therewith by at least one-quarter of an inch.

The adjustable frame 13 which carries the centering strings 12 for the driver armature ring 8 is preferably separately adjustable independently of the cone supporting frame 2. The field coil form 31 is preferably made of brass or copper so as to reduce the transformer leakage through the field frame. The coil should be insulated from the form by a layer of paper or cloth or other insulating sheet.

The leads 33 are preferably of well-insulated wire and are soldered to tabs on a convenient fibre or bakelite terminal board as described above, which may also serve for the transformer leads. The coil 30 is preferably designed to carry an input of about 6.6 watts, and in order to reduce temperature rises all exposed surfaces are finished in dull black.

If desired, the front plate 31 may be of copper.

The armature or driving ring 8 is preferably designed to have an input impedance of slightly over 3000 ohms which is a desirable balance for the usual power tube output. The portions of the ring that are not in the air gap are made of double thickness. The position of the armature 8 should be adjusted so that a maximum clearance is provided for it in the air gap.

The casing 26 is preferably made of non-magnetic conducting material such as brass, so that it acts as a pole shield and functions to reduce the amount of flux that leaks from the transformer laminations. This function is improved by means of a copper sheet 38 separating the cores 21 and 24. This copper sheet 38 has rectangular clips 39 which engage the pole pieces and coact to isolate the magnetic circuit of the laminated core from the surrounding media. The clips 39 are connected by strips 40 of like material. In some cases, it may be found desirable to place the end shield directly on the pole end, but this will result in a slight decrease in efficiency. The shields are extremely important inasmuch as they increase the range of the loud speaker considerably. The copper shields 39 mentioned above also serve to clamp the central portion of the laminated core into position.

The laminations of the transformer core 24 and the copper shield 38 preferably fill the whole space between the forked ends of the field frame core 21.

As mentioned above, the centering strings 12 which suspend the armature ring should be silk or metal thread stretched simultaneously to an initial tension. In practice, in my device, it is possible to reduce the amplitude of the driving frequency to a third harmonic less than two per cent. It is entirely negligible for normal excitation.

In a centering device of this type, there is always an anharmonic restoring force, which introduces some distortion at high amplitudes. I have found it practical to so choose the length and initial tension of the centering wires on strings that such distortion is negligible, even at high amplitudes. The high electromagnetic damping of the armature aids materially in the perfection of the speaker's reproduction.

The moving system is tuned by the tension in the strings, which is set in assembly. The fundamental resonance frequency is adjusted below the electrical range of the instrument to extend its bass response, without introducing any unnatural quality to its tones.

The cone support at the free edge is made to exert a force that is small compared with that of the supporting threads 12.

The magnetic field of the field frame 15 is mainly forked and forced to go around the laminations of the transformer core. The degree of separation of the magnetic field is aided by two gaps; one where the driving ring floats, and the second at the junction between the transformer laminations. The gap between the laminations themselves also aids the separation to some extent. The conducting material in both gaps also aids in the separation of the fields.

The pillars 7 are preferably strong enough so that the only necessary supports to the moving parts are the centering supports of the driving ring and the supports at the periphery of the acoustic radiator.

With the preferred construction illustrated and described above, a loud speaker is provided that is highly efficient, and one that has a total range greater than any radio or phonograph source in commercial use, of which I am aware.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a loud speaker, in combination a paper cone, a smaller oppositely facing paper reinforcing cone secured thereto within the apex thereof, a pair of parallel hollow paper posts mounted on the outer side of the cone parallel with the center thereof, a rectangular copper armature having a pair of projecting members extending into said posts and wooden inserts binding the member to the walls of the posts, and means for flexibly suspending the armature in the air gap of a magnetic circuit.

2. In a loud speaker, in combination a cone, a smaller oppositely facing reinforcing cone secured thereto within the apex thereof, a pair of hollow posts mounted on the outer side of the cone parallel with the center thereof, a rectangular armature having a pair of projecting members extending into said posts and inserts binding the member to

the walls of the posts, and means for flexibly suspending the armature in the air gap of a magnetic circuit.

3. In a loud speaker, in combination a cone, a smaller oppositely facing reinforcing cone secured thereto within the apex thereof, a pair of posts mounted on the side of the cone, an armature having a pair of projecting members extending into said posts and inserts binding the member to the walls of the posts, and means for suspending the armature in the air gap of a magnetic circuit.

4. A loud speaker comprising a U-shaped field frame of magnetic material having pole pieces terminating in an opening, a U-shaped core of magnetic material mounted on the inside of the frame and extending between the opening formed by the pole pieces, a laminated rectangular core of magnetic material disposed between the ends of said core having a central member in line with the core, a coil carried by the core, a coil divided into two parts carried by the central member with one part on each side of the pole pieces, a rectangular frame of non-magnetic conducting material mounted on the pole pieces and supporting the armature, an armature of conducting material suspended from said frame in the air gap between the core and the pole pieces, said armature having integral forward extensions, hollow pillars mounted on said extensions, and a conical diaphragm fixed to the ends of the pillars having reinforcing means therebetween.

5. A loud speaker comprising a U-shaped field frame of magnetic material having pole pieces terminating in an opening, a U-shaped core of magnetic material mounted on the inside of the frame and extending between the opening formed by the pole pieces, a laminated rectangular core of magnetic material disposed between the ends of said core having a central member in line with the core, a coil carried by the core, a coil carried by the central member, a rectangular frame of non-magnetic conducting material mounted on the pole pieces and supporting the armature, an armature of conducting material suspended from said frame in the air gap between the core and the pole pieces, said armature having integral forward extensions, hollow pillars mounted on said extensions, and a conical diaphragm fixed to the ends of the pillars having reinforcing means therebetween.

6. A loud speaker comprising a field frame of magnetic material having pole pieces terminating in an opening, a core of magnetic material mounted on the inside of the frame and extending between the opening formed by the pole pieces, a laminated rectangular core of magnetic material disposed between the ends of said core having a central member in line with the core, a coil carried by the core, a coil carried by the central member, a frame of non-magnetic conducting material mounted on the pole pieces and supporting the armature, an armature of conducting material suspended from said frame in the air gap between the core and the pole pieces, said armature having integral forward extensions, pillars mounted on said extensions, and a diaphragm fixed to the ends of the pillars.

7. A loud speaker comprising a conical diaphragm supported by flexible means at its outer edge, reinforcing means near its apex, tubes secured to the back of the diaphragm, an armature ring secured to the ends of said tubes, flexible means suspending said armature from a plurality of fixed points, a frame of magnetic material having poles on opposite sides of said ring, a core mounted on said frame and extending within said ring, said ring being centered in spaced relation to the poles and the core, a field coil carried by said core, a laminated rectangular core of magnetic material surrounding the ring having a central member passing through the inside of the ring, and a coil carried by said central member having portions on each side of the ring.

8. A loud speaker comprising a diaphragm supported by flexible means at its outer edge, reinforcing means near its apex, tubes secured to the back of the diaphragm, an armature secured to the ends of said tubes, flexible means suspending said armature from a plurality of fixed points, a frame of magnetic material having poles on opposite sides of said ring, a core mounted on said frame and extending within said ring, said ring being centered in spaced relation to the poles and the core, a field coil carried by said core, a laminated rectangular core of magnetic material surrounding the ring having a central member passing through the inside of the ring, and a coil carried by said central member.

9. In a loud speaker, the combination with a conical diaphragm, a reinforcing cone secured to said diaphragm at the apex thereof, a plurality of hollow posts connected to said diaphragm and extending rearwadly therefrom parallel to the axis thereof, a reinforcing cross bar connected to said diaphragm and extending between the bases of said posts on the inside of said diaphragm, an armature connected to said posts, and means for energizing said armature.

10. In a loud speaker, the combination with a conical diaphragm, a plurality of posts connected to said diaphragm and extending rearwardly therefrom, a reinforcing cross bar connected to said diaphragm and extending between the bases of said posts on the inside of said diaphragm, an

armature connected to said posts, and means for energizing said armature.

11. In a loud speaker, the combination with a conical diaphragm, a pair of oppositely disposed reinforcing cones secured to the apex of said diaphragm, a reinforcing cross bar connecting sides of said apex, a plurality of posts extending rearwardly from said diaphragm at said apex, an armature secured to said posts, and means for energizing said armature.

In witness whereof I have hereunto set my hand.

CHARLES D. BOCK.