May 15, 1934. H. R. PARSHALL 1,959,005

SOUND REPRODUCER

Original Filed March 10, 1930 2 Sheets-Sheet 1

Fig: 2

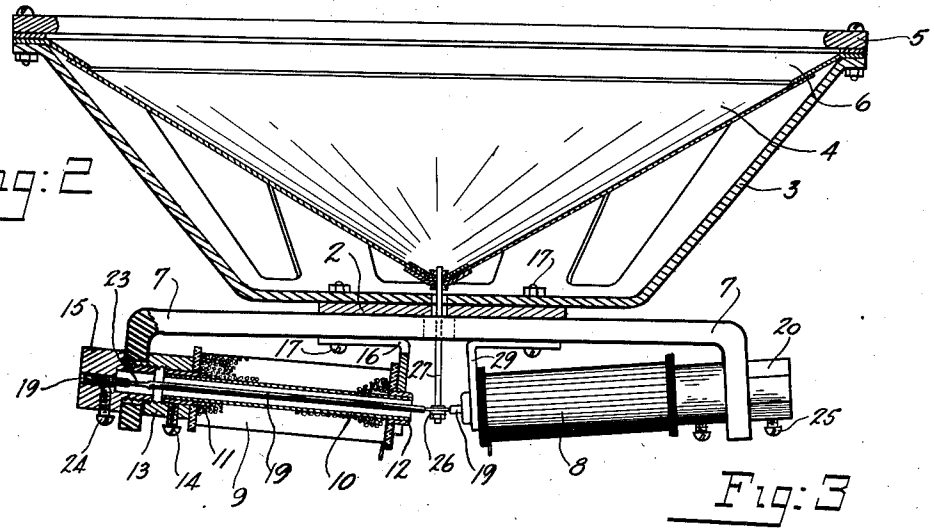

Fig: 3

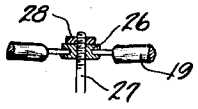

Fig: 1

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Fig: 5

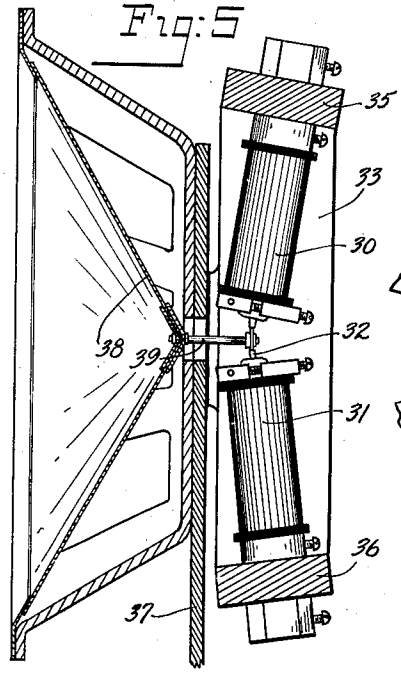


Fig: 4

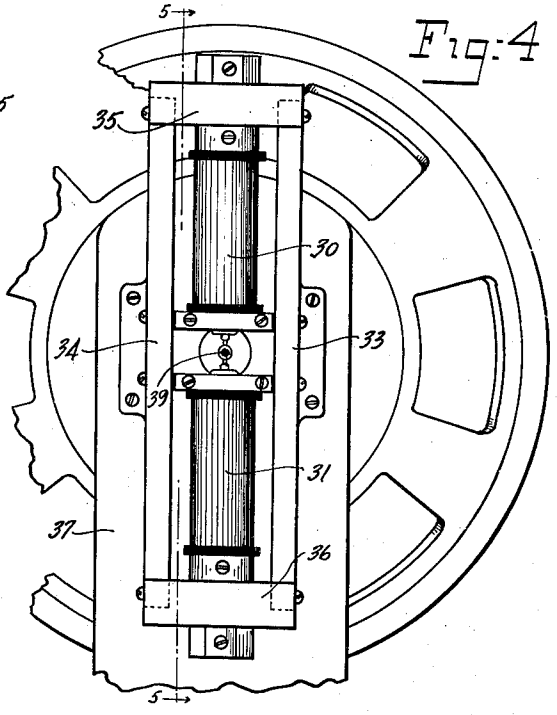


Fig: 7

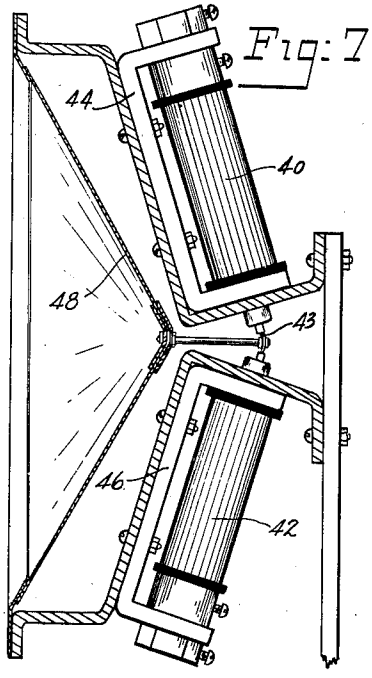
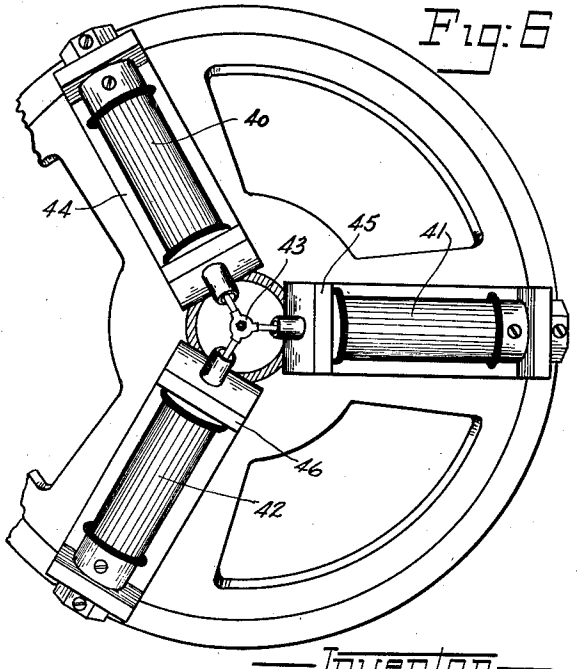


Fig: 6



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Patented May 15, 1934

1,959,005

UNITED STATES PATENT OFFICE

1,959,005

SOUND REPRODUCER

Harry R. Parshall, Chicago, Ill.

Application March 10, 1930, Serial No. 434,484
Renewed September 10, 1931

9 Claims. (Cl. 179—110)

My invention relates in general to a sound reproducer, and more specifically to an improved reproducer or loud speaker employing the principle of magnetostriction and so designed as to utilize this magnetic action to the greatest extent.

The principle of magnetostriction which consists in the elongation and shortening of a metallic bar when subjected to variations of magnetic flux passing therethrough has been known for a great many years since its discovery by Professor Page, but it has not been utilized to a great extent.

In the loud speaker of my invention I have utilized this principle and have so designed the moving part of the speaker that I am able to obtain great volume and still retain clearness and quality. This is possible due to the fact that the moving body of the speaker is very light in weight and has no inertia or audible harmonics of its own to interfere with its operation by alternating currents over a great range of frequency.

It has been found that nickel shrinks or shortens with increases in magnetic flux, and that iron, cobalt, or like metals expand or lengthen as the magnetic flux therethrough increases. Any of these metals may be used with success in a speaker of my design. At present it seems that a rod of nickel alloy adapts itself best to such a speaker and its use is contemplated, however it will be understood that any such metal rod may be used. Also in the adaptation of my invention illustrated I have shown a certain type of speaker using a cone with its edges secured but it should be understood that the principle of my invention may be as well utilized with any type of device for producing sound; a free edge cone, double cone, ordinary diaphragm, or any other practical types and such details of mounting, etc., are only shown diagrammatically for the purpose of illustration.

The variations in the length of a short metallic rod due to magnetic variations are small and vary somewhat in accordance with the molecular structure of the rod, and also to the degree of magnetization of the rod.

In the speaker herein described I utilize a rod of nickel alloy or the like which is flattened at its center point to a thin structure and having its two ends bent to form an angle of approximately five degrees. The two ends of the rod are firmly secured and the elongations and contractions, therefore, cause the rod to bend at its center point. Thus the elongations and contractions are translated into a sidewise movement of the center of the rod which is secured to the diaphragm or cone and this sidewise movement is approximately six times greater than the elongations in the rod.

In addition I provide a permanent magnet, of such strength as to bring the metal of the rod to its point of greatest sensitivity at which point given variations of magnetic flux produce the greatest variations in length of the rod.

Further details of my improved speaker will be apparent from the following detailed description, reference being had to the accompanying drawings in which:

Fig. 1 is a rear view of a cone speaker embodying the features of the invention.

Fig. 2 is a top view of the speaker of Fig. 1 with certain parts shown in cross-section to clarify the description.

Fig. 3 is a sectional view of the center point of the rod 19 of Fig. 1 to more clearly show the method of fastening the same.

Fig. 4 is a rear view of a modified form of speaker also embodying my invention.

Fig. 5 is a side view of the speaker of Fig. 4 with certain parts shown in section.

Fig. 6 is another modification showing another adaptation of the invention.

Fig. 7 is a side view of the speaker in Fig. 6 with certain parts shown in section.

Referring now to Figs. 1 and 2, I have shown a well-known type of cone speaker having an operating unit constructed in accordance with my invention. At 1 is a base to which is attached the usual standard or upright 2 by means of screws. To the upright 2 is secured, by bolts, the usual spider or cone support 3. The cone 4 is secured to a strip of chamois 6 clamped between structure 5 and spider 3 by a series of bolts and nuts. Mounted on the upright back of the apex of the cone 4 is a strong permanent magnet 7 of hardened steel with its ends bent backward and having a large hole through each end of the two backward extending ends. Mounted on the ends of magnet 7 are a pair of coils 8 and 9 each wound with a like number of turns of copper wire. Coils 8 and 9 are wound on a tube of fibre or like insulating material such as shown at 10 in Fig. 2, or on a non-magnetic metallic tube properly slotted to prevent any inductive lag or slow-acting effect. A pair of metallic sleeves 11 and 12 are secured over each end of tube 10 and the spool heads are secured to sleeves 11 and 12 in any manner such as swedging. Over the outside of sleeve 11 is a soft iron collar 13 held in place over sleeve 11 by screw 14. One end of sleeve 13 is threaded on the inside to receive a hollow stud 15, also of soft iron. The stud 15 has a nut on the outside and is screwed into sleeve 13 to securely hold the coil assembly against

magnet 7 and to complete the magnetic circuit to rod 19. The other end of coil 9 is held in a bracket 16 mounted on the screw 17 which bracket has a hole slightly smaller than sleeve 12 and is notched or slotted at 18 so that sleeve 12 may be inserted therein and held without play. Although I have shown only the construction of coil 9 and its mounting in detail, the coil 8 is constructed and held in exactly the same manner.

Before mounting coils 8 and 9 on the ends of magnet 7, the rod 19 is inserted into the hollow cores of coils 8 and 9. Inside of the studs 15 and 20 is a hole of small diameter at one end, shown in Fig. 2, which provides a bearing for rod 19. The rod 19 is secured by set screws 24 and 25 which hold the rod tightly in the studs as shown. At its center point rod 19 is flattened out to a strip of thin metal as shown in detail in Fig. 3. In the center a hole is drilled and in this hole a small brass bushing 26 is inserted and either riveted, as shown, or held by a lock nut. The pin 27 is screwed in a threaded hole through bushing 26 and held in place by nut 28. At each end or near each end rod 19 is also flattened out as shown at 23, these flattened parts act as hinges and if desired might be thin springs welded to the rod permitting free vibration thereof.

It will be noticed that the ends of magnet 7 are bent at an angle slightly less than 90°, and that the holes in brackets 16 and 29 are farther from magnet 7 so that coils 8 and 9 are mounted at an angle of approximately 5° in accordance with the bend in rod 19. Thus when set screws 24 and 25 are tightened against the ends of rod 19 the rod is centralized and the connection with pin 27, which connects with the cone 4 in the usual manner, is held at a center point and rod 19 is held in the center of the hollow sleeves inside magnets 8 and 9. Rod 19 is thus magnetized by magnet 7 through the soft iron parts to maintain its molecules in a state where changes in the flux therein cause greatest changes in the length of the rod.

The coils of magnets 8 and 9 are connected in series and to the output of a radio set or other audio frequency amplifying system from which alternating current from the output is passed through the coils. This alternating current alternately increases and decreases the magnetic flux passing through rod 19 and the rod increases and decreases in length in accordance with the strength of the changes in flux. The ends of the rod being securely held, such increases and decreases in length cause the center point of rod 19 to move laterally, bending at the points adjacent to bushing 26 and at 23 where the metal is thin. This lateral movement causes endwise movement of pin 27 and thereby vibrates cone 4 in accordance with the variations of the alternating current output from the radio receiving set. It will be understood that the thin part of rod 19 acts as a hinge and that the construction shown is for illustrative purposes only. Other similar constructions may be utilized, such as a hinged or pivoted connection of the rod 19 to pin 27.

Referring to Figs. 4 and 5, I have shown a modified form of my invention showing a pair of coils 30 and 31 similar to coils 8 and 9 of Figs. 1 and 2 and having a rod 32 similar to rod 19. In this modification the main difference is a substitute for permanent magnet 7. In this embodiment I provide a pair of bar magnets 33 and 34 secured by a pair of soft iron cross pieces 35 and 36 in the sides of which the magnets are held by means of screws as shown. The magnets and cross-pieces are held against the upright 37 by brackets, either welded to the magnets as shown, or attached thereto by screws. I have not endeavored to show all the details of the entire speaker as details of known construction may be added and are immaterial to the invention. The main distinction between this modification and Figs. 1 and 2 is that the two bar-magnets 33 and 34 permit coils 30 and 31 to be bent at a similar angle to coils 8 and 9 but toward the cone instead of away from it. Thus the pin 39 may be shorter than was pin 27 of Figs. 1 and 2, and the apex of the angle of rod 32 nearer to the apex of the the cone 38. If desired the pin 39 may be eliminated by fastening the cone directly to the center of rod 32. Also this construction permits the use of magnets of greater strength and mechanical rigidity. It will be understood that rod 32 and coils 30 and 31 may be secured and mounted in the same manner as the structure of Figs. 1 and 2 or by any other equivalent mechanical means.

Referring now to Figs. 6 and 7, I have shown another modification of my invention consisting of a sort of umbrella construction comprising three magnets 40, 41, and 42, each constructed in a manner similar to magnets 8 and 9 and Figs. 1 and 2, and each having a rod similar to rod 19 secured therein. In this case the three rods through coils 40, 41, and 42 are secured at their outer ends as was rod 19 and all are welded or otherwise securely fastened at the inner ends to a three-pointed spider construction 43 of thin metal. The coils 40, 41, and 42 are mounted on an angle and each has a permanent magnet at 44, 45, and 46 to magnetize the rods, the coils are preferably connected in series and in such manner that similar magnet poles are in the central point and variations in the current through the coils will cause corresponding simultaneous variations in the three rods which in turn will cause the endwise movement of pin 47 to vibrate cone 48. This construction, it will be seen, as well as that of the modification shown in Figs. 4 and 5, operates on the same principle as that shown in Figs. 1 and 2. The magnetization of the rods by permanent magnets, such as shown, brings the molecular structure of the nickel alloy rods to such a condition that slight changes in the flux produced by the coils produces the maximum change in the length of said rods. The angular position of the rods and the securing of the ends in the manner shown causes the maximum vibration of the cone. It will be seen also that the vibrating unit of the speaker is very light and is free to follow changes in magnetic flux without introducing any auxiliary vibrations of its own due to mechanical inertia. Although in Figs. 6 and 7, I have shown the coils and rods at a somewhat greater angle than in the other figures it should be understood that this angle may as well be the same as that used in the other form with rods 19 and 32. Furthermore, it will be understood that in all of the forms of the invention shown I may use electromagnets in place of the permanent magnets shown to magnetize the rods. These electromagnets may be energized by direct current from a separate source or by the plate current from the radio set or similar audio frequency amplifying system if desired.

If electromagnets are used, then elements of soft iron or the like will be used in place of the permanent magnets to provide the return path for the magnetic flux and also to maintain structural rigidity. In either case, magnetostrictive changes in the iron or in the elements above mentioned is of course opposite to the changes in

the rods of nickel iron alloy. It is therefore apparent that the contrary action of the iron supporting frame including the permanent magnets and the cores of the electromagnets will be cumulative in effect upon the diaphragm.

From the above description it will be seen that a novel system for providing mechanical movements has been devised in which a completely closed magnetic circuit is utilized, this closed magnetic circuit in Fig. 2, for instance, includes the permanent magnet 7, elements 15, and rods 19. It will be seen that whether electro or permanent magnets are used the magnetic circuit may be completely closed as described. The mechanical movement will still be attained even though a break or breaks in the magnetic circuit is used in the mechanical construction.

It will, therefore, be seen that I have provided a very efficient type of loud speaker which is so designed as to utilize the magnetostrictive properties of metal to the greatest degree. The design causing changes in length of a rod to be amplified to give sufficient power without distortion. Having fully described the invention and ascertained the features and aspects of my invention, what I consider to be new and desire to have protected by Letters Patent will be pointed out in the appended claims.

What is claimed is:

1. In a sound reproducer, a metallic member bent at an intermediate point in the form of an obtuse angle and secured at both ends, a diaphragm secured to said intermediate point of said member, helices around said member connected in a source of alternating current, the current flowing in said helices causing like linear displacements of said member on both sides of said point through the inherent magnetostrictive qualities thereof and consequent vibration of the diaphragm.

2. In a sound reproducer, a plurality of magnetostrictive members joined at a central point by a flexible connection, coils around said members connected in a variable source of current, a diaphragm having its center point connected to the junction point of the members, current changes in the coils causing like linear displacements of said members to in turn cause lateral movement of the junction of the members and consequent vibration of the diaphragm.

3. In a sound reproducer, a diaphragm, a plurality of metallic members joined at a central point, the outer ends of said members being rigidly secured, electromagnets encircling said members and connected in a source of alternating current, the variations in current in said coils causing changes in length of the members and consequent lateral movement of the members at the central point, said diaphragm connected to the central point of the members and vibrated thereby.

4. In a sound reproducer, a metallic member, a diaphragm connected to an intermediate point of the member, said member having a thin portion adjacent the connection to the diaphragm and adjacent its outer ends, said member rigidly secured at its outer ends and bent at an angle, an electromagnet encircling said member and connected to a source of variable current, the changes in the current in said electromagnet causing said member to elongate and contract and increase its angle to thereby vibrate the diaphragm.

5. In a sound reproducer, a diaphragm, a metallic member suspended in a magnetic field, said member secured at both ends and bent at an angle near its central point, said diaphragm linked to the member near its central point, and a helix encircling said member and connected in a source of variable current, variations in the current in said helix causing changes in the dimension of the member to thereby cause the central point to move laterally and thereby vibrate said diaphragm.

6. In a reproducer, a cone diaphragm, a metallic member, a link from the apex of the cone to an intermediate point of the member, both ends of the member bent at an angle away from the cone forming an angle the apex of which is attached to the link, a coil surrounding each of the ends of the member and extending around an appreciable length thereof, said coils connected in a circuit including a variable source of current, said member secured so that variations in length cause maximum movement to occur at the apex of the member.

7. In a reproducer, a diaphragm, an operating unit for said diaphragm comprising a completely closed metallic circuit, means for producing and varying a magnetic flux in said metallic circuit, a magnetostrictive element in said circuit operable to elongate or contract responsive to changes in the magnetic flux therethrough to vibrate the diaphragm.

8. In a sound reproducer, a metallic member, having the same magnetostrictive qualities throughout its length, rigidly secured at both ends, a diaphragm secured to a point intermediate said ends, means for premagnetizing said rod, helices surrounding said rod and connected in circuit with a variable source of alternating current, the variations in current in said helices causing lateral displacement of said rod due to the magnetostrictive qualities thereof, and consequent vibrations of said diaphragm, said member arranged so that the lateral displacement of said rod always occurs in the same plane.

9. In a sound reproducer, an operating member comprising a rod having like magnetostrictive qualities throughout its length, means for initially magnetizing the rod to its most efficient point of sensitivity on the magnetostrictive curve, an electromagnet associated with the rod, said rod rigidly secured at both ends and a diaphragm secured to a point intermediate the ends, said electromagnet connected to a source of alternating current and responsive to variations therein to cause variations in the length of the rod and consequent vibration of the diaphragm by lateral displacement of the intermediate point of the rod, said rod arranged so that the direction of said lateral displacement is predetermined.

HARRY R. PARSHALL.