Dec. 1, 1931. H. R. PARSHALL 1,834,498

SOUND REPRODUCER

Filed March 10, 1930

Fig: 2

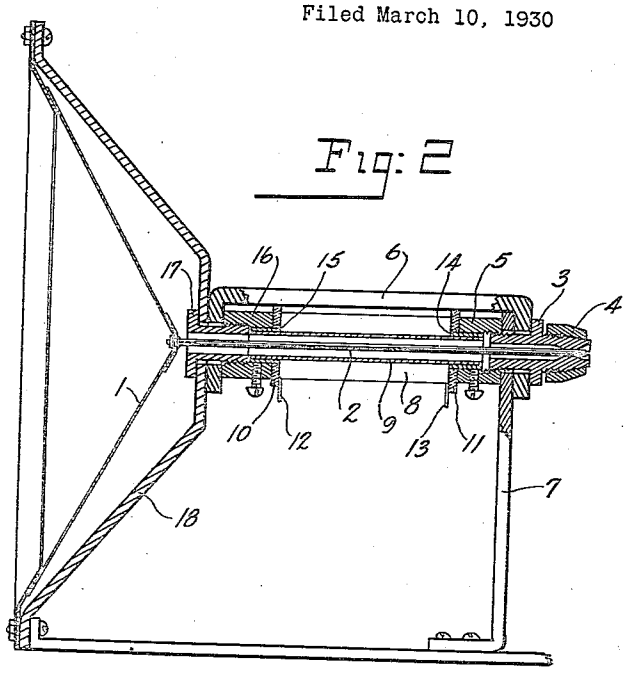
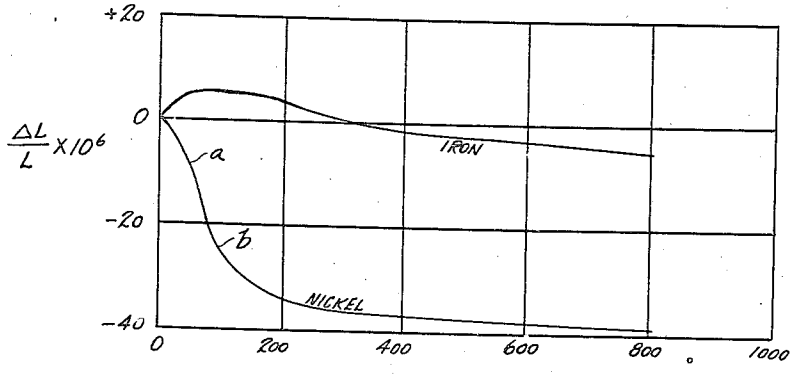



Fig: 1




Inventor

Harry R. Parshall

Wm Walter Owen. Atty:

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# UNITED STATES PATENT OFFICE

HARRY R. PARSHALL, OF CHICAGO, ILLINOIS

## SOUND REPRODUCER

Application filed March 10, 1930. Serial No. 434,483.

My invention relates in general to a sound reproducer or loud speaker employing the "Joule" effect or the linear expansion and contraction of a metalic rod due to magnetostriction to operate a diaphragm.

More specifically, my invention consists of a reproducer having a diaphragm or cone directly connected to one end of a metallic rod, the other end of which is firmly fixed, and in causing variations in the magnetic flux in this said rod and consequent variations in the length thereof to effectively operate the cone to reproduce sound.

"Magnetostriction" was first discovered in 1837 by Dr. C. G. Page and is a term applied to changes in dimension of a magnetic metal when placed in a magnetic field. Experiments brought to light the changes in linear dimension (commonly called the "Joule" effect) due to variations in the magnetic flux, and also various other phenomena such as twisting effects upon the metal were observed, but very little was done toward applying this phenomena to any practical use.

All ferromagnetic metals are found to expand and contract when placed under the influence of a varying magnetic field by virtue of their magnetostrictive properties. Iron first expands, then returns to its original length and then contracts in a longitudinal magnetic field of increasing strength. Pure iron and steels which are alloys of iron and carbon although strongly magnetic show weak magnetostrictive effects. Cobalt first contracts, then returns to its original length and then expands, while annealed cobalt contracts continually. Pure nickel contracts continually and has strong magnetostrictive qualities. Certain alloys such as nickel (36%) and iron (64%) are active, while among the most active metals readily obtainable are alloys of chromium, nickel and iron, such as nichrome and "Monel" metal.

It has also been noted that heat treatment, twisting, or stretching, increase the magnetostrictive qualities of certain metals and I have also observed that ageing by electrical vibration increases the action. It has been noted that the curve representing the change in length of a metallic rod is not constant.

Fig. 1 of the drawings shows the curve of iron and nickel, and is thought to be self-explanatory.

Fig. 2 shows the construction of the reproducer of my improved design in somewhat diagrammatic form.

Referring to Fig. 1, it will be noted that nickel, which contracts steadily with increasing magnetism, has a point between *a* and *b* in which magnetic variations of given amount produce the greatest changes in length. In my improved reproducer I propose to use a metallic rod of nickel or of "invar" and good results have been obtained with both. In order to utilize the most effective portion of the magnetostrictive curve I employ a strong permanent magnet such as shown in Fig. 2, or an electromagnet, to polarize the rod and to bring it within the sensitive or effective portion of this curve so that any given change in the current through the coil around the rod will cause the greatest change in length of the rod and consequently the maximum volume in the reproducer. Rods of different metal and length will require magnets of different strength.

Referring now to the illustration of my invention shown on the accompanying drawings in Fig. 2, I have shown an ordinary cone of standard type at 1 having attached to its apex in known manner a metallic rod 2 which is rigidly held at its opposite end by a metallic stud 3 which has a split sleeve on its right hand end over which the nut 4 fits to clamp against rod 2. The stud 3 clamps a collar 5 against an upright support 7 and secures a permanent magnet 6 between the upright and the shoulder of stud 3. The coil 8 is wound on a fibre sleeve 9 and has spool heads 10 and 11 and terminals 12 and 13 which are connected with the alternating current output of a radio receiving set. Each end of sleeve 9 has a metallic sleeve at 14 and 15 which are held in collars 5 and 16 by set screws. The hollow screw 17 clamps the collar 16, magnet 6, and support 18 together. Thus the entire assembly is rigidly held together and magnet 6 magnetizes rod 2 to a point above zero and preferably to the point

of magnetism between points *a* and *b* on the curve shown in Fig. 1.

The use of magnet 6 is not only to magnetize the rod to its efficient point of the curve but to polarize the rod as explained. It is understood that the flux in the rod must not pass through zero. As alternating current from the secondary of a transformer is received from the ordinary commercial receiving set instead of undulating current, the premagnetization by magnet 6 causes changes in flux due to alternating current cycles through electromagnet 8 to only increase and decrease the flux through the rod 2 above the zero point. It should be understood that an electromagnet may be employed in place of permanent magnet 6 and may be excited either by the plate current from the radio set or by a separate source of direct current.

If such electromagnet were used then an element or elements of soft iron or the like would be used in place of the permanent magnet 6 to provide the return path for the magnetic flux, and also to maintain the rigidity of the structure. In such case, as in the case of the permanent magnet, the magnetostrictive changes in the iron of the magnet or the elements above mentioned may of course be opposite to the changes in the rod 2, depending upon the materials used in the construction of the rod and magnet. In case the materials have opposite magnetostrictive characteristics, then the contrary action of the iron supporting frame 18 and the nickel element or rod connected to diaphragm would be cumulative in effect on the diaphragm.

It should be noted that a strong magnetic field (800 gauss) or approximately 30 amperes of current is required to completely expand or contract a rod by magnetostriction. The reproduced sounds will be increased 800 times, by the use of a permanent magnet, over those produced by weak voice currents only, if the rod is not premagnetized. Therefore, in a construction such as shown I have produced a reproducer which gives a greater volume of sound, free from distortion, than has been produced before.

While I have described the expansible element of the speaker as a metallic rod 2, it should be understood that this term is used and a rod shown merely for illustration and the element may assume different dimensions. It is only necessary that it be a member of metal or alloyed metal of greater length than diameter acted upon by a coil to produce linear expansion and premagnetized or polarized by a magnet. Furthermore, as the rod or movable element of the reproducer will have practically no audible frequency or natural vibration of its own, and as the lag in magnetostriction is practically nil, the reproduction will be accurate and without distortion.

Although I have shown a cone speaker with free edges, it should be understood that any type of cone or diaphragm may be used, and also any known leverage arrangement may be utilized between the rod and cone as desired.

What is claimed is:

1. In a sound reproducer, a metallic rod having strong magnetostrictive qualities, an electromagnet encircling said rod and spaced slightly therefrom, a strong permanent magnet arranged with opposite poles thereof opposite different ends of the rod, a clamping means rigidly securing one end of the rod, a diaphragm connected to the opposite end of the rod, said coil when connected to alternating current effective to vibrate the diaphragm in accordance with the current.

2. In a sound reproducer, a vibratory member, an actuating element for the member constructed of ferro-magnetic metal having strong magnetostrictive qualities, said element rigidly secured at one end and attached at the other end to the vibratory member, a permanent magnet of relatively large and predetermined strength arranged longitudinally to said element, said magnet premagnetizing said element to its most efficient point of sensitivity to magnetostrictive variations, a helix or electromagnet encircling said element for the greater part of its length, said helix connected to a source of alternating current to cause corresponding lineal expansion and contraction of said element to thereby vibrate said member.

3. In a sound reproducer, a ferro-magnetic member, specifically treated to increase its lineal displacement due to magnetostrictive effects, an elongated U-shaped permanent magnet of predetermined strength, said member longitudinally supported in the magnetic field of said permanent magnet, one pole of the magnet in magnetic contact with the member at one rigidly fixed extremity, the other pole in close proximity but out of engagement with the member providing a return path for magnetic flux in the member with minimum air gap, a diaphragm connected to one end of the member, an electromagnet associated with the member connected with the output of a suitable audible frequency sound amplifier, said electromagnet causing undulations of the magnetic flux in said member and corresponding changes in lineal dimensions of the member to thereby reproduce voice sounds by vibrating the diaphragm.

4. In a sound reproducer, an elongated U-shaped permanent magnet, a diaphragm, an actuating member for the diaphragm having strong magnetostrictive qualities supported keeper fashion across the poles of the permanent magnet, a helix surrounding the actuating member supported by and secured to the permanent magnet, a chuck member of ferro-magnetic material supporting one end

of the actuating member and rigidly securing it to the permanent magnet, a frame supporting the diaphragm, a hollow sleeve of ferro-magnetic metal securing the frame to the permanent magnet to the free end of said member extending through said hollow sleeve and secured to the center of the diaphragm, said helix when connected to a source of alternating current causing vibrations of the diaphragm in accordance with current changes.

5. In a sound reproducer, a vibrating element, an actuating member therefor, a permanent magnet, an operating member of ferro-magnetic material having strong magnetostrictive qualities supported by the magnet and rigidly secured thereto at one end, a frame supporting the vibrating element rigidly secured to the other end of the magnet, said operating member extending through an opening in one end of the permanent magnet and engaging said vibrating member, and an electromagnet for varying the effect of said permanent magnet on said operating member to vibrate the element, said magnetic member and element forming a unitary structure.

6. In a sound reproducer, a diaphragm, a permanent magnet, an operating member for the diaphragm of ferro-magnetic material having magnetostrictive qualities opposite to that of said permanent magnet, said member rigidly supported and in magnetic contact with one linch of the magnet and having its free end encircled by the other linch of said magnet, and engaging with the diaphragm, an electromagnet arranged longitudinally to both magnet and member and connected to a source of variable current, variations in current in the electromagnet causing opposite magnetostrictive effects in the member and magnet cumulative in their effect on the diaphragm.

In witness whereof, I hereunto subscribe my name this 7th day of March A. D. 1930.

HARRY R. PARSHALL.