Dec. 11, 1928. 1,695,126

J. E. SEDERHOLM

LOUD SPEAKER

Filed Feb. 23, 1928 2 Sheets-Sheet 1

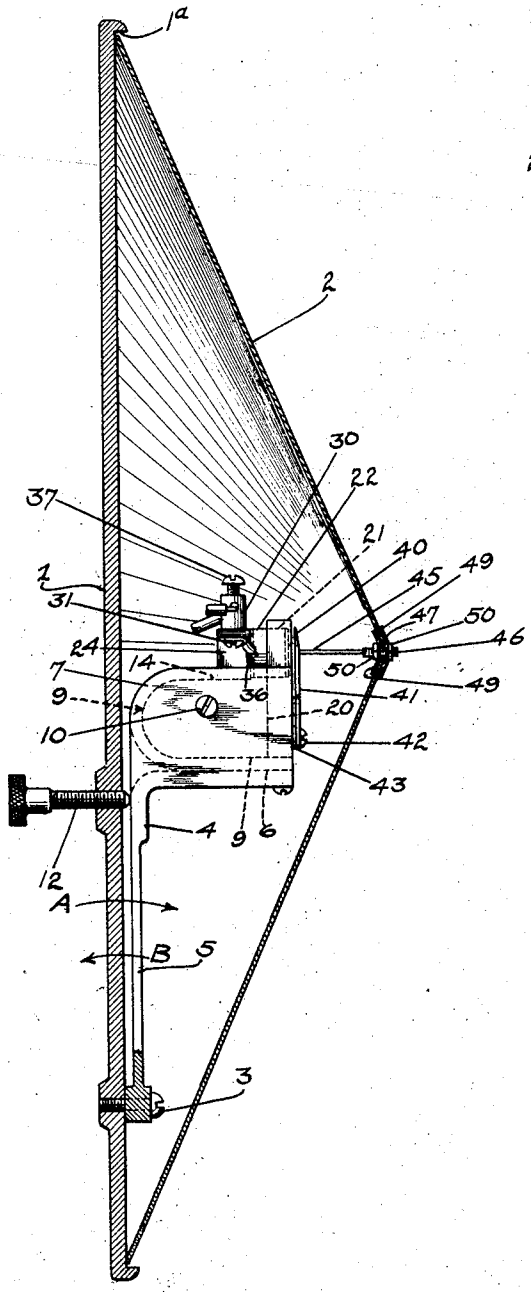


Fig. 1

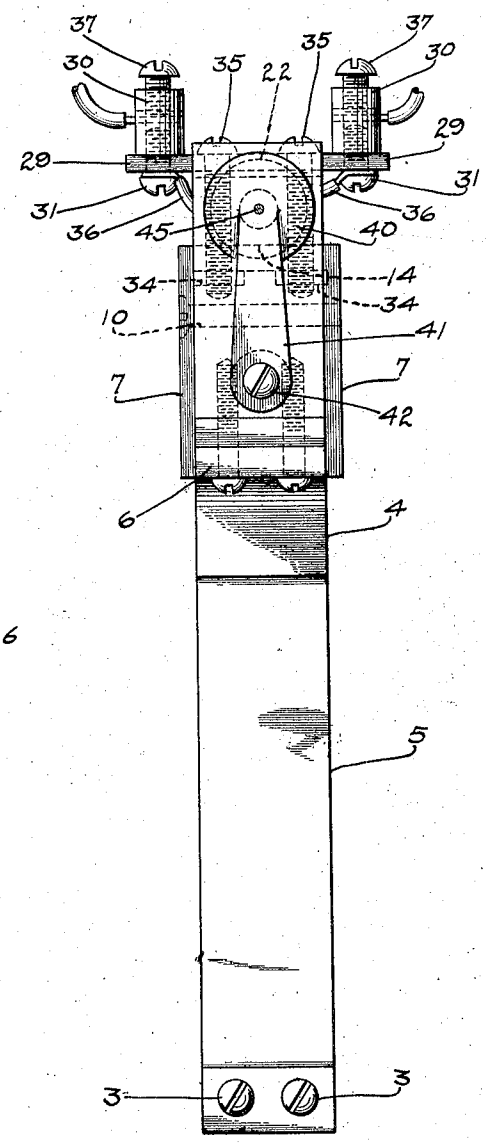


Fig. 2

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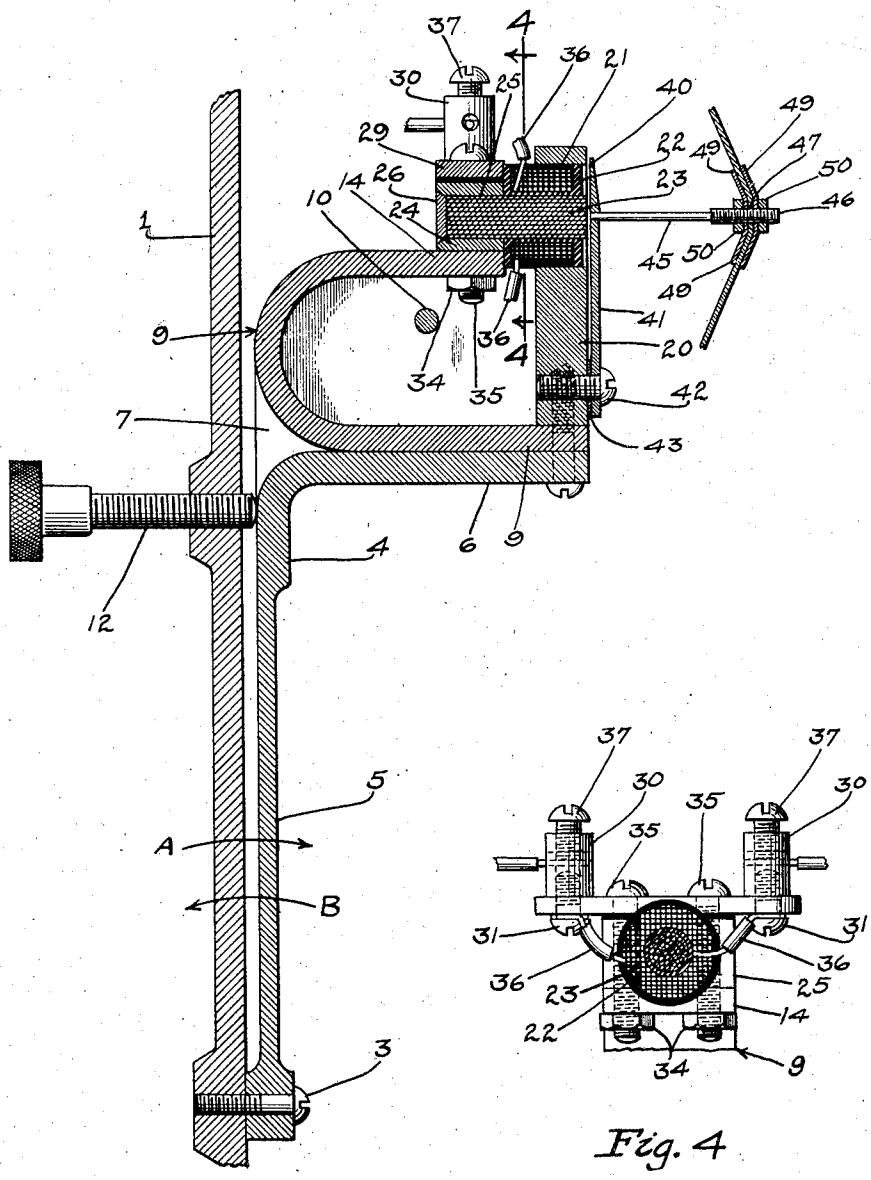


Fig 3

Fig. 4

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UNITED STATES PATENT OFFICE.

JOHN E. SEDERHOLM, OF ST. PAUL, MINNESOTA, ASSIGNOR TO AMERICAN HOIST & DERRICK COMPANY, OF ST. PAUL, MINNESOTA, A PARTNERSHIP COMPOSED OF F. J. JOHNSON AND W. O. WASHBURN.

LOUD SPEAKER.

Application filed February 23, 1928. Serial No. 256,341.

This invention relates to improvements in loud speakers, the main object of the invention being to clearly reproduce all sounds with the maximum of volume and clearness. Another object is to produce a loud speaker which will clearly produce sounds with a maximum volume, and with a minimum expenditure of electrical energy, and which will operate in this improved manner with any type of radio set, to clearly reproduce mixtures of vibrations.

In order to understand the problems of a device of this kind, it is to be known that the ordinary speakers have a natural vibratory period of from three thousand to seven thousand vibrations per second. When the speaker responds to vibrations which correspond closely to these natural periods, blasting or distortion results so that it is practically impossible to transmit a mixture of vibrations with clearness and proper volume. Some of the instruments of an orchestra will be taken as an example, a tuba, for example, having four hundred vibrations per second, another instrument having five hundred fifty vibrations per second, the next seven hundred, the next eight hundred twenty-five, and so on up to four thousand vibrations per second. The various vibrations are being received simultaneously and in some bands the total vibration may reach five hundred thousand per second at any given time.

Features of the invention include the broad idea of using a stiff armature and furnishing sufficient energy to properly operate the same, along with all details of construction for accomplishing all results.

Therefore, the vibrating element, or vibrator should have a natural vibratory period equal to or considerably above that of the human ear. The present invention provides a vibrator whose natural period is far above that of which the ear is capable of responding, and which has been found to properly respond to the high vibratory frequencies of a mixture of varying frequencies, as, for example, produced by the band or orchestra above mentioned.

The difficulty heretofore has been to properly operate with that amount of electric power obtainable in a radio set, a vibrator responsive to frequencies sufficiently high to obtain the above result. By providing a partially closed magnetic circuit which acts to conserve the electric energy I am able to operate a high frequency vibrator in the manner outlined.

Although the details of construction of the device and combinations and sub-combinations are claimed, there is no intention to limit the invention to these details, because the invention broadly contemplates the conservation of magnetic force in a manner to operate a stiff vibrator or a vibrator which can respond to vibrations of unusually high frequencies, as well as to vibrations of lower frequencies.

Advantages of the invention will be set forth in the description of the drawings forming a part of this application, and in said drawings

Figure 1 is a vertical section through the entire device showing the magnetic unit in side elevation;

Figure 2 is an enlarged view showing the magnetic unit in front view with the connector for the vibrators and cone shown in section;

Figure 3 is a central vertical section of Figure 2; and

Figure 4 is a detailed vertical section through the coil approximately on line 4—4 of Figure 3.

The device provides a support 1 and a cone 2 having its periphery resting against the support. Intermediately of the cone and support, and attached to the support at one point as by screw 3, is a frame generally indicated at 4 and having a thin resilient portion 5 and a horizontal shelf portion 6. The frame provides side portions 7 between and against which, and the shelf 6, is secured a U-shaped element 9 of magnetic steel. A screw bolt 10 is passed through the walls 7 to clampingly secure the element 9 between these walls. A screw 12 accessible from the outer side of the support engages the frame 4 to adjust it, against the tension of element 5. As now constructed the U-shaped element is made of tungsten steel which forms the permanent magnet. The lower leg 9 rests flatly against the shelf-like portion 6 and has its front edge flush with the front edge of the shelf 6. The arm 14 lies directly above the arm 9 and is of less length as best shown in Figure 3. Mounted upon the upper surface of the outer end of this lower arm is a block 20 perpendicularly arranged, and having an

opening 21 therethrough, adjacent its top portion. Within this opening is fitted a coil 22 having a core 23. The core projects rearwardly as shown in Figure 3, and its front portion is spaced inwardly from the front surface of the block 20. The rear surface of the coil engages the free end of the arm 14 and also abuttingly engages a block 24, said block having an opening 25 receiving an extension of the core 23. This extension passes partly through the bore 25 and is secured at 26, as by soldering, the soldering closing the bore 25 as shown. On the top of the block is arranged a metallic strip or bar 29, upon which are mounted binding posts 30 held by suitable screws 31. The strip 29 is secured upon the block 24 and the block is secured to the arm 14 by screws 35 having retaining nuts 34. Connections of respective binding posts with the coil are indicated at 36. The binding screws are shown at 37. It will be understood that suitable electrical power connections are provided to energize the coil.

To the outer face of the block 20 is attached a relatively thick vibrator. In the device as at present made this vibrator has a thickness of about one-sixteenth of an inch. The vibrator has a circular head portion 40 and a reduced portion 41 attached by a screw 42 to the block 20. A washer 43 is interposed as shown so that the clearance is about five one-thousandths of an inch. Of course, this clearance has been exaggerated in the drawing. Centrally of the disk-like portion 40 is secured a rod 45, which is about one and one-sixteenth inches in length and about three sixty-fourths of an inch in diameter, the diameter of the outer end 46 of the rod is approximately three thirty-seconds of an inch and about one-half inch in length, and passes through an opening 47 in the cone 2. Clamping means, including elements 49 and nuts 50 secure the cone to the rod. The rod at the inner end may be connected either by screwing or soldering It is assumed to be soldered, in this instance. In the device as at present made the length of the vibrator from the axis of the screw 42 to the axis of the rod is approximately one and nine-thirty-seconds inches. The diameter of the head portion 40 is approximately thirteen-sixteenths of an inch, while the opening 21 of the block is approximately three-fourths of an inch in diameter. The width of the block is about one inch, its thickness about three-eighths of an inch, and its length over-all is about two and one-sixteenths inches. The measurements are only given to show the approximate proportions of the device as now made and operating. The tungsten steel U-shaped element has a width of about one inch, and a thickness of about three-sixteenths of an inch. The lower arm from center of curvature outwardly has a length of about two and one-fourth inches, while the upper arm from the center of curvature outwardly has a length of about one and five-eighths inches. The length over-all before bending is about five and seven-eighths inches. The vertical distance between the axis of the adjusting screws 12 and the axis of the attaching screw 3 is substantially five inches.

The movement of the frame in direction of the arrow A obtains a close adjustment of the armature, while a movement in direction of the arrow B obtains an opposite adjustment. It will be understood that a greater distance spacing of the armature from the coil requires more power for operation. The frequency of the present armature is estimated to be from eleven to fifteen thousand.

The angle of taper of the cone is twenty degrees which is found to give the best results. The periphery of the cone is spaced inwardly from the inner surface of the peripheral wall 1^a of the cone about three-thirty-seconds of an inch.

It will be seen that a portion of the coil is surrounded and enclosed by the element 20, as the outer pole piece connected to the permanent U-shaped magnet, and thus there is provided, through elements 9, 14, 24, 23, 41, 20, a complete magnetic circuit. Thus a practically closed magnetic circuit is provided, a portion of which incloses the coil and prevents stray or wasting of magnetic energy. It will be noted therefore that substantially all the magnetic circuit is through metal. It will be also noted that the conducting element for the magnetic circuit is placed outside the coil as well as within it.

It will be noted that the present invention provides and can successfully operate, a vibrator whose natural period is far above that, of which the human ear is capable of detecting or responding, and which therefore will properly respond to high vibratory frequencies or mixtures of vibrations of varying frequencies, as, for example, produced by a full orchestra or band. Heretofore it has been impossible to properly reproduce the combined frequencies of a plurality of different instruments, because of the lack of selectability of vibrating elements and its inability to respond to the high frequency effects produced by added effects of different instruments with such varying frequencies.

It will be noted that the vibrator has more than the ordinary stiffness, and it is possible to operate a vibrator of this stiffness because of conservation of magnetic force by means of a practically closed magnetic circuit.

Referring to Figure 1, adjustment of the frame in direction of the arrow A will cause the vibrator to approach the magnetic coil. Adjustment in direction of the arrow B will cause the vibrator to recede from the magnet. This is true because the vibrator is connected by the element 45 with the cone and when the frame is moved in the direction B and the vi-

brator is held from movement, as the result of the engagement of the cone 2 with the support 1. There are, during these very fine adjustments, variations of pressure between the periphery of the cone with the support.

The permanent magnet is formed from magnetic steel, in this case tungsten alloy. The element 20 is of soft iron or as ordinarily termed, of magnetic iron. This magnetic iron is not capable of becoming a permanent magnet but is capable of responding to changes in the magnetic field and of intercepting, absorbing and distributing magnetic energy, while at the same time offering little electrical resistance. The function of the permanent magnet is to maintain the armature or vibrator under tension, and the function of the soft or magnetic iron element, as a portion of the magnetic circuit, is to absorb magnetic energy which would otherwise be lost.

It will thus be seen that a device is provided which comprises a practically closed circuit including a permanent magnet and a section of magnetic iron spaced from one pole of the magnet in a manner to form a gap along with a coil embedded in the magnetic iron section and projecting across the gap and having a core connected at one end with one pole of the permanent magnet along with a vibrator operatively opposed to the opposite end of the core and mounted upon the magnetic iron section.

I claim as my invention:

1. A frame, a permanent magnet secured to the frame, a block secured to the permanent magnet and having a bore extending therethrough, a coil fitted within the bore and having a core attached to the magnet, said magnet, core and block constituting a partially closed magnetic circuit, and a vibrator attached to the block and opposed to the core.

2. A unit for the purpose described, comprising a frame having a resilient portion for attachment to a support to permit a swinging motion of the frame, a permanent magnet secured to the frame, a block secured to the permanent magnet and having a bore extending therethrough, a coil fitted within the bore and having a core attached to the magnet, said magnet, core and block constituting a partially closed magnetic circuit and a vibrator attached to the block and opposed to the bore and core.

3. A device of the class described comprising a support, a frame swingingly attached to the support, a permanent magnet mounted on the frame, a block mounted upon one portion of the permanent magnet, a coil embedded in the block and having a core connected with another portion of the permanent magnet all in a manner to provide a partially closed magnetic circuit, and a vibrator carried by the block and arranged to be operable by the magnet, the cubical content of the metal of the block being substantially greater than that of any other portion of the magnetic circuit.

4. A support, a cone engaged against the support, a frame attached to the support to permit a swinging motion, means for swingingly adjusting the frame, a permanent magnet secured to the frame, a block secured to the permanent magnet and having a bore extending therethrough, a coil fitted within the bore and having a core attached to the magnet, said magnet, core and block constituting a partially closed magnetic circuit, a vibrator attached to the block and opposed to the core, a stiff connection linking the vibrator and cone, and electrical means for energizing the coil, and movement of the frame toward and away from the support acting to adjustably space the vibrator with respect to the core.

5. A device of the class described comprising a support, a frame swingingly attached to the support, means for adjustably swinging the frame, a permanent magnet mounted on the frame, a block carried by the permanent magnet, a coil embedded in the block and having a core connected with the permanent magnet all to provide a partially closed magnetic circuit, a vibrator operable by the magnet, a cone having its periphery engaged or engageable with the support, means connecting the vibrator and the cone, the arrangement being such that adjustment of the frame varies the spacing of the vibrator with respect to the core.

6. A device of the class described comprising a support, a frame resiliently swingingly attached to the support, means for adjustably swinging the frame, a permanent magnet mounted on the frame, a block carried by the permanent magnet, a coil embedded in the block and having a core connected with another portion of the permanent magnet all to provide a partially closed magnetic circuit, a relatively stiff vibrator carried by the block and operable by the magnet, a cone engaged with the support, a stiff connection between the vibrator and the cone, the arrangement being such that the frame lies between the support and the cone, and such that adjustment of the frame in one direction acts to vary the spacing of the vibrator with respect to the core.

7. A device of the class described comprising a support, a cone engaged against the support, a frame adjustably secured to the support and having mounted thereon an electro-magnet and a vibrator operable by the magnet, a connection between the vibrator and the cone, and means for adjusting the frame, the arrangement being such that if the frame is moved in one direction the vibrator is caused to approach the magnet and

pressure engagement of the cone with the frame is increased and when moved in an opposite direction the vibrator is caused to recede from the magnet and the pressure of the cone with the base is decreased.

8. A support a cone having its periphery engaged against the support, a frame having a resilient portion attached to the support to permit a swinging motion of the frame, the point of attachment being laterally of the axis of the cone, means for swingingly adjusting the frame against its resilient action, a U-shaped permanent magnet secured to the frame, a block of conducting material secured to one leg of the permanent magnet in upright position and having a bore extending therethrough, a coil fitted within the bore and having a core attached to the other leg of the magnet, said magnet, core and block constituting a partially closed magnetic circuit, a relatively stiff vibrator attached to the block and having a portion opposed to the bore and core and overlapping the bore, and a stiff connection linking the vibrator and cone, the axes of the cone, core, coil and connector being substantially coaxial, and electrical means for energizing the coil, said frame being disposed betwen the support and the cone, and adjustment toward and away from the support acting to adjustably space the vibrator with respect to the core.

9. A device of the class described comprising a practically closed circuit including a permanent magnet and a section of magnetic iron spaced from one pole of the permanent magnet to form a gap, a coil embedded in the magnetic iron section, and projecting across the gap and having a core connected at one end with one end of the permanent magnet, and a vibrator operatively opposed to the opposite end of the core and mounted upon the magnet iron section.

10. A device of the class described comprising a permanent magnet, a block of magnetic iron connected with one pole of the permanent magnet and spaced from the other pole to form a gap, a coil embedded in the magnetic iron and projecting across the gap, and having a core having one end connecting with that pole of the permanent magnet which is spaced from the magnetic iron block, and a vibrator operatively opposed to the other end of the core and mounted upon said block.

In witness whereof, I have hereunto set my hand this 20th day of February, 1928.

JOHN E. SEDERHOLM.