Aug. 9, 1932. R. L. WEGEL 1,870,271

ACOUSTIC DEVICE

Filed Aug. 17, 1929

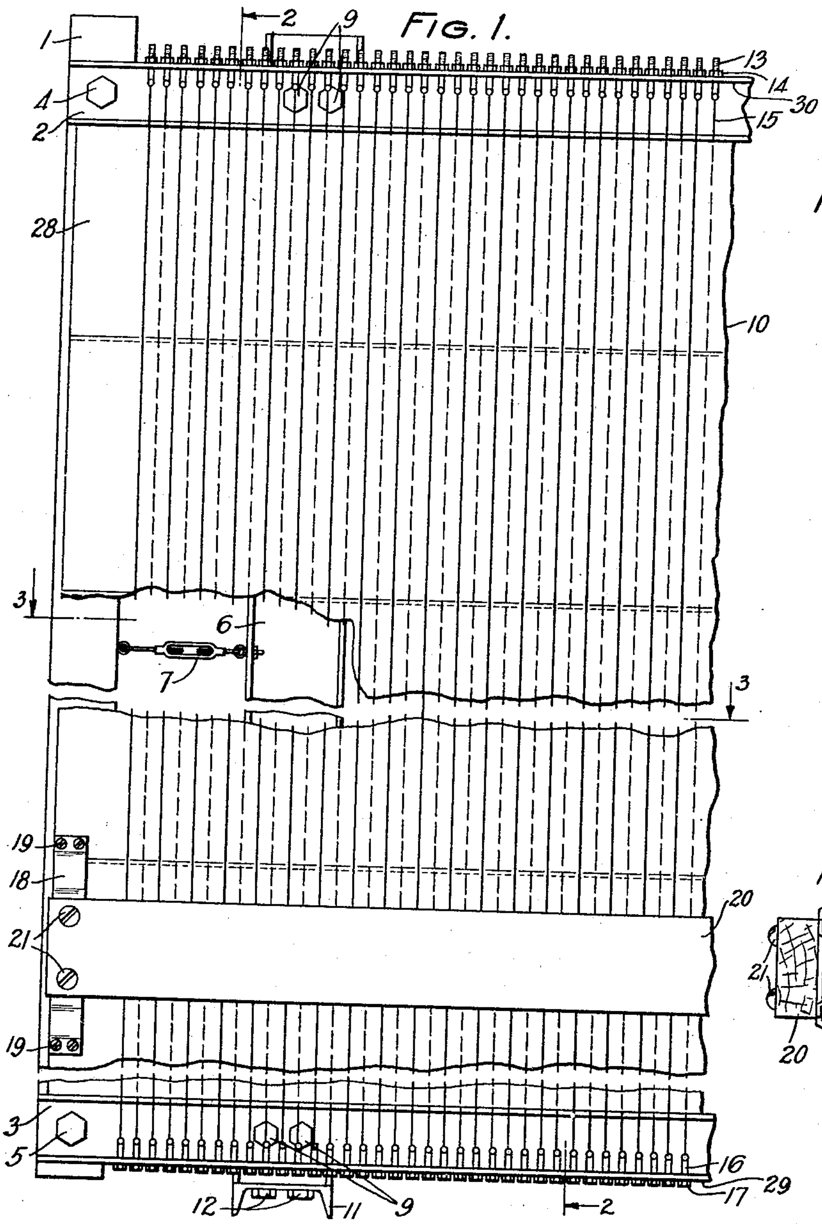


FIG. 1.

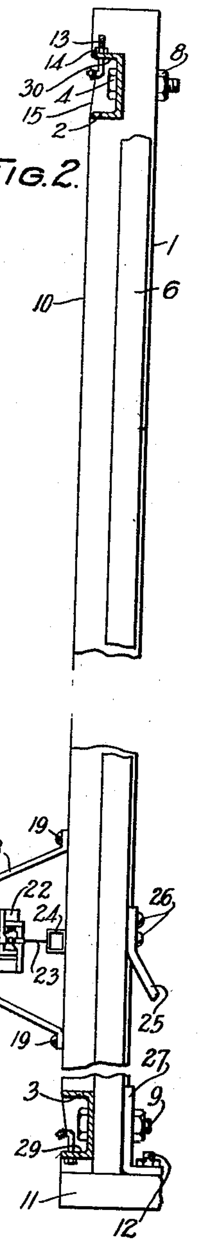


FIG. 2.

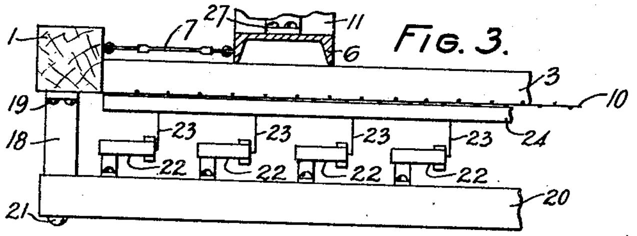


FIG. 3.

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**Patented Aug. 9, 1932** **1,870,271**

# UNITED STATES PATENT OFFICE

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## ACOUSTIC DEVICE

Application filed August 17, 1929. Serial No. 386,605.

This invention relates to acoustic devices and particularly to a large direct acting sound radiator.

The object of this invention is to radiate sound energy with substantially uniform efficiency over at least a large portion of the frequency range of speech and music.

In accordance with this invention there is employed a large direct acting sound radiating surface comprising a plurality of spaced parallel stretched wires, tuned to the same or to different frequencies and between which is interlaced a very thin material which is secured at its extremities to a suitable frame. This thin material, which occupies the space between the stretched wires, may be in one piece or in strips and need not interlace—that is, be drawn under and over alternate wires—with the stretched wires but may be secured thereto on one surface only. It is also to be understood that the sound radiating diaphragm might comprise simply a plurality of wires so spaced that the air gaps therebetween are very small to minimize the leakage of sound disturbances in the air on one side of the diaphragm through the diaphragm to the other side. The wires, incidentally need not be of the conventional circular section but might be rectangular, square or any other suitable shape. The diaphragm, of wire and interlaced material, becomes a unitary structure when a coating of adhesive material is applied thereto which, upon drying, causes adhesion of the two, resulting in a fairly smooth surface having therein a slight lateral tension of negligible value and effect and fills up the pores of the thin material to make it imperforate to air. Any suitable drive, but preferably of the line type, upon being actuated, produces the disturbances in the diaphragm that are propagated along its length with a velocity comparable to that of sound waves in air. Although a magnetic drive is illustrated in the accompanying drawing, it will be understood that an electrodynamic drive may also be used.

To obtain a more complete understanding of this invention reference is made to the appended drawing, wherein:

Fig. 1 is a partial view of an acoustic device having a large direct acting diaphragm embodying the features of this invention;

Fig. 2 is a side elevation of the acoustic device shown in Fig. 1 along the line 2—2;

Fig. 3 illustrates a possible means for driving the diaphragm employed in the embodiment of this invention shown in Fig. 1.

Referring now to the various figures, a frame for the sound radiating surface, or diaphragm, 10 is provided which consists of the upright members 1, preferably of wood, and channeled iron members 2 and 3 which extend horizontally between the first mentioned members (only one of which is shown), embedded therein, as shown most clearly by Fig. 2, and secured thereto at each extremity by bolts 4 and 5, respectively. This frame is supported by a plurality of base members similar to the channel iron 11 which is secured by means of an angle plate 27 and bolts 9 and 12 to the supporting and bracing upright 6 which later is assembled securely to the cross members 2 and 3 by bolts 9. To give the required rigidity to such a supporting structure, use is made of brackets 25 pressed firmly against the upright 6 by screws 26 threading therein, and, it is to be understood, secured at the other end to the base member 11. To maintain the lateral upright 1 in its proper position to prevent introduction of undesirable lateral tensions in the diaphragm if the upright should warp or be otherwise deformed, the turn-buckle 7 is provided as shown between the uprights 1 and 6.

The diaphragm 10 consists of a plurality of spaced, parallel stretched wires 15 and, interlaced over and under alternate wires, strips 28 of a very thin material, such as paper or fabric, but preferably the former, which overlap each other slightly. It is assembled in the following way: Each wire is secured at its lower extremity to a hook 16 which threads into and projects through the lower leg 29 of the cross member 3 sufficiently to be engaged by a nut 17. The other extremity of each wire is then twisted about the looped portion of the hook 13 which threads into and projects through the upper leg 30 of the cross member 2 sufficiently to be engaged by the nut 14. Each wire is tuned by adjusting the position of nut 14 until it is vibrating at the desired frequency and is tensioned (the amount depending on the mass of the wire) preferably, to such a degree that it will transmit acoustic vibrations impressed thereon with a velocity considerably in excess of that of sound in air. All of the wires are tensioned either to the same degree, i. e. to the same fundamental frequency, or to different frequencies depending on which condition is required after the wires have been loaded by means of the thin strips of paper, to permit acoustic vibrations in said diaphragm being propagated therein at a velocity substantially equal to that of sound waves in air on a line along the lengthwise dimension of the diaphragm and in that direction without parasitic modes of vibration distributed over the surface of said diaphragm. After the wires have been tensioned to the desired degree, the paper is drawn therebetween under and over alternate wires and given a coating of a dilute solution of a lacquer which, upon drying, causes the elements of the diaphragm to adhere and introduces therein a small amount of lateral tension, since, if a rectangular diaphragm of the desired characteristics is to be obtained, the thin paper must be given a daub of lacquer at each extremity and secured to the frame member 1. The paper should be of such thickness, together with the coating of the lacquer, that the mass added to the tuned strings will be such as to produce a diaphragm which will propagate acoustic disturbances impressed thereon with a velocity comparable to the velocity of sound waves in air and such that the disturbances will be in phase along the length of the diaphragm at all points across the face of the diaphragm on a line parallel to the line of drive. With the velocity of propagation in the diaphragm comparable to that of sound in air and the sound waves radiated from the various portions of the diaphragm along a line extending in the direction of its length substantially in phase the sound wave radiated from the driven portion of the diaphragm is supplemented or increased in intensity by waves radiated from other portions in the diaphragm. The diaphragm is preferably of sufficient length between its supported ends so that the energy of the waves is largely dissipated by radiation before the waves reach the supported ends, thus diminishing wave reflection in the diaphragm and consequently peaks and valleys in the frequency response characteristic at small values.

Secured to and across one face of the diaphragm, a short distance from one extremity thereof, is a tubular brass member 24, of rectangular cross section, which forms a line drive to transmit sound disturbances to the diaphragm from the reeds 23 of a plurality of electromagnetic receivers 22 which are mounted upon a support 20 of non-magnetic material, such as wood or brass. This support 20 is secured by means of screws 21 at each end to a bracket 18 which is in turn fastened to the upright 1 by screws 19. It is to be understood of course that the drive need not necessarily consist of a plurality of receivers but might take the form disclosed and described in H. C. Harrison's Patent 1,726,105, issued August 27, 1929 or in E. H. Smythe's Patent 1,778,871, issued October 21, 1930.

One embodiment of the features of this invention was constructed in which forty-nine piano wires, having a diameter of approximately .014 inch and spaced one-half inch apart, were tuned to a fundamental frequency of 145 cycles per sec. In this condition, they were capable of propagating acoustic vibrations at a speed of approximately fifty thousand centimeters per sec. which is, of course, considerably in excess of the speed of sound in air. By using paper of substantially .0007–.0008 inch in thickness, which upon being coated with a lacquer increased in thickness to approximately .001 inch interlaced between the stretched wires, sufficient mass was added to produce a diaphragm wherein the velocity of propagation of acoustic vibrations was substantially equal to that of sound in air and having a fundamental frequency of approximately 70 cycles per sec. and a lower cut-off slightly below 70 cycles per sec. In this particular embodiment the diaphragm was five feet eight inches in length and approximately one-third of the wave-length of the lowest frequency to be reproduced and each receiver was so positioned as to work into the load provided by six stretched wires and the condenser paper secured thereto. This acoustic device was found to be very efficient particularly at the lower frequencies.

What is claimed is:

1. In an acoustic device, an elongated direct acting sound radiating surface comprising a plurality of stretched metallic members and thin material vibratable with and secured to said members, and means connected to said surface for directly impressing vibrations on each of said members.

2. In an acoustic device, a direct acting sound radiating surface comprising a plurality of stretched members arranged parallel to each other in a single plane, and means connected crosswise of one face of said surface and to each of said members for imparting vibrationless forces thereto.

3. In an acoustic device, a direct acting sound radiating surface quadrilateral in shape comprising a plurality of stretched metallic members arranged parallel and adjacent to each other in a plane and thin mate-

rial connected to and vibratable with said members.

4. In an acoustic device, a pair of spaced supports, a diaphragm for radiating sound waves directly into the surrounding air without the aid of a horn or sounding board, comprising a plurality of metallic members stretched longitudinally between said supports, and vibratable material connected to said members for vibration therewith.

5. In an acoustic device, a diaphragm for radiating sound waves without the aid of a horn or sounding board, comprising a plurality of stretched metallic members and thin material interlaced therebetween.

6. A large direct-acting sound radiating surface comprising a plurality of wires tensioned to a high degree and thin material interwoven between said wires and secured thereto.

7. A large direct acting sound radiating surface comprising a plurality of highly stretched parallel wires and thin material secured thereto and vibratable therewith.

8. A large direct acting sound radiating surface comprising a plurality of wires and very thin material occupying the spaces between and secured to said wires, said wires being initially tensioned so that vibrations may be propagated therealong at a rate greater than the velocity of sound waves in air, said thin material loading the wires such that vibrations may be propagated along said surface at a rate approximately equal to the velocity of sound waves in air.

9. A large direct acting rectangular-shaped sound radiating surface comprising a plurality of highly stretched wires and very thin material occupying the space between and secured to said wires.

10. A large direct acting sound radiating surface comprising a plurality of wires and very thin material occupying the spaces between and secured to said wires, the velocity of propagation of acoustic vibrations therein being comparable to that of sound waves in air.

11. In an acoustic device, a direct acting sound radiator comprising a plurality of wires and very thin material occupying the space between and secured to said wires, said wires being stretched to a high degree, and means for driving said sound radiator.

12. An acoustic device comprising a direct acting sound radiator comprising a plurality of wires and very thin material occupying the space between and secured to said wires, said wires being stretched to a high degree, and means for driving said radiator, said means consisting of a tubular member secured to and across the face of the radiator.

13. In an acoustic device a large direct acting sound radiating surface comprising a plurality of wires and very thin material occupying the spaces between and secured to said wires, and driving means of the line type to impact acoustic vibrations to said sound radiating surface.

14. A long direct acting sound radiating surface comprising a plurality of stretched wires and sheets of very thin material drawn transverse to the direction of the wires under and over alternate wires.

15. A long direct acting sound radiating surface comprising a plurality of stretched wires and sheets of very thin material drawn transverse to the direction of the wire under and over alternate wires and secured thereto by an adhesive.

16. A long direct acting sound radiating surface, comprising a plurality of wires and thin material occupying the space between and secured to the wires, of such mass and elasticity that acoustic vibrations therein will be transmitted through the long dimension of the radiating surface with a speed comparable to that of sound waves in air and such that the disturbances along a line across the face of the radiating surface will be substantially in phase.

17. A loud speaking device for giving off sound waves into the surrounding air without the use of an auxiliary device such as a sound board or a horn comprising a plurality of stretched metallic elements of equal length arranged parallel to each other in a plane, and means for actuating said elements comprising a tubular member affixed to each of said elements.

18. A loud speaking device comprising a driving means, a sound radiator comprising a plurality of parallel stretched metallic members, and means connected to said driving means and each of said metallic members to vibrate all of said members simultaneously in response to variations in current transmitted to said driving means.

19. In a loud speaking device for giving off sound waves into the surrounding air without the use of an auxiliary device, such as a horn or a sound board, a sound radiator comprising a plurality of wires, stretched to a degree such that acoustic vibrations are propagated therein with a velocity substantially equal to that of sound waves in air.

20. The method of constructing a sound radiating diaphragm for giving off sound waves into the surrounding air without the aid of an auxiliary device, such as a sound board or a horn, which comprises arranging a plurality of elongated elements in the same plane, stretching said elements to such a degree that the velocity of propagation of acoustic vibrations therein exceeds that of sound waves in air, and thereafter loading said elements whereby the velocity of propagation of acoustic vibrations thereby is substantially that of sound waves in air.

21. The method of constructing a sound radiating diaphragm for giving off sound

waves into the surrounding air without the use of an auxiliary device, such as a sound board or a horn, which comprises arranging a plurality of elongated metallic elements in the same plane, stretching said elements to such a degree that the velocity of propagation of acoustic vibrations therein exceeds that of sound waves in air, and thereafter loading said elements by means of thin material secured thereto by an adhesive, thereby reducing the velocity of propagation of acoustic vibrations therein to substantially that of sound waves in air.

22. A sound translating surface rectangular in shape, comprising a plurality of stretched wires, extending in the direction of the long dimension of said surface, and a thin material secured thereto to prevent acoustic short circuit between opposite faces of said surface, said surface having substantially no lateral tension present therein.

23. An acoustic device comprising a diaphragm having a plurality of stretched metallic members and a thin material attached to and vibratable with said members, a magnet structure comprising spaced pole pieces, means in operative relation to said pole pieces, to be influenced by current variations corresponding to sound waves, and a direct connection between said means and said diaphragm for actuating the diaphragm, said connection being substantially along a line extending across one surface of the diaphragm.

24. In combination, an electrical device having a movable element, said device acting to transform current variations corresponding to sound waves into movements of said element, and a direct acting sound radiating surface comprising a plurality of stretched metallic members, said movable element being connected to said surface substantially along a line across one dimension of said surface, said surface being directly actuated in accordance with the movements of said movable element.

25. In combination, an electrical device having a movable element, said device acting to transform electrical currents representing sound waves into movements of said element, and a direct acting sound radiating surface comprising a plurality of parallel stretched metallic members, and means connecting said surface and said movable element so that the movements of said movable element are impressed on all of the stretched members simultaneously.

In witness whereof, I hereunto subscribe my name this 12th day of August, 1929.

RAYMOND L. WEGEL.

# CERTIFICATE OF CORRECTION.

Patent No. 1,870,271. August 9, 1932.

RAYMOND L. WEGEL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, line 124, claim 2, for "vibrationless" read vibrational; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 29th day of November A. D. 1932.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

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