June 23, 1931. G. PORTER 1,811,558

LOCATOR OF ABNORMAL SOUNDS AND VIBRATIONS

Filed Oct. 4, 1930 2 Sheets-Sheet 1

Fig. 1.

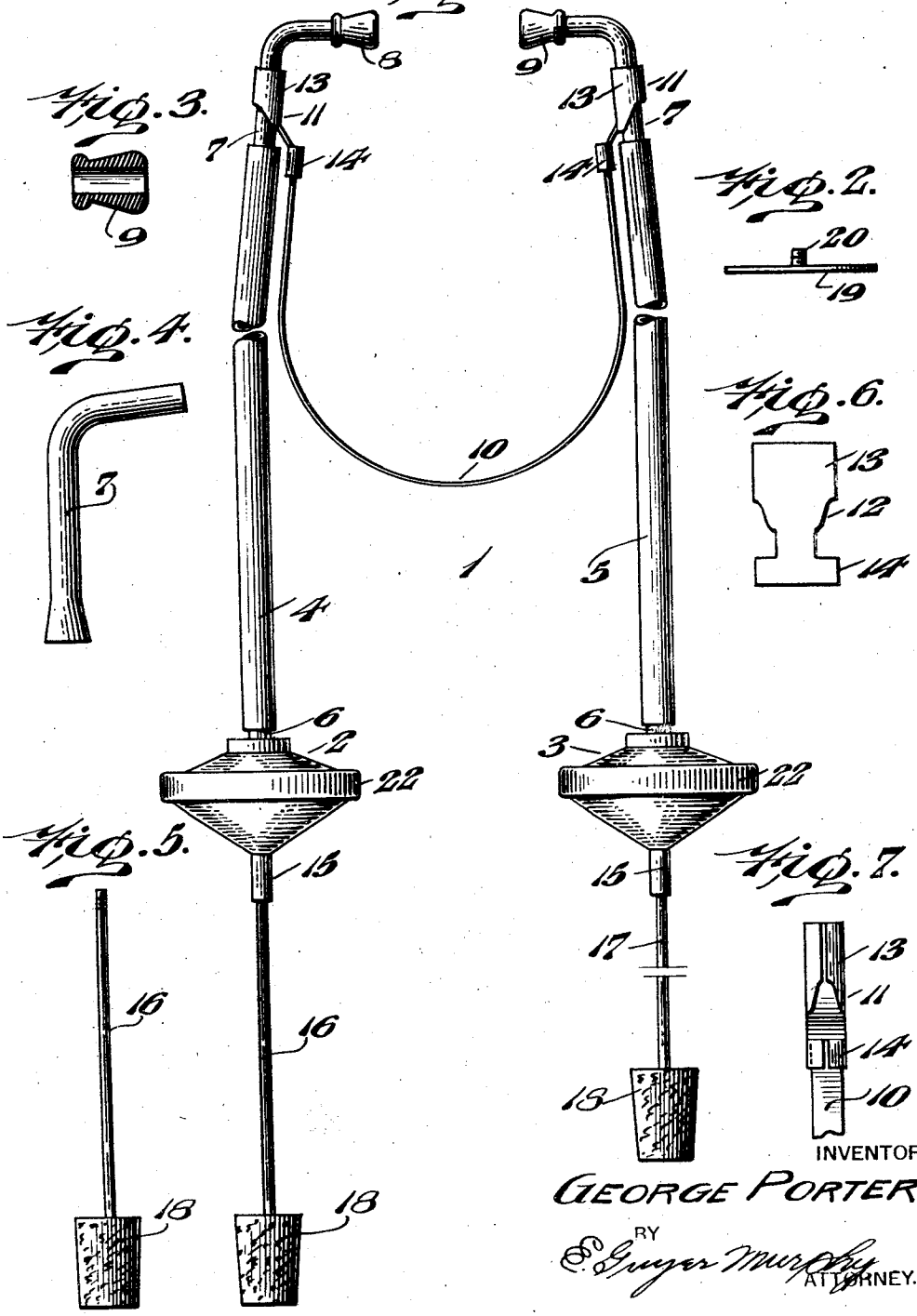


Fig. 3.

Fig. 2.

Fig. 4.

Fig. 6.

Fig. 5.

Fig. 7.

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Fig. 8.

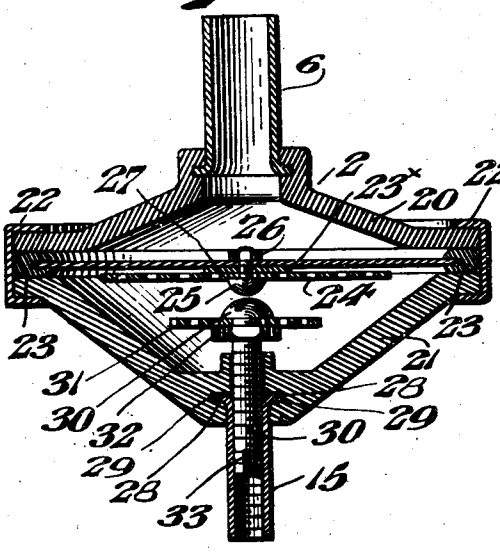


Fig. 9.

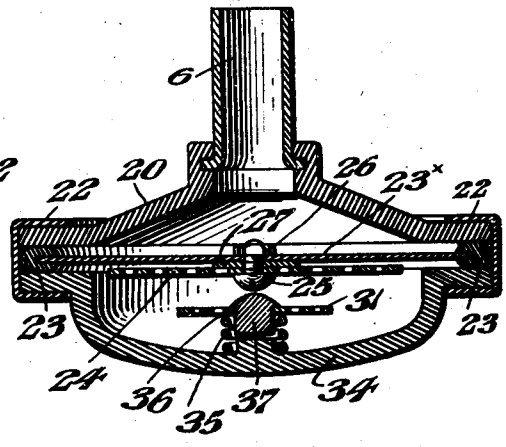


Fig. 10.

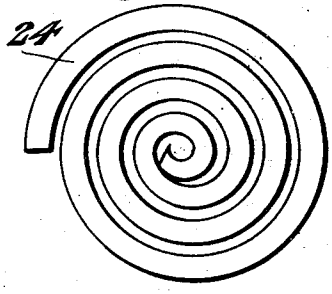


Fig. 11.



Fig. 12.

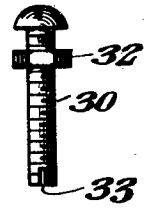


Fig. 13.

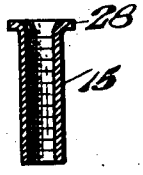
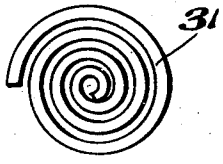


Fig. 14.



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UNITED STATES PATENT OFFICE

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LOCATOR OF ABNORMAL SOUNDS AND VIBRATIONS

Application filed October 4, 1930. Serial No. 486,300.

My invention relates to a new and useful locator of abnormal sounds and vibrations, and more particularly to a device of this character adapted for detecting, amplifying, and locating abnormal or unnatural sounds and determining, with great accuracy, the direction of the source or origin of such sounds, as well as the circumstances giving rise to such sounds.

My invention further relates to a device of this character, which is adaptable for the detection, amplification, and location of abnormal sounds, whether such sounds issue from machinery in general, or whether such sounds occur in the bodies of living organisms such as human beings and other animals.

My invention is based upon, and makes use of the general principle of "double", comparative, or relative hearing, so as to enable the auditory organs not only to detect, but also to distinguish, faint and closely resembling sounds, as well as sounds having rather close points of origin, which sounds could not be detected or distinguished with the naked ears.

My invention further involves the principle of sound insulation, whereby all sounds emanating from sources other than those directly under investigation are shut off or excluded, thus enabling the operator to concentrate his attention to the detection, study and comparison of the sound or sounds with the determination of which he is primarily concerned, without any undue interruption by extraneous sounds.

By the spacing of the ears on the head, and by the possession of separate, spaced auditory nerve centers in the brain, animals in general are enabled to determine the direction, intensity, and nature of sounds, provided such sounds are within range of hearing.

When, however, amplifying means are resorted to for the purpose of detecting and amplifying sounds, which the naked ears, unaided, cannot detect, the advantage inherent in the possessing of two, separate, spaced, and distinct ears is lost, since only one particular sound is detected, amplified, and transmitted to both ears with equal intensity, without any regard to the direction of origin or source and, of course, permitting of no comparison of different sounds, since all extraneous sounds are excluded and all the sounds transmitted are equally amplified and intensified. Thus, the binaural stethoscope, heretofore constructed and commonly employed in the medical and allied professions, is provided with a single sound detecting and amplifying element from which extend a pair of sound insulating and conveying tubes which convey the particular sound amplified to both ears with equal intensity, the general direction of such sound being dependent not upon the direction of the original source but upon the direction in which the amplifying element of the device is pointed. Similarly, it is not possible, with a device of this character, to distinguish between two or more sounds simultaneously amplified and conveyed. For instance, a physician using the ordinary stethoscope must rely entirely upon his memory as to what the normal sound of the heart or lung is, and then compare therewith the sounds heard in the chest of the patient. Furthermore, the sounds thus transmitted are equally intense in both ears and have a common point of origin so that no difference in direction or characteristics can be detected, and no comparison of different sounds with one another or with extraneous sounds can be had.

It is the object of my invention to provide a sound detecting and amplifying device, which, in addition to amplifying and bringing within range sounds otherwise inaudible, will also simultaneously convey different contemporaneous sounds, separately and exclusively to each ear, thus permitting of the comparison and contrast of different sounds, and enabling the listener to determine the direction of origin as well as the nature or cause of each sound heard.

A further object of my invention is to design means whereby the operator is enabled to hear and compare two different contemporaneous sounds from two different points, thus to set up a physiological automatic action in the brain of the operator, concentrating his mind on the particular

sound or sounds under investigation and better enabling the operator to determine the origin and cause of such sounds.

A further object of my invention is to provide a locator of abnormal sounds and vibrations which will enable the operator to hear the particular sound or sounds under investigation to the exclusion of all other extraneous, interfering sounds.

A further object of my invention is to produce a device of this character which will be of universal adaptability and applicability, said device being adapted for the reception of sounds and vibrations from every possible source and under all circumstances.

To the above ends my invention consists of a pair of sound detecting and transmitting devices, a pair of sound amplifiers, each of said devices being provided with separate, independent and individual sound insulating and conveying means leading to the ears of the operator to enable the latter simultaneously to hear and distinguish two different, contemporaneous sounds and to compare such sounds with one another or with other sounds, and further enabling the operator to detect any difference in the direction or point of origin of such sounds regardless of the distance or proximity of such points of origin.

My invention further consists in a novel construction of the sound amplifiers above referred to, wherein the vibratory, amplifying element is insulated from the outer shell or sound box containing the same so that said amplifying element is not affected by any extraneous sounds or vibrations other than those with which the device is deliberately brought in contact, thus enabling the operator to hear and distinguish certain sounds to the exclusion of all others.

My invention further consists in adapting my novel locator of abnormal sounds and vibrations for the reception of a great variety of attachments, thereby rendering my novel apparatus applicable to all kinds of machinery and practicable for all occasions and under any set of circumstances.

For the purpose of illustrating my invention, I have shown in the accompanying drawings forms thereof which are at present preferred by me, since the same have been found in practice to give satisfactory and reliable results, although it is to be understood that the various instrumentalities of which my invention consists can be variously arranged and organized and that my invention is not limited to the precise arrangement and organization of the instrumentalities as herein shown and described.

In the accompanying drawings:

Fig. 1 is a side elevational view of a locator of abnormal sounds and vibrations embodying my invention, and having its detectors particularly adapted for use on rapidly moving machinery;

Fig. 2 represents a side elevation of a detector plate employed for adapting the device shown in Fig. 1 for use in connection with slow moving machinery;

Fig. 3 is a sectional view of one of the ear pieces forming part of my invention;

Fig. 4 is a side elevational view of an angle tube interposed between the ear pieces and the sound conveying tubes;

Fig. 5 is a side elevation of one of my novel detectors, shown detached;

Fig. 6 is a side elevational view of a blank from which a connecting arm is formed for connecting the central, supporting, and tensioning spring to the sound conveying tubes and securing them together;

Fig. 7 is a side elevational view of the connecting member formed by folding the blank shown in Fig. 6;

Fig. 8 is a sectional view of a sound amplifier forming part of my invention;

Fig. 9 is a similar sectional view of a modified construction embodying my invention;

Fig. 10 is a plan view of a vibratory element forming part of the amplifier shown in Figs. 8 and 9;

Fig. 11 is a view similar to that shown in Fig. 5 with the end piece removed;

Fig. 12 is a detailed view of the adjustable screw construction seen in the lower portion of Fig. 8;

Fig. 13 is a sectional view of the sleeve seen in the lower portion of Fig. 8 shown detached; and

Fig. 14 is a plan view of a vibratory element forming part of my novel amplifier shown in Figs. 8 and 9.

Referring to the drawings, in which similar numerals of reference indicate corresponding parts, 1 designates a novel locator of the causes of abnormal sounds and vibrations embodying my invention and comprising a pair of sound amplifiers 2 and 3, made of any suitable sound proof or insulating material and from which extend the sound conveying tubes 4 and 5, preferably made of pure soft rubber to insure perfect sound insulation; that is, to prevent the loss of any of the sound amplified in the amplifiers 2 and 3 and to prevent any extraneous sounds, i. e. sounds originating outside the amplifiers 2 and 3, from reaching the ears. The tubes 4 and 5 are detachably secured at their lower ends to the upper ends of the tubular extensions or sleeves 6 of the amplifiers 2 and 3, and at their upper ends to the lower ends of the angle tubes 7 which carry the ear pieces 8 and 9. 10 designates a flat spring or its equivalent, secured to the angle tubes 7 by means of the pair of connecting arms 11 formed by folding a blank 12 in the manner shown in Fig. 7, said arms being secured by soldering the upper sleeves 13 thereof to the angle tubes 7 and

by soldering the lower clip portions 14 thereof to the ends of the spring 10, as will be understood from Fig. 1, it being understood that the spring 10 or its equivalent may be secured to the tubes 4 and 5 or the angle tubes 7 in any suitable manner.

The amplifying elements 2 and 3 are provided with the pendant, internally threaded tubular extensions 15 into which are adapted to be threaded the applicator rods or stems 16 and 17 or any other attachments. Thus, the applicator or diaphragm plate 19, provided with the threaded sleeve 20 is adapted to be screwed into the tubular extension 15 in lieu of the rods 16 and 17, and the device is now ready for use in connection with and for locating the causes of abnormal sounds and vibrations in slow, and relatively quiet machinery where a high degree of amplification is necessary. Similarly, the rods 16 and 17 may be stripped of the cushions or corks 18 and are then ready for use for detecting leaks in underground pipes, and in connection with mining and allied operations.

Each of the amplifiers 2 and 3 comprises a sound box formed of an upper body member 20 and a lower body member 21, preferably made of disc-like contour considered in plan, and of a conical or tapering shape in vertical cross-section; and also preferably made of sound proof or sound insulating material such as rubber or the like. An annular retainer 22 clamps the upper and lower body members 20 and 21 respectively together as will be understood from Figs. 1, 8, and 9. 23 designates an annular cushioning gasket made of soft rubber or the like, which is clamped between the rims or peripheries of the body members 20 and 21, and which supports the periphery of the diaphragm or vibratory element $23x$ in insulated relation with respect to the members 20 and 21, so that the diaphragm $23x$ is not affected by the vibrations of the parts 20 and 21, but is affected only by vibrations transmitted thereto by the stems or rods 16 and 17 or other similar sound detecting and transmitting attachments employed, such attachments being directly connected with or applied to the sound or sounds under investigation. This insulation of the amplifying diaphragm $23x$ from the parts 20 and 21 of the sound box is advantageous in that it enables the operator to concentrate upon the particular sound or sounds originating at any given points, without any interferences or disturbances due to extraneous competing sounds and vibrations, which might possibly affect or be "picked up by" the parts 20 and 21. Another advantage of the novel cushioning of the diaphragm $23x$ is that it affords the latter a greater freedom of vibrations and thus produces maximum amplification. For the purpose of securing maximum insulation, I have also made the metallic or other hard members 6 and 7 as short as possible, thus to reduce to a minimum the transmission of all external, interfering sounds. A vibratory element 24, which may be a suitable spring, diaphragm or the like, is secured to the underside of the diaphragm $23x$ by the bolt 25 and nut 26, and is suitably spaced therefrom by the spacing washer 27. The internally threaded tubular extension 15 is secured to the tapering end of the lower body member 21 by means of the annular flange 28 engaging the seat or recess 29, and is in threaded engagement with the screw 30 which carries the second vibratory element 31, confined between the head of said screw 30 and the nut 32. The screw 30 is provided with the slot 33 which is adapted to be engaged by the end of a screw driver or similar tool inserted through the lower end of the sleeve 15, for the purpose of turning said screw 30 and thus adjusting the spaced relation of the vibratory springs or elements 24 and 31 to different requirements.

In Fig. 9 I have shown a modified construction of my novel amplifier, wherein I have replaced the lower body member 21 with the member 34 having a relatively flat bottom surface, this construction being particularly adapted for detecting, amplifying and locating sounds occurring in the bodies of living organisms as is necessary in the medical and allied arts. In this construction the vibratory element 31 is maintained in position by the pressure of the spring 35 which presses the element 31 upwardly against the shoulder 36 of the head or stud 37, as will be understood from Fig. 9.

The operation is as follows: The operator inserts the ear pieces 8 and 9 evenly into both ears and places the applicator or stem 16 in contact with a source of sound or vibration such as a machine, and, if only the natural sounds normally incident to the proper functioning of the machine are heard, the stem or detector 16 is maintained stationary and the applicator or detector 17 is then placed in contact with another similar source of sounds and vibrations, that is, a similar machine, and the sounds heard through the applicator 17 are then compared with those heard through the applicator 16. Since the sounds heard through the applicator 16 are known to be "normal", any difference between these sounds and the sounds heard in or through the applicator 17 indicates that the machine with which the latter applicator is in contact is not "normal". The exact location, nature, and cause of the abnormal sounds thus heard can next be determined by more minute and detailed testing.

Similarly, one part of a machine may be compared to or tested with relation to another. Thus, in testing a multi-cylinder motor or engine, one of the applicators or stems 17 is placed in contact with one cylinder and the other applicator 16 is placed upon an-

other, say the adjacent cylinder. By comparison it is determined which of these two cylinders is normal or functioning properly, and one of the applicators or detectors 17 is kept on that cylinder, while the other applicator 16 is moved around and about onto another cylinder, the sounds heard in each successive cylinder thus tested being compared with those heard simultaneously in the normal cylinder, thus determining which cylinders are and which are not normal. Furthermore, if there is more than one defect in the same part of the machine such as the same cylinder, one of the applicators can be kept nearest one of those defects while the other applicator is moved around to detect other defects. Thus, if in any one cylinder there is a wrist pin knock and a screech due to a loose bearing or other defect, one of the applicators 17 is placed directly over the defect causing the wrist pin knock, that is at the point where the wrist pin knock is heard loudest in the right ear. The other applicator 16 is moved around away from the wrist pin knock, and while the left ear constantly hears the wrist pin knock, still it hears it less loudly and distinctly than the right ear does and the left ear is therefore in a position to detect other sounds which the right ear, deafened by the greatly amplified and all dominating wrist pin knock cannot detect. Similarly, if a physician, employing the embodiment of my invention shown in Fig. 9, wishes to listen to the sound of the heart beat, he can place one amplifier 2, directly over the heart. However, the sound heard through this amplifier also includes the sound of breathing in the lungs. The physician then places the other amplifier away from the heart, where a maximum of breathing sound is heard and a minimum of heart beat. By discounting, or eliminating the sound of breathing in the lungs heard through the amplifier 3 from the combined breathing and heart beat sounds heard in or through the amplifier 2, an accurate idea can be formed as to how much of the sound heard through the amplifier 2 was due to the heart beat and how much of it was due to the breathing sound in the lung and the condition of the heart or the lungs, or both, is thus accurately determined. In other words, by a process of comparison and elimination of different contemporaneous sounds simultaneously heard, the cause of any particular sound thus detected can be quickly and easily located, and by experience the operator is enabled to interpret these sounds and resolve them into their respective causes without the necessity of taking the machine apart and without the necessity of surgical operations in the case of living beings.

In Fig. 1, I have shown my novel device as adapted for use in connection with rapidly moving machinery which ordinarily produces loud, sharp sounds. For use on machines of this character, I provide the applicators or detectors 16 and 17 with the corks or other cushioning means 18 which serve to lessen the vibration and clarify the sound. If, on the other hand, a machine produces very little sound and moves very slowly, a maximum amplification is desirable, and the stems or applicators are replaced by the diaphragms or plates 19. Similarly, when it is desired to discover whether or not an under-ground pipe leaks, and where such leak is, the applicators 16 and 17, stripped of the cushions 18, are thrust into the ground, and the sounds thus transmitted determine the condition of the pipes and the location of the defect, if any.

In Fig. 9 I have illustrated a modified form of my novel amplifier forming part of my novel locator of abnormal sounds and vibrations, especially adapted for use in detecting sounds in living organisms and under similar conditions where maximum amplification is necessary.

It will thus be seen that I have devised a locator of abnormal sounds and vibrations which is of universal applicability and which can be adapted by merely changing a detachable attachment for the detection and amplification of sounds occurring in every kind of machine or organism and under any set of circumstances.

I am aware that the invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and I therefore desire the present embodiment to be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the foregoing description to indicate the scope of the invention.

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

1. In a device of the character stated, a pair of independent sound detecting and transmitting elements, a corresponding pair of independent sound insulating and conveying elements and a pair of independent sound amplifiers operatively interposed between said corresponding pairs of elements respectively, each of said amplifiers comprising a sound box, a diaphragm transversely secured therein, cushioning means for said diaphragm, a plurality of spaced vibratory elements in said box intermediate said diaphragm and the corresponding sound detecting and transmitting element, and means for adjusting the distance between said vibratory elements.

2. In a device of the character stated, a pair of disconnected sound detecting and transmitting elements, a corresponding pair of disconnected sound insulating and convey-

ing elements, and a pair of disconnected sound amplifiers operatively interposed between said sound detecting and transmitting elements and the corresponding sound insulating and conveying elements, each of said amplifiers comprising a sound box, a diaphragm transversely disposed therein, cushioning means for said diaphragm, and a plurality of vibratory elements of different sizes in said box intermediate said diaphragm and the corresponding sound detecting and transmitting element.

3. In a device of the character stated, a pair of disconnected sound detecting and transmitting elements, a corresponding pair of disconnected sound insulating and conveying elements and a pair of disconnected sound amplifiers operatively interposed between said corresponding pairs of elements respectively, each of said amplifiers comprising a sound box having oppositely disposed ends, a diaphragm transversely mounted in said box, and a plurality of vibratory elements of different sizes in said box intermediate said diaphragm and said sound detecting and transmitting element, one of said vibratory elements being carried by and in spaced relation to said diaphragm and the other of said vibratory elements being carried by and in spaced relation to the adjacent end of said box.

4. In a device of the character stated, a pair of independent sound detecting and transmitting elements, a corresponding pair of disconnected sound insulating and conveying elements, and a pair of disconnected sound amplifiers operatively interposed between said sound detecting and transmitting elements and the corresponding sound insulating and conveying elements, each of said amplifiers comprising a sound box, a diaphragm transversely disposed in said box, and a plurality of upper and lower vibratory elements in said box intermediate said diaphragm and the corresponding sound detecting and transmitting element, and means for adjusting the spaced relation of the lower of said vibratory elements to said upper vibratory element, to said diaphragm, and to said box.

5. In a device of the character stated, a sound box, a diaphragm therein, a vibratory element carried by said diaphragm in parallelism therewith, a second vibratory element below said diaphragm, and a vertically adjustable support for said second vibratory element for varying the distance between said vibratory elements.

6. In a device of the character stated, a sound box, a diaphragm therein, cushioning, sound insulating means intermediate said diaphragm and said sound box, a vibratory element carried by said diaphragm in parallelism therewith, a second juxtaposed vibratory element carried by said sound box, and means for varying the distance between said juxtaposed vibratory elements.

7. In a device of the character stated, a sound box, a diaphragm therein, an upper vibratory element carried by said diaphragm and in parallelism therewith, a lower vibratory element below said upper vibratory element, a vertically adjustable support for said lower element comprising an internally threaded sleeve having its head seated in an adjacent wall of said sound box and having its other end projecting through and beyond said wall, and a screw threaded stem carrying said lower vibratory element at one end thereof, and having the body portion thereof adapted for threaded engagement with said sleeve.

8. In a device of the character stated, a sound box, a diaphragm therein, a vibratory member carried by said diaphragm and in parallelism thereto, a second vibratory member below said diaphragm and a vertically adjustable support for said lower vibratory member comprising an internally threaded sleeve having its head seated in an adjacent wall of said sound box and having its other end projecting through and beyond said wall, and a stem carrying said lower vibratory element at one end thereof and having its body portion adapted for threaded engagement with said sleeve, there being a slot in the end of said stem adapted to be engaged by a screw driver whereby said stem may be rotated within said sleeve to adjust the distance between said springs.

9. In a device of the character stated, a sound box, a diaphragm therein, cushioning means for said diaphragm, intermediate the latter and said sound box, a vibratory element carried by the underside of said diaphragm in parallelism therewith, a second juxtaposed vibratory element below said diaphragm and carried by an adjacent wall of said sound box, and sound insulating and conveying means operatively connected to said sound box.

10. In a device of the character stated, a sound box, a diaphragm therein, a vibratory element carried by said diaphragm and in parallelism thereto, a second vibratory element below said diaphragm and a vertically adjustable support for said lower spring comprising an internally threaded sleeve carried by an adjacent wall of said sound box, and a threaded stem carrying said lower vibratory element on one end thereof and being adapted for threaded engagement with said sleeve, said sleeve being adapted to engage and support a variety of sound detecting and transmitting elements in operative relation to said sound box and its adjuncts.

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