

L. V. KING,
TUNING OF DIAPHRAGMS FOR GENERATING OR RECEIVING SOUND WAVES.
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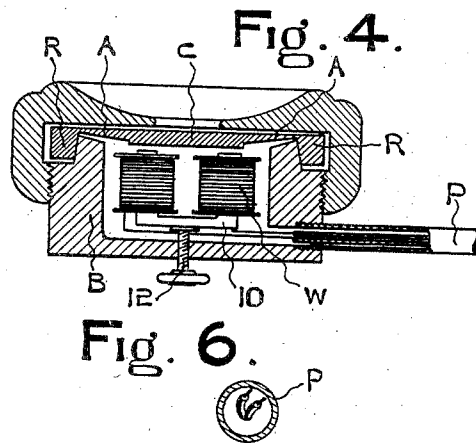
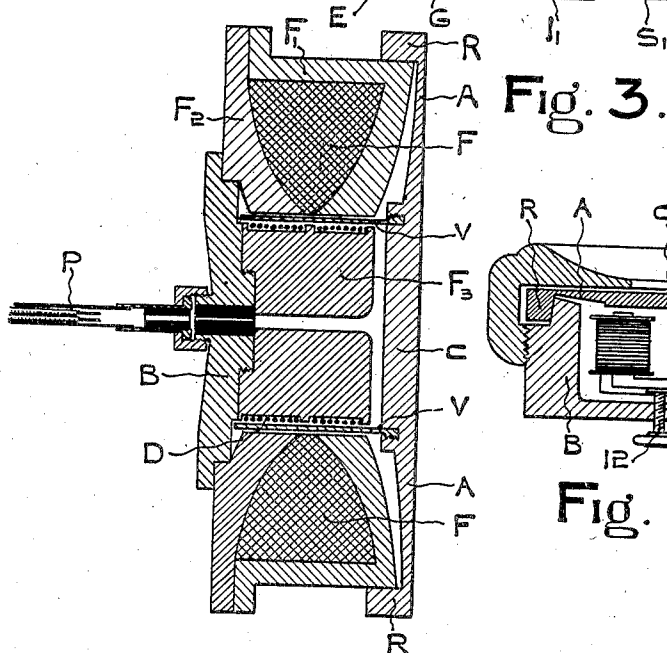
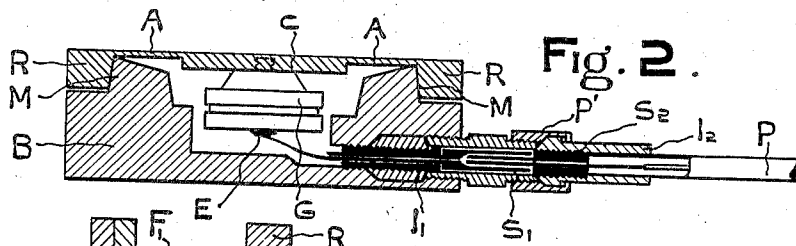
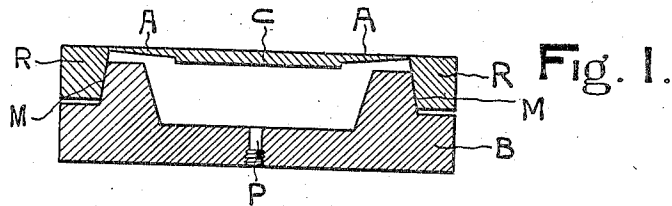
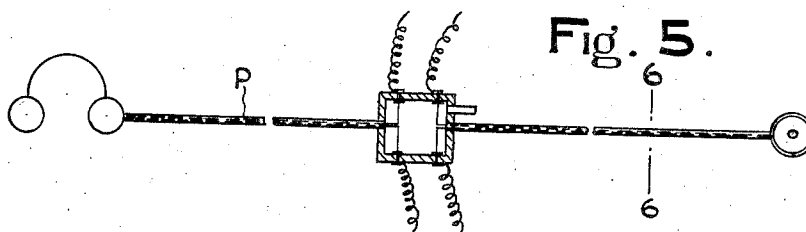


Fig. 6.



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TUNING OF DIAPHRAGMS FOR GENERATING OR RECEIVING SOUND-WAVES.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, LOUIS VESSOT KING, a subject of the King of Great Britain, and resident of the city of Montreal, Province of Quebec, Dominion of Canada, have invented certain new and useful Improvements in the Tuning of Diaphragms for Generating or Receiving Sound-Waves; and I do hereby declare that the following is a full, clear, and exact description thereof.

Heretofore it has not been possible to adjust from a distance at will and to meet continuously varying conditions, the fundamental pitch of diaphragms for the purpose of tuning the same to the frequency of the actuating vibratory force; neither has it been possible to know the change of volume for each pulsation and hence the acoustic load, and consequently, the characteristics of the diaphragm could not be accurately predetermined. To overcome these defects is the object of my invention and to this end I have provided a diaphragm of particular construction and combined with it means whereby it may be tuned at will and continuously from a distance within reasonable limits of pitch, and means whereby an electro-vibratory force is applied to a certain defined area of the diaphragm.

More specifically stated the invention consists in a diaphragm having a solid and practically undeformable area connected to the means for mounting same by a relatively thin, flexible, or deformable portion. This diaphragm is mounted in a position on a suitable body presenting with the diaphragm an hermetically sealed gas chamber with means for supplying a gaseous pressure or suction thereto and, consequently, over the interior of the diaphragm, thereby causing it to bulge slightly outward or inward as the case may be. To generate pulsations I equip the undeformable area of the diaphragm with a vibrator of tubular form constituting a component part of the diaphragm and constructed and arranged to generate or receive pulsations to or from the diaphragm without disturbing the continuity of tuning. Electrical pulsations are transformed into sound pulsations and vice-versa by an electro-magnetic mechanism forming the body upon and within which this diaphragm, which I term a "piston-diaphragm" is mounted.

The electrical devices illustrated in the drawings with my diaphragm and means

for tuning the same applied thereto are well known and form no part of my invention, except in combination.

For full comprehension, however, of my invention reference must be had to the accompanying drawings in which similar reference characters indicate the same parts and wherein:

Figure 1 illustrates diagrammatically a diaphragm fashioned according to my invention and adapted to general use where microphone and electro-vibratory properties are not required;

Fig. 2 illustrates diagrammatically the diaphragm applied to a body having microphone properties;

Fig. 3 illustrates diagrammatically the diaphragm combined with electro-vibratory mechanism according to my invention;

Fig. 4 illustrates diagrammatically the diaphragm applied to a telephone receiver; and

Fig. 5 illustrates diagrammatically a microphone receiver and a telephone receiver arranged for the simultaneous unisonal tuning of their diaphragms; and

Fig. 6 is a sectional view taken on line 6—6 of Fig. 5.

I will now describe in what manner the invention relates to a means of altering continuously at will from a distance, by the application of fluid pressure (or suction) obtained by the use of compressed (or rarefied) air or other gases, the fundamental pitch or frequency of the diaphragm forming part of an apparatus for generating or receiving sound waves in any elastic medium such as air or water; and the mode of constructing such a diaphragm in order that tuning by the aforesaid method may be effected and the change of volume for each pulsation and hence the acoustic load be known and consequently the characteristics of the diaphragm may be predetermined.

The essential feature of the invention is illustrated in Fig. 1 showing the diaphragm mounted in position on the body B, the form of the latter may be varied to suit the condition under which the diaphragm is to be employed. The diaphragm is an accurately turned solid of revolution preferably fashioned from a single piece of metal or other elastic substance having as high an elastic limit as possible. It consists of a solid central portion C, and of a heavy rim R connected by a relatively thin annulus A.

The relative dimensions of these parts may be calculated to give any frequency desired in practice, as well as to provide for a maximum range of tuning possible for a material of given elastic properties. The rim of the diaphragm fits very accurately on a slightly tapered mounting M of the body. By the application of gaseous pressure (or suction) over the interior of the diaphragm (supposed to be in gas-tight connection with the body) it is caused to bulge slightly (outward or inward). As the solid center is practically undeformed by its displacement relative to the rim, the distance between the outer edge of the former and the inner edge of the latter is increased (or diminished) by an amount depending on the pressure (or suction) applied. The tension of the thin annulus is thus increased (or diminished) and as a result the frequency of the vibration of the central part of the diaphragm about the new equilibrium position is raised or lowered. By this means the fundamental pitch of the diaphragm may be continuously adjusted between reasonable limits by an alteration of gaseous pressure.

In the drawings accompanying the present specification, Fig. 1 illustrates diagrammatically the diaphragm mounted in position on the body B showing the rim R, annulus A and solid center C. Air pressure for the purpose of tuning may be admitted through any aperture in the body B, such as that at P. Fig. 2 illustrates the diaphragm forming the subject of the present invention embodied as part of a tunable microphone as actually constructed for receiving selectively submarine sounds. A microphone button G of the carbon-granule variable-contact type is screwed into the solid center C. Air-pressure or suction is applied through a copper tube P which may be connected to the body B by means of a universal coupling P'. Threaded loosely through the copper tube is a rubber-insulated copper wire connected to a hollow plug S² firmly fixed in an insulating bushing I². A corresponding hollow socket S¹ is similarly fixed in position in the body by means of an insulating bushing I¹, and terminates in a platinized contact E at the conducting base of the microphone button G, which is thus included in a circuit consisting of the insulating copper wire and the external copper tube surrounding it. The circuit is by this means completely protected against induction effects and stray currents which are otherwise difficult to avoid when it is required to pick up very faint sounds.

Fig. 3 illustrates the tunable diaphragm forming part of the present invention adapted to an electro-magnetic mechanism. The magnetic circuit consists of three pieces F¹, F² and F³ of high permeability steel. F¹

and F² are designed to inclose a field winding F so that an intense radial field may be produced in the gap between these pieces and the core F³, the lines of force in each half of the field being in opposite directions. The pieces F² and F³ are held in rigid connection by a non-magnetic piece B which carries a universal coupling by means of which a tube P is joined in gas-tight connection to the interior of the apparatus. This tube besides serving to transmit the pressure or suction applied to the diaphragm for tuning purposes, preferably serves also to carry three insulated wires, two of which carry direct current to the field winding (through plugs and sockets in the insulated bushings I¹, I²) while the third is connected in similar manner to the armature windings D, the return current being the copper tube itself. The armature-winding D is wound in opposite directions on the core F³ to which alternating current of the desired frequency may be supplied. In the gap is the copper vibrator V rigidly connected to the solid center of the diaphragm, substantially as shown. The solid center forms in this way what I term an extremely rigid "piston diaphragm" held in position by the annulus A and heavy rims R accurately mounted (and in air-tight connection) on the rigid field-piece F¹, when alternating current is supplied to the armature winding D the current of the same frequency is induced in the copper vibrator V. Through the interaction of the magnetic field in the gap, the vibrator is subjected to a powerful alternating force which is transmitted to the diaphragm and to the water in which the apparatus is immersed, giving rise to submarine sound-waves whose frequency may be varied between certain limits. From theoretical considerations it may be shown that the apparatus will not radiate efficiently unless the pitch of the diaphragm is tuned very closely to the frequency of the alternating current supplied. Hence if it is desired to transmit selectively submarine signals of various wave-lengths (as in radio-telegraphy) it is necessary to be able to tune the diaphragm to the frequency of the alternating current by adjusting the pressure on the diaphragm in the manner indicated.

Fig. 4 illustrates the diaphragm adapted to form part of a telephone receiver. A steel or soft-iron diaphragm constructed in the manner already described is mounted in gas-tight connection on a chambered body B constructed of aluminium or some light-non-magnetic alloy, the diaphragm serving as a cap or closure for the chamber. The body B may contain any of the electro-magnetic arrangements generally used in connection with telephone receivers. The alternating current which it is required to detect is brought to the magnet windings W through

wires inclosed in a metal tube P connected to the body B in such a way that air pressure or suction may be applied to the diaphragm. The diaphragm is caused to vibrate by the change of magnetic flux between the diaphragm and pole-pieces in the well known manner. By tuning the diaphragm (by the application of gaseous pressure or suction) or resonance with the alternating current the audibility may be greatly improved. In order to accommodate the magnets to the diaphragm when tuned these magnets are mounted on a frame 10 and adjusted through this frame by a screw 12 to, in turn, adjust the air-gap between the poles of the magnets and the diaphragm thereby maintaining conditions of maximum sensitiveness. A cap of the telephone is indicated at 15.

The technical advantages which I claim for this invention are as follows:

1. Multiplex aerial or submarine acoustic signaling.

Diaphragms form an essential part of aerial or submarine sound receivers or generators. It is well known that a sound-generator will radiate very little energy unless the frequency of the alternating force causing the diaphragm to vibrate is very close to the free period of the diaphragm. As a result, sound-generators can be operated efficiently only at a single frequency, that of the diaphragm. By the use of the specially shaped diaphragms tuned by compressed air as described above, it becomes possible to operate an aerial or submarine sound-generator efficiently over a considerable range of frequencies. The same remarks apply to the receptive properties of aerial or submarine sound-receivers, the best conditions for audibility being when the diaphragm is tuned to the frequency of the incident waves. It follows that by the use of sound generating and receiving apparatus capable of "tuning in and out" (as in wireless telegraphy) multiplex acoustic submarine signaling is made possible. It thus becomes possible to transmit submarine signals not only by code but by including in the code pre-arranged changes of frequency, a system which makes interpretation by another listener extremely difficult.

2. Amplification of telephone reception.

The telephone-receiver is the most common electrically operated sound generator. It is well known that its sensitiveness in detecting small alternating currents is very much increased when the frequency of the impressed electro-motive force coincides with that of the diaphragm. By constructing telephone-diaphragms capable of variable tuning in the manner described, it follows that in reception of signals of a musical char-

acter (as in radio-telegraphy or acoustic submarine telegraphy) the telephone receiver itself may be tuned to the frequency of the incoming wave and thus constantly employed at maximum audibility.

3. Submarine detection.

The under-sea sound-waves generated by the screw of a ship or by a submarine propeller probably include a number of periodic notes. The detection of such peaks in the acoustic spectrum of propeller noises requires some form of receiver capable of continuous tuning. This requirement is met by fitting submarine microphones with diaphragms capable of continuous tuning in the manner described. In these circumstances the enhanced sensitiveness (low damping) which is known to result from sharp tuning may be utilized to greatest advantage by employing a telephone receiver whose diaphragm is also tunable by compressed air, conditions being so adjusted that the resonance-frequency is attained at the same pressure throughout the range of the frequency desired.

I wish it to be understood that I do not limit myself to the application to the field of acoustics of a diagram continuously tunable by the application of gaseous pressure which is the principal and essential element of my invention and which may be adapted to other uses without departing from the spirit of my inventive idea.

What I claim is as follows:

1. The combination with a diaphragm having a practically rigid central effective area supported by a relatively thin annular surrounding portion whose tension determines the pitch of the vibrations of the central area, and means whereby the said central area is adjusted by the application of gaseous pressure or suction.

2. A diaphragm consisting of a unitary solid of revolution having a solid central portion and heavy rim connected by a relatively thin annulus.

3. The combination with a slightly tapered mounting of a diaphragm consisting of a unitary solid of revolution and having a solid central portion and heavy rim, the said rim being accurately fitted upon the tapered mounting.

4. An electro-magnetic mechanism comprising as essential elements, pieces of high permeability steel inclosing a field winding and core, a non-magnetic connecting piece, primary winding carried by the core adapted to be connected to a source of high frequency current, a tubular vibrator adapted to form a part of and be actuated by the electro-vibratory force generated, an acoustic diaphragm, the central portion of which is connected directly to the said tubular vibrator, and means for tuning the pitch of

the diaphragm to the frequency of the electro-vibratory force, said diaphragm consisting of a unitary solid of revolution of the substance described and having a solid central portion and heavy rim connected by a relatively thin annulus.

5. An electro-magnetic mechanism comprising as essential elements pieces of high permeability steel inclosing a field winding and core and non-magnetic connection piece, primary windings carried by the core adapted to be connected to a source of high frequency current, a tubular vibrator adapted to form a part of and be actuated by the electro-vibratory force generated, an acoustic diaphragm, the central portion of which is connected directly to the said tubular vibrator, said diaphragm consisting of a unitary solid of revolution of the substance described and having a solid central portion and heavy rim connected by a relatively thin annulus, the said solid central portion having the tubular vibrator in operative relation therewith to impart thereto the pulsations due to the electro-vibratory force.

6. An electro-magnetic mechanism comprising as essential elements pieces of high permeability steel inclosing a field winding and core, a non-magnetic connection piece carrying a unisonal coupling, primary windings carried by the core adapted to be connected to a source of high frequency current, a tubular vibrator adapted to form a part of and be actuated by the electro-vibratory

force generated, an acoustic diaphragm the central portion of which is connected directly to the said tubular vibrator, said diaphragm consisting of a unitary solid of revolution and having a solid central portion and heavy rim connected by a relatively thin annulus, the said solid central portion having the tubular vibrator in operative relation therewith to impart thereto the pulsations due to the electro-vibratory force, with means for tuning the diaphragm by gaseous pressure or suction to the frequency of the electro-vibratory force.

7. The combination with a slightly tapered mounting, of a diaphragm consisting of a unitary solid of revolution of the substance described and having a solid central portion and heavy rim, the said rim being accurately fitted upon the tapered mounting, and the said mounting and diaphragm containing between them a microphone contact for the purpose of electrically detecting acoustic vibration, and means whereby the diaphragm may be tuned continuously from a distance into unison with the incident vibrations.

In testimony whereof I have signed my name to this specification in the presence of two witnesses.

LOUIS VESSOT KING.

Witnesses:

GORDON G. COOKE,
WILLIAM J. C. HEWETSON.