June 24, 1930. L. H. PADDLE 1,768,211

MICROPHONE

Filed Aug. 28, 1928 3 Sheets-Sheet 1

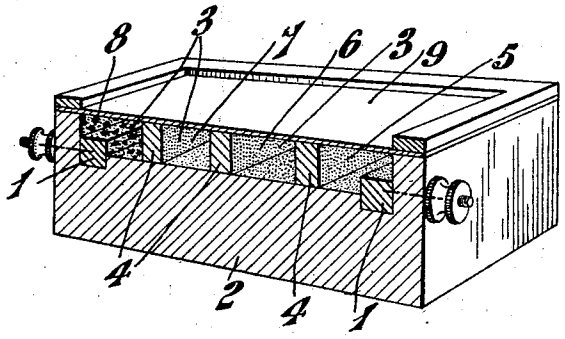

Fig. 1.

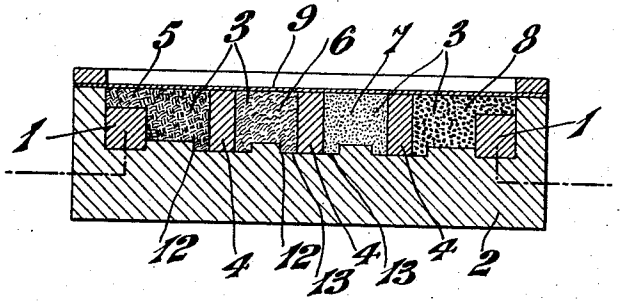

Fig. 2.

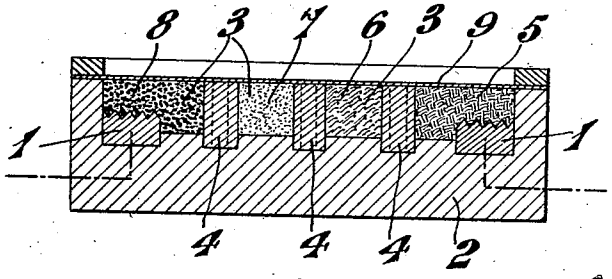

Fig. 3.

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MICROPHONE

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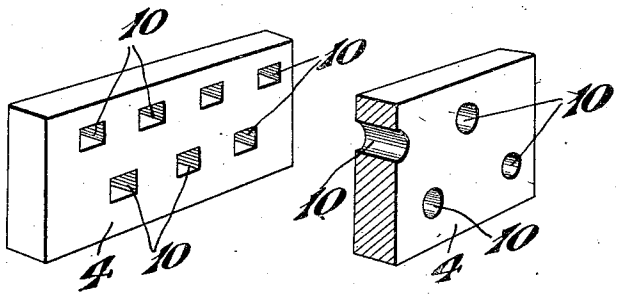

Fig. 4.

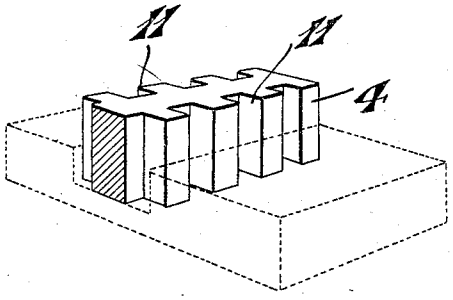

Fig. 5.

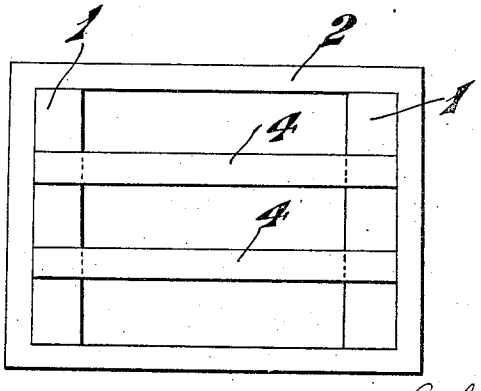

Fig. 6.

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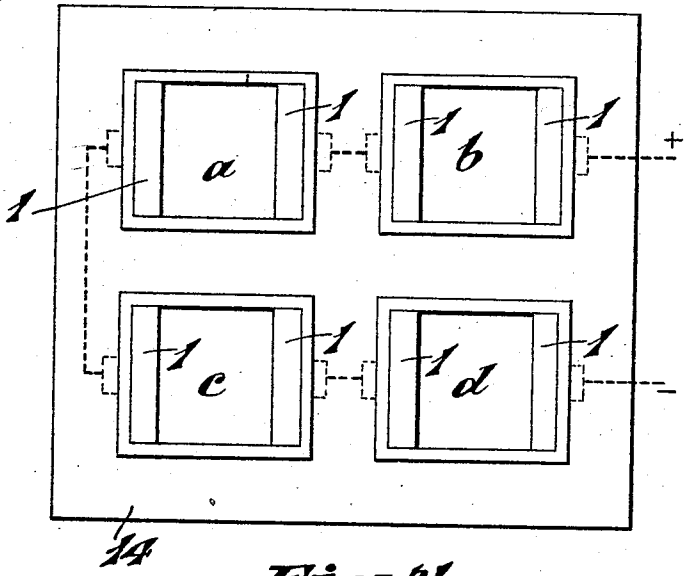

Fig. 7.

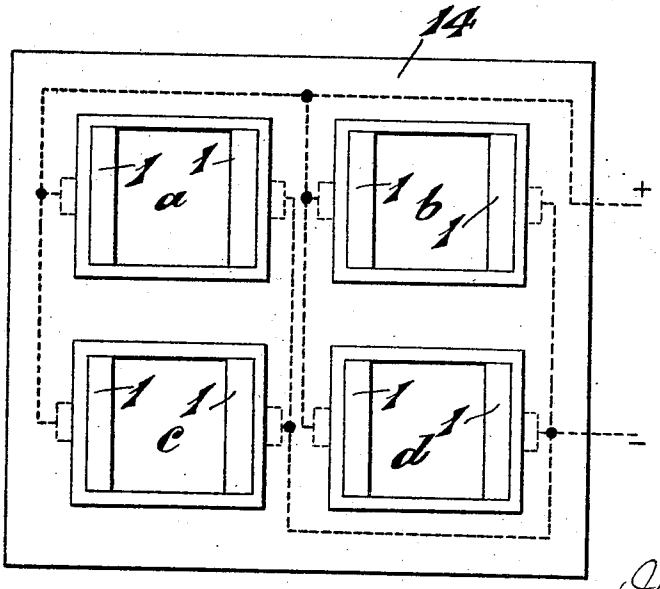

Fig. 8.

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Patented June 24, 1930 1,768,211

UNITED STATES PATENT OFFICE

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MICROPHONE

Application filed August 28, 1928, Serial No. 302,615, and in Great Britain August 30, 1927.

This invention has reference to telephone transmitters of the microphone type and more particularly although not essentially, to that kind wherein sound waves or other vibrations are caused to vary the intensity of a steady current flowing through granular conducting material disposed between fixed electrodes in such manner that the sound waves or other vibrations impinge on a skin or diaphragm, associated with the granular conducting material, in a direction substantially perpendicular to the direction of current flow through the said granules whereby a variation of resistance in the current path is caused which is dependent on the frequency and amplitude of the influencing vibrations.

The invention has for its object to effect improvements in microphones whereby fidelity of reproduction of audio frequencies may be obtained.

It is well known to those versed in the art that the frequency response characteristic of a microphone depends to some extent on the size of the carbon granules employed. Thus, for example, the natural period of vibration of a given quantity of granules of large mass would be low relative to the natural period of a similar quantity of granules of small mass.

It will therefore be appreciated that a microphone employing a mass of granules of substantially one size will suffer the defect of resonating and giving undue prominence to a band of frequencies corresponding to the natural period and harmonics thereof of the mass of granules used.

In order to overcome this disadvantage it has been proposed to use granules of various sizes mixed together. To some extent the trouble has been avoided but it will be followed, on consideration that avoidance of the disadvantage cannot wholly, by this means, be secured since the granules of largest mass will tend to gravitate to the lowest position while the granules of lesser mass will find their level according to size. For example, in a transmitter employing five different grades of granules there will be substantially five layers merging one into the other, the order of the layers being dependent on the plane or angle in which the transmitter is held. Let us consider that, due to the manner of suspension of the microphone, the granules of largest mass are near the surface, that is, in juxtaposition to the sound reception surface of the transmitter, whilst the granules of small mass are remote therefrom. Under these circumstances the energy in the high frequency component of a given audio frequency band would be, to a great extent, damped out due to high frequency vibrations having less power of penetration than have the lower frequencies. Thus a true reproduction of the influencing sound would not be secured.

In order to obviate this disadvantage, according to the present invention, a transmitter is so constructed that granules of one grade of size suitable for reproduction of a particular band of frequencies are located and confined in one particular zone while groups of granules of other sizes suitable for reproduction of other frequency bands are similarly confined to separate zones, each zone being in electrical circuit with another or other zones and each group of granules being so disposed that its surface can readily be influenced directly by sound waves or other vibrations.

The invention is illustrated in the accompanying drawings in which Figure 1 is a sectional perspective view showing one form of construction while Figures 2 and 3 are sectional views showing modifications. Figure 4 is a view to an enlarged scale showing in perspective two details of modifications. Figure 5 is a perspective view of another modified detail while Figure 6 shows diagrammatically in plan a further modification.

An arrangement shown in Figure 7 illustrates one emobdiment of the invention wherein four separate microphone units, each adapted to respond to a separate frequency band, are connected together and are adapted collectively to form one complete microphone. Figure 8 is a view similar to Figure 7 showing a modified arrangement.

Referring to Figure 1, two rectangular electrodes 1 of carbon are mounted in spaced parallel relationship and disposed diametrically opposite each other in rectangular recesses formed in a massive block of insulating material 2 such as ebonite or other suitable material in such manner that current flows from one electrode to the other through granular material 3 which covers the exposed surfaces of the electrodes, and which is situated between the electrodes. The influencing vibrations are incident on the surface of the granular material in a direction substantially at right angles to the direction of the current flow. Disposed in the region between the electrodes are spaced barriers or walls 4 of non-oxidizable conducting material, which are carried by the block or bed 2 of insulating material, and which are disposed parallel to each other. In the series of compartments formed between the barriers or in some cases between an electrode and a barrier is situated the granular conducting material 3. One compartment 5 formed partly between the side wall of one electrode and partly between the solid block 2 and the side wall of an adjacent barrier 4 contains granules of a very fine character, say for example, such that would just pass a sieve of 500 meshes per square inch, the next receptacle 6 containing granules of a larger size, and so on in progression, the last compartment 8 formed partly between a side of the other electrode and partly between the solid block 2 and a barrier containing the largest granules. Adapted to extend over and touch each of the barriers 4, which may be of greater height from the insulating bed or block than are the electrodes, is a skin or diaphragm 9 of thin rubber or oiled silk, mica or the like, which serves to retain the groups of granules in their respective chambers or troughs and forms the sound or other vibration reception surface.

The cubic capacity of each granule chamber may be made different so that when each respectively is filled with its allotted granules it will normally be of equal resistance to any of the others.

According to modifications illustrated in Figure 4 each barrier is perforated with holes 10 of such size that the granules of two groups are permitted to mix to some extent with each other. The holes may be of such size, however, that the bigger granules are not permitted to pass through but which will admit of the smaller associated granules entering the holes and contacting with the larger granules which effectually preclude the smaller granules from percolating through and mixing with the larger ones.

From Figure 5 it will be seen that each barrier surface adapted to contact with granules may be corrugated or serrated as at 11 in order to present a large surface area.

A further modification illustrated in Figure 3 provides in the insulated bed, grooves 12 adapted to accommodate and form a seating for the barriers 4.

These grooves 12, as can be seen from Figure 2, may be of greater width than the thickness of a barrier thereby forming channels 13 on either side of the base of a barrier which will accommodate granules.

In Figure 6 there is shown an arrangement wherein the barriers 4 which in this instance may be formed on non-conducting material, are arranged parallel to one another although at right angles to the electrodes 1, whereby each group of granules of one grade of size extends directly from one electrode to the other.

Figure 7 illustrates an arrangement according to the invention wherein four separate units *a*, *b*, *c* and *d*, each respectively adapted to contain a group of granules of a size different from any other group, each of which latter respectively are disposed between stationary electrodes 1, as shown, or with the interposition of barriers such as hereinbefore described are electrically connected together in series as indicated by the dotted lines and are mounted in one frame or holder 14 which may be a solid massive substantially vibrationless body or any other suitable means.

An arrangement similar to Figure 7 is shown in Figure 8 but wherein the separate units *a*, *b*, *c* and *d*, are electrically connected together in parallel. In this example to ensure that each unit is of similar normal resistance and takes a similar amount of current under non-working conditions, the cubic capacity of the chambers formed between the electrodes 1 are made different for each unit, in such manner that a chamber of larger cubic capacity would accommodate a group of granules which would have a resistance substantially equal to a lesser volume of another type of granule situated in another chamber of smaller cubic capacity.

What I claim and desire to secure by Letters Patent is:—

1. A microphone comprising two electrodes, a quantity of granular material completing a conductive path between them, means dividing said granular material into separate groups and means whereby sound waves approaching in a direction normal to said conductive path set up variations in the conductivity thereof by varying the density of the granules in the several groups, said granules being graded according to the groups which comprise them whereby the conductivity variation will

faithfully accord to the sound waves over a wide range of frequencies.

2. A microphone comprising two electrodes, a quantity of granular material completing a conductive path between them, means dividing said granular material into separate groups in series with one another in said conductive path and means whereby sound waves approaching in a direction normal to said conductive path set up variations in the conductivity thereof by varying the density of the granules in the several groups, said granules being graded according to the groups which comprise them whereby the conductivity variation will faithfully accord to the sound waves over a wide range of frequencies.

3. A microphone comprising a container two electrodes located in said container, a plurality of conductive partitions traversing said container between said electrodes in a direction transverse to the path between said electrodes, granular material located in the compartments constituted in said container by said partitions and means whereby sound waves approaching said container in a direction normal to the conductive path between said electrodes constituted by said material and said partitions, set up variations in the conductivity thereof by varying the density of the granules in the several compartments, said granules being graded according to the compartments they occupy whereby the conductivity variation will faithfully accord to the sound waves over a wide range of frequencies.

4. A microphone comprising a container, two elongated electrodes located in said container, a plurality of conductive partitions traversing said container between said electrodes in a direction substantially parallel to said electrodes, granular material located in the compartments constituted in said container by said partitions and means whereby sound waves approaching said container in a direction normal to the conductive path between said electrodes constituted by said material and said partitions, set up variations in the conductivity thereof by varying the density of the granules in the several compartments, said granules being graded according to the compartments they occupy whereby the conductivity variation will faithfully accord to the sound waves over a wide range of frequencies.

5. A microphone according to claim 3, wherein said partitions are perforated.

6. A microphone according to claim 3, wherein each barrier surface in contact with the granules is corrguated.

In witness whereof I affix my signature.

LESLIE HAROLD PADDLE.