

March 16, 1954

H. C. PYE
SOUND TRANSLATING DEVICE WITH RESONATING
AND DAMPING CHAMBER

2,672,525

Filed June 16, 1950

2 Sheets-Sheet 1

FIG. 1

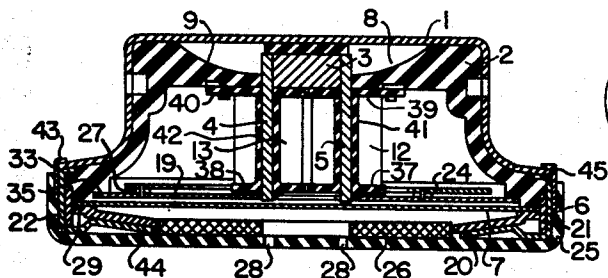


FIG. 2

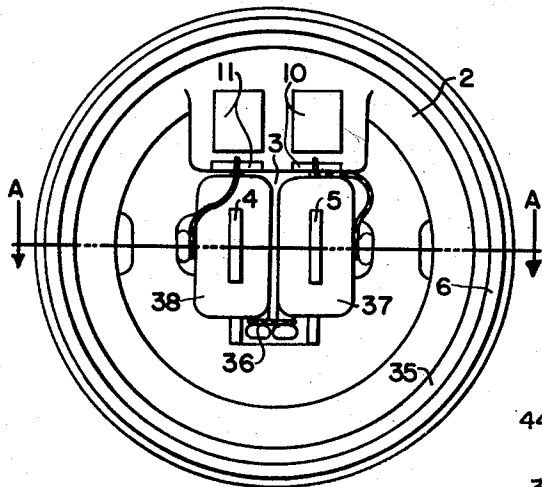
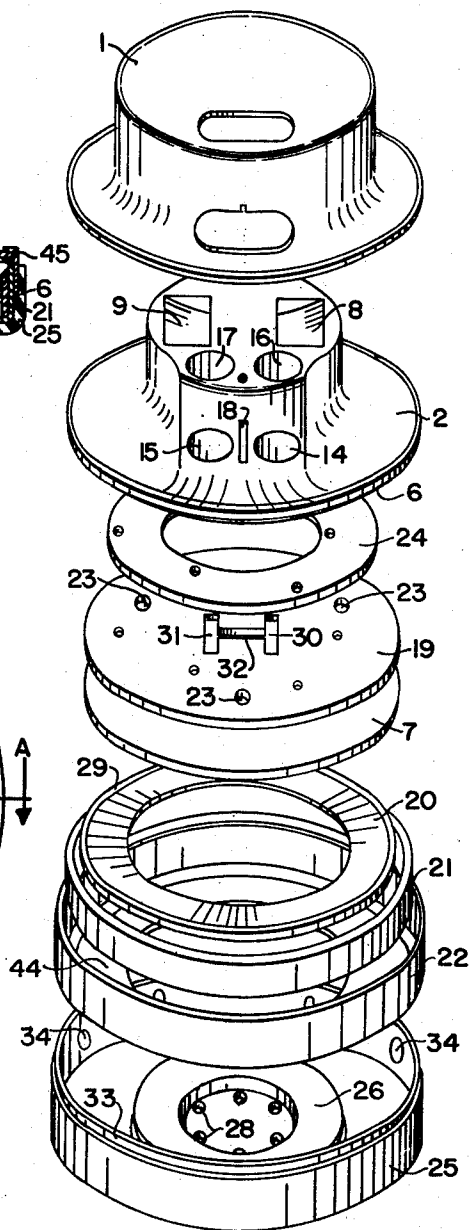


FIG. 6



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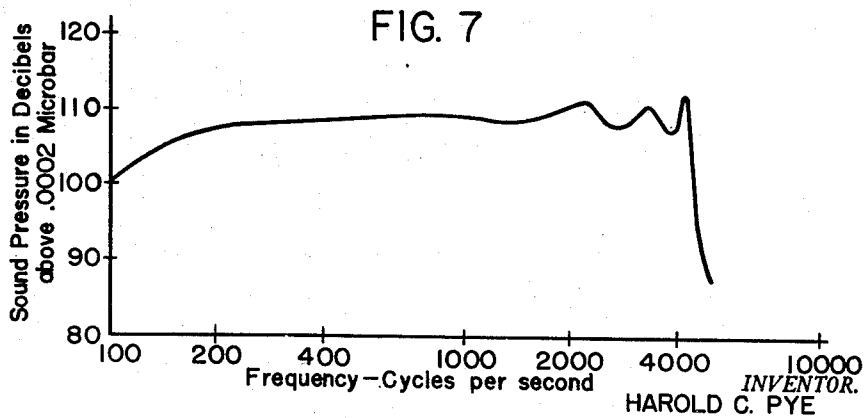
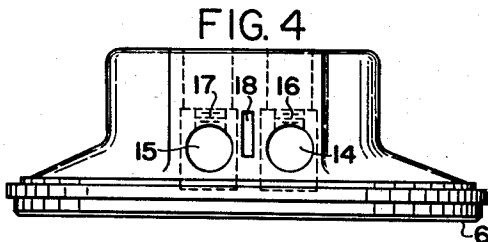
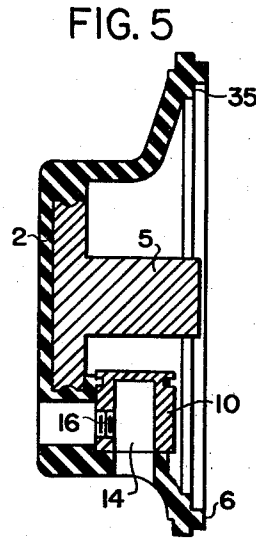
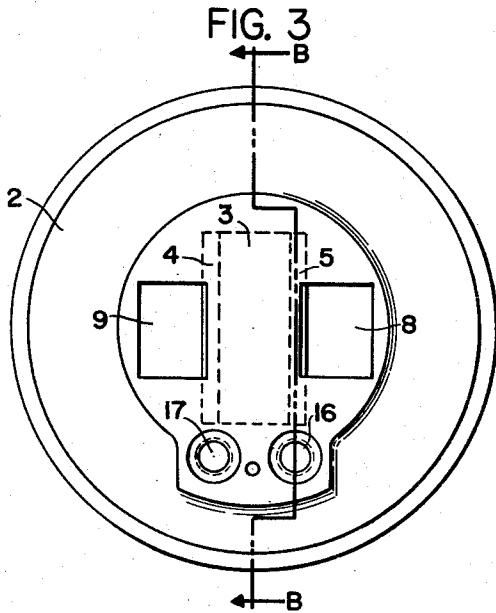
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UNITED STATES PATENT OFFICE

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SOUND TRANSLATING DEVICE WITH RESONATING AND DAMPING CHAMBER

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5 Claims. (Cl. 179-114)

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The present invention relates in general to sound translating devices and methods of making the same and more particularly to improvements in telephone receivers of the permanent magnet type and methods of making the same.

It is an object of the present invention to provide an improved sound translating device which is of extremely simple, economical, light weight, and rugged construction, is compact in arrangement, and is efficient in operation.

It is another object of the invention to provide an improved sound translating device which has a uniform frequency response over a greater range than heretofore.

In general, the objects as set forth above are in part attained in accordance with the present invention by providing a sound translating device which includes a plastic cup shaped housing; two pole pieces, the ends of which are molded into the housing; a permanent Alnico bar magnet separating the pole pieces and completely molded or rather imbedded in the housing; a diaphragm; a front resonating chamber so constructed and dimensioned that its natural acoustic resonating frequency is approximately 4000 cycles per second; and a damping means in that front chamber for decreasing the peak amplitude at that natural frequency. Briefly explained, the frequency response range is first extended by effecting a natural resonant peak at 4000 cycles and then by "flattening" the natural peak ordinarily produced by such resonance, the response curve is made practically uniform from 200 to 4000 cycles per second.

A feature of the improved sound translating device is the arrangement of the permanent magnet within the plastic housing such that magnetization may be accomplished after the complete assembly of the receiver unit; thus eliminating foreign magnetic particles within the field structure that may be attracted during the assembly of a magnetized bar magnet.

Other objects and features will be evident and a complete understanding of the construction and operation may be had from a perusal of the description in conjunction with the accompanying drawings, in which:

Fig. 1 shows a side sectional view of the sound translating device taken along the line AA of Fig. 2.

Fig. 2 shows a bottom elevational view of the device with a diaphragm assembly removed therefrom.

Fig. 3 shows a top view of the plastic housing.

Fig. 4 shows a side view of the plastic housing.

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Fig. 5 shows a sectional side view of the plastic housing taken along the line BB of Fig. 3.

Fig. 6 shows an exploded view illustrating the method of assembling the device shown in Fig. 1.

Fig. 7 is a typical graph showing the extended frequency response range of the improved sound translating device.

Referring now more particularly to the drawings, there is illustrated a sound translating device in the form of a telephone receiver which includes a shield 1 formed from a magnetic sheet metal, such as steel, which acts as a magnetic shield for the device. Any extraneous foreign unwanted signals present will be prevented from interfering with the sound translation by means of this shield; and conversely, the flux produced by the magnetic field structure itself will be prevented from influencing any other magnetic devices in proximity with the sound translating device. The cup shaped plastic housing 2, which, of course, could be constructed of any non-magnetic conductive material, is molded with the permanent magnet 3, preferably made of an aluminum nickel cobalt alloy having a coercive force greater than 500 oersteds and a remanence greater than 10,000 gauss, imbedded therein. T-shaped pole pieces 4 and 5, preferably made of Allegheny electric metal, are also partially (the tops of the T's) imbedded in the molding operation and are located one on each side of the permanent magnet 3 in a parallel relationship. The lower portion of housing 2 flanges out and forms a smooth annular ring 6 for providing a bearing surface for receiving diaphragm 7. Housing 2 also has "scooped" out recess portions 8 and 9 for enabling the magnetization of permanent magnet 3 after the device has been assembled, but before the shield is attached. Fig. 1 illustrates this feature quite well as it can be seen that magnet 3 is accessible for a magnetizing operation any time until the shield 1 is affixed. Terminal assemblies 10 and 11, preferably constructed of brass and also molded within housing 2, provide connecting points for the two leads coming off the coils 12 and 13 as illustrated in Fig. 2. Holes 14 and 15 in housing 2 are provided in order that the cord tips of the two leads (not shown) extending to the receiver can be inserted to effect the connection in a simple operation. This feature is best illustrated in Fig. 5 where it can be seen that a cord tip inserted into hole 14 will make connection with terminal 10 and, of course, one side of the coil. Holes 16 and 17 are provided in order that set screws may be inserted to anchor the cords in place. Rectangular opening

18 in the housing 2 is provided in order that an anchoring means for the cords may be attached for transferring the burden of the cord strain from the terminals. The magnetic field of the structure thus comprises the two pole pieces 4 and 5 upon which the coils 12 and 13 of the receiver are wound, and a permanent magnet 3 which, in conjunction with the diaphragm 7 and the pole pieces 4 and 5, forms a substantially closed magnetic circuit interrupted only by the narrow air gaps extending between the pole faces of the pieces 4 and 5 and the diaphragm 7. The coil winding 12 is wound upon the pole piece 5 between winding heads 37 and 39, constructed of insulating material, and is insulated from the pole piece 5 by a layer of insulating material 41 which may, for example, comprise varnished cambric or empire cloth. In a similar manner, the winding 13 is wound upon the pole piece 4 between winding heads 38 and 40 and is insulated from the pole piece 4 by a layer of insulating material 42.

The diaphragm assembly comprises, in addition to the diaphragm 7, an inner plate 19, a clamp plate 20, an annular supporting and space ring 21, an assembly ring 22, and a front cover 25, constructed of Bakelite in the present embodiment, with a fibrous damping member 26 affixed thereto. The clamp plate 20 is provided with a projecting annular portion 29 having a smooth upper surface which is adapted to cooperate with the oppositely disposed lower surface of the annular ring portion 6 of the housing 2 to clamp the peripheral edge of the diaphragm 7 therebetween. The clamping surfaces of the two annular portions 6 and 29 are so formed that the peripheral edge of the diaphragm 7 is clamped therebetween with uniform pressure at all points around the outer circumference of the diaphragm. Front cover 25 has a clamping ring 33, made of aluminum in the present embodiment, molded into the Bakelite with the aid of six bonding holes 34, and provides a projecting ring for crimping in order to hold said cover in place—as illustrated in Fig. 1. In accordance with one feature of the invention, the inner plate 19, in conjunction with the diaphragm 7 and the annular ring 6, defines a damping chamber adjacent the inner surface of the diaphragm 7, while the clamp plate 20, in conjunction with the diaphragm 7 and front cover 25 with damping member 26, a sound absorbent felt washer in the present embodiment, defines a resonating chamber adjacent the outer surface of the diaphragm 7. The dimensions of the damping chamber and of the restricting passages communicating therewith are so proportioned that the peak in the response characteristic of the device caused by the natural period of vibration of the diaphragm 7 is substantially reduced to flatten the overall frequency response characteristic of the device. More particularly, the inner plate 19, which is constructed of non-magnetic material, such, for example, as aluminum, is provided with three openings 23 and has mounted thereon in spaced apart relation a flat annular ring 24 which defines a relatively long, narrow, restricted and annular passage 27 communicating between the interior of the housing 2 and the chamber formed by the inner plate 19 and the diaphragm 7. By suitably proportioning the size of the holes 23, and the length and width of the restricted passage 27, there is achieved the desired damping effect over the band of frequencies within which the natural period of vibration of the diaphragm 7 is most effective to

cause distortion of the overall response characteristic. Also, the layer of air in this chamber serves artificially to enhance the stiffness of the diaphragm 7, thereby to improve the fidelity of reproduction of the device. Although given by way of example only, the following specifications for the parts defining the dimensions of the damping chamber and the passages communicating therewith have been found to be highly satisfactory in practice:

	Inches
Diameter of chamber	1.688
Depth of chamber	.020
Diameter of holes 23	.076
Depth of passage 27	.003
Width of ring 24	.319
Outer diameter of ring 24	1.444

The inner plate 19 has formed therein a pair of slots 30 and 31 through which the pole face ends of the pole pieces 4 and 5 extend. A cross slot 32 connecting the two slots 30 and 31 is also provided for preventing the circulation of eddy currents in the inner plate 19. The dimensions of the slots 30 and 31 are substantially greater than the cross sectional dimensions of the pole face ends of the pole pieces 4 and 5 so that relatively large air gaps are provided between the adjacent surfaces of the pole pieces and the inner plate 19. By virtue of this arrangement the coupling between the magnetic circuit of the magnetic field structure and the inner plate 19 is extremely loose and the production of eddy currents in the plate is substantially prevented.

The front cover 25, which, in conjunction with the diaphragm 7, damping member 26 and clamp plate 20, defines a resonating chamber adjacent the outer surface of the diaphragm, is provided with six passages or holes 28 through which sound waves are transmitted from the resonating chamber to the exterior of the device. In accordance with another feature of the invention, the dimensions of this front resonating chamber and of the passages 28 are so proportioned that the natural period of vibration of the chamber occurs at approximately 4,000 cycles per second, whereby the response of the moving system is materially enhanced at frequencies in that region. However, in order to reduce the actual peak, ordinarily produced at the natural frequency of a resonating chamber and thus in effect flatten the response curve in that region, damping member 26 is utilized. To achieve this greater and more uniform response in the frequency region indicated, it has been found that the following dimensions for the resonating chamber and the passages 28 are satisfactory:

	Inches
Outer diameter of chamber adjacent diaphragm 7	1.688
Maximum depth of chamber	.093
Diameter of each passage 28	.102
Depth of each passage 28	.050
Inside diameter of damping member 26	.625
Outside diameter of damping member 26	1.188
Depth of damping member 26	.050

In constructing the device described above, the plastic housing 2 is, of course, first formed with magnet 3 and pole pieces 4 and 5 molded therein. The coils 12 and 13, connected in series at point 36 (Fig. 2), with their associated winding heads 37, 38, 39 and 40, are then inserted over pole pieces 5 and 4 and cemented to the housing 2. The two remaining leads from said pole pieces are soldered to terminals 10 and 11. After this

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field structure assembly is completed the diaphragm assembly is mounted upon the rim of the cup shaped housing 2. To this end, the inner plate 19 is forced within the snugly engaging side walls of the annular ring 6 to abut against surface 35 of housing 2 and cemented to winding heads 37 and 38. This operation is performed with the flat annular ring 24 mounted upon the inner plate 19, by means of rivets and washers, and during the performance thereof the pole face ends of the pole pieces 4 and 5 pass through the slots 30 and 31 provided in the plate 19. The next step in the construction of the device is to clamp the diaphragm 7 between the clamping surfaces of the two ring portions 6 and 29 projecting respectively from the housing 2 and the clamp plate 20. While the diaphragm is clamped in position, the assembly ring 22 with the annular ring 21 inserted or telescoped therein is telescoped over the clamp plate 20 until the flange portion 44 thereof engages the tapered surface of the clamp plate 20, following which the rim of the assembly ring is bent or crimped over as indicated at 45 to engage the diaphragm assembly rigidly secured to housing 2. The next step in the construction of the device is that of magnetizing the magnet member 3 by positioning this member in a strong direct magnetic field. After the device is fully constructed shield 1 is placed over housing 2 and front cover 25, with damping member 26 cemented thereto, is placed over the diaphragm assembly. Ring 33, molded to front cover 25, is now crimped over as indicated at 43 in order to hold front cover 25 and shield 1 assembled to the device. If shield 1 is not needed it may be left out of the assembling operation and front cover 25 may be crimped to assembly ring 22.

In the operation of the device constructed and arranged in the manner set forth above, an attractive force is normally exerted upon the diaphragm 7 by virtue of the flux produced in the magnetic field structure by the permanent magnet 3. When incoming signal current traverses the coils 12 and 13, the steady state flux is increased and decreased in the usual manner in accordance with the undulations of the signal current. The variations in the flux traversing the diaphragm 7 cause this diaphragm to vibrate in the usual manner so that sound waves are transmitted by way of the passages 28 to the exterior. The provision of the inner damping chamber defined by the plate 19 prevents an excessive response of the diaphragm 7 at frequencies approaching the natural frequency of vibration of the diaphragm—approximately 1,000 cycles per second. Also, the provision of the front resonating chamber, with the damping means, defined by the cover 25 enhances the response of the moving system at frequencies in the upper portion of the operating range—approximately 4,000 cycles. Thus, a substantially flat response characteristic, as illustrated in Fig. 7, typifying good fidelity of reproduction, is obtained.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made herein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

Having described my invention in detail, what I claim and desire to have protected by issuance of Letters Patent of the United States is:

1. In a sound translating device, a housing, a

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diaphragm mounted within said housing, said diaphragm having a predetermined response characteristic over an operating frequency range when mounted within said housing for substantially free vibration, said diaphragm also having a natural frequency of vibration such that said response characteristic peaks at frequencies in the low frequency end of said range, an inner plate mounted within said housing and displaced from said diaphragm to define a first chamber adjacent the inner side of said diaphragm, means comprising a second plate mounted upon said inner plate in spaced apart relation for defining a passage communicating with said first chamber, the spacing between said plates being so proportioned that said first chamber acts substantially entirely as a damping chamber effective to remove said peak from the response characteristic of said diaphragm at frequencies in the low frequency region of the range, means defining a second chamber adjacent the outer side of said diaphragm having a passage communicating therewith, the dimensions of said last-mentioned passage being so proportioned that said second chamber acts substantially as a resonating chamber effective to peak the response characteristic in the high frequency region thereby increasing the range, and damping means comprising a sound absorbing member within said second chamber rigidly mounted at a distance from said diaphragm for removing said peak in the high frequency region thus effecting uniform response over a greater range of frequencies.

2. In a sound translating device, a housing, a diaphragm mounted within said housing, said diaphragm having a predetermined response characteristic over an operating frequency range when mounted within said housing for substantially free vibration, said diaphragm having a natural frequency of vibration such that said response characteristic peaks at frequencies in the low frequency end of said range, an inner plate mounted within said housing and displaced from said diaphragm to define a first chamber adjacent the inner side of said diaphragm, means comprising a second plate mounted upon said inner plate in spaced apart relation for defining a passage communicating with said first chamber, the spacing between said plates being so proportioned that said first chamber acts substantially entirely as a damping chamber to remove the low frequency peak from the response characteristic of said diaphragm and substantially to decrease the response of said diaphragm at frequencies within a band of frequencies extending from a frequency of the order of 1500 cycles per second toward the low frequency end of said range, a front cover for said device in spaced apart relation with said diaphragm to substantially define a second chamber adjacent the outer side of said diaphragm, an opening in the central portion of said cover communicating with said second chamber, said opening being so dimensioned and proportioned that said second chamber resonates and increases the response of said diaphragm at frequencies within a band of frequencies extending from a frequency of the order of 3200 cycles per second and such that the response characteristic peaks at a frequency of 4000 cycles per second, and a sound absorbing annular damping member mounted on the inner side of said cover and completely removed from the diaphragm for removing the high frequency peak thereby effecting a uniform response up to 4000 cycles per second.

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3. In a sound translating device, a molded housing having a magnetic field structure including a bar magnet and a pair of pole pieces molded into the rear section thereof, said pole pieces projecting into the interior of said housing, coils mounted on said pole pieces, a diaphragm structure secured to the open end of said housing to form a sealed chamber for said field structure, and recessed portions in the rear section of said housing adjacent the pole faces of said bar magnet to facilitate magnetization of said bar magnet after the formation of said sealed chamber.

4. In a sound translating device, a molded housing constructed of insulating material and having a magnetic field structure including a bar magnet and a pair of pole pieces molded into the rear section thereof, said pole pieces projecting into the interior of said housing, terminal members also molded into the rear section of said housing, coils mounted on said pole pieces and electrically connected to said terminal members, a diaphragm structure and a front cover secured to the open end of said housing in spaced apart relation to form a sealed chamber to the rear of said diaphragm structure and a resonating chamber forward of said diaphragm structure, external recesses in said housing on opposite sides of said bar magnet to facilitate magnetization thereof after the formation of said sealed chamber in order to prevent adherence of magnetic particles to said field structure during the as-

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sembling, and external recesses in said housing on two sides of said terminal members to permit access thereto for connections to said coils.

5. In a sound translating device as claimed in claim 4, a magnetic shield enclosing said housing for preventing external electrical interferences from influencing said field structure and to prevent the flux produced by said magnetic field structure from influencing other external devices in proximity thereof.

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