LB-818

AN UNOBTRUSIVE DYNAMIC PRESSURE MICROPHONE

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Approved

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Introduction

The general trend in microphones is in the direction of small units for the intimate type of pickup. Velocity and ribbon-pressure types of small microphones have already been commercialized. Because it was felt that there is also a need for a small unobtrusive dynamic pressure microphone a project to develop such an instrument was initiated. This bulletin describes an unobtrusive dynamic pressure microphone which resulted from this work.

Theory

A pressure type dynamic microphone consists of a diaphragm coupled to a voice coil located in a magnetic field, and suitable damping means for controlling the motion of the diaphragm. The motion of the coil in the magnetic field leads to the induction of a voltage which is proportional to the velocity of the voice coil. The vibrating system and mechanical network of a dynamic microphone is shown in Fig. 1. The velocity $\dot{x}$ of the system, in centimeters per second, is given by

$$\dot{x} = \frac{f_M}{r_M + j\omega m + \frac{1}{j\omega C_M}} \qquad (1)$$

where f_M = driving force, in dynes,

f_M = pA,

p = sound pressure in dynes per square centimeters,

A = area of the diaphragm, in square centimeters,

r_M = mechanical resistance of the suspension system, in mechanical ohms,

m = mass of the diaphragm and coil, in grams,

C_M = compliance of the suspension system, in centimeters per dyne.

A typical response frequency characteristic of the system for a constant sound pressure at the diaphragm is shown in Fig. 2. This shows a peak of high response in the mid range with the output falling off below and above this frequency. An examination of Eq. 1 shows that the controlling element must be a mechanical resistance in order to obtain a constant relationship between the pressure and the voltage output over the frequency range to be covered by the microphone. This is illustrated by the response frequency characteristic of Fig. 3 in which the mechanical resistance is the controlling element in the vibrating system.

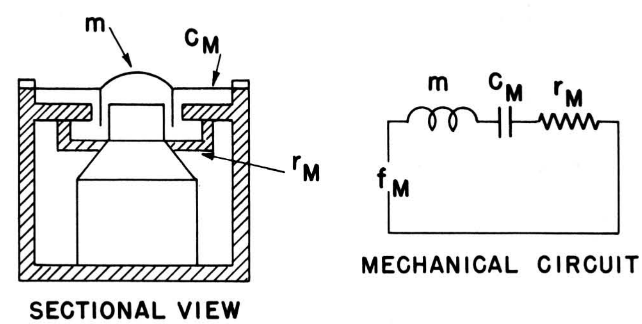

Fig. 1 – Sectional view and the mechanical circuit of a dynamic microphone. In the mechanical circuit: f_M = driving force. M = mass of the diaphragm and coil. C_M = compliance of the suspension system. r_m = mechanical resistance.

The system shown in Fig. 1 does not include the compliance of the cavity behind the diaphragm and suspension and the mass of the air in the felt washer used as damping. The effect of these elements is to increase the response in the region from 8000 to 15,000 cycles.

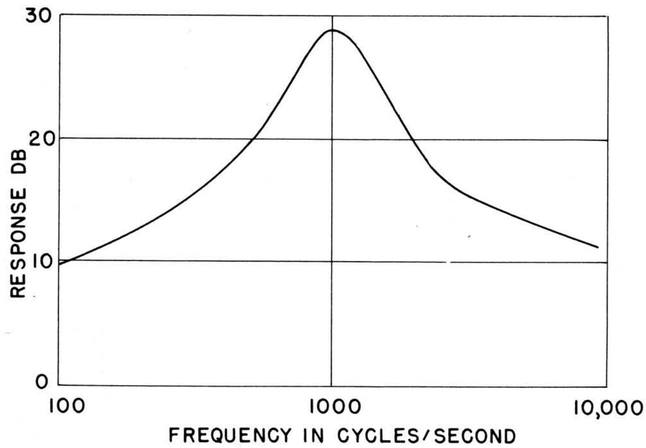

Fig. 2 - Response frequency characteristic of the dynamic microphone of Fig. 1 in which the mechanical resistance is small compared to the mechanical reactance in the low and high frequency ranges.

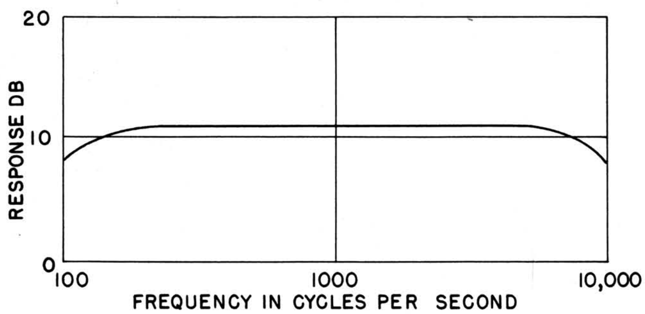

Fig. 3 - Response frequency characteristic of the dynamic microphone of Fig. 1, in which the mechanical resistance is large compared to the mechanical reactance throughout the response frequency range.

Development Work

Magnetic Structure

The magnetic structure used in this microphone is shown in the drawing of Fig. 4. A photograph of the magnetic structure is shown in Fig. 5. This magnetic structure is of the conventional center magnet system. The structure is made of Armco iron. The magnet is Alnico V. The air gap is 0.021 inch. The flux density in the air gap is 7,000 gausses.

Diaphragm

The diaphragm, suspension and voice coil for this microphone are depicted in the drawing of Fig. 6. A photograph of the diaphragm is shown in Fig. 5. The diaphragm is dome shaped with the voice coil fastened to the outer part of the dome. The suspension system is of the fluted type. This particular configuration appears to be the most suitable system for obtaining a compliant suspension which will not break up into modes in the high frequency

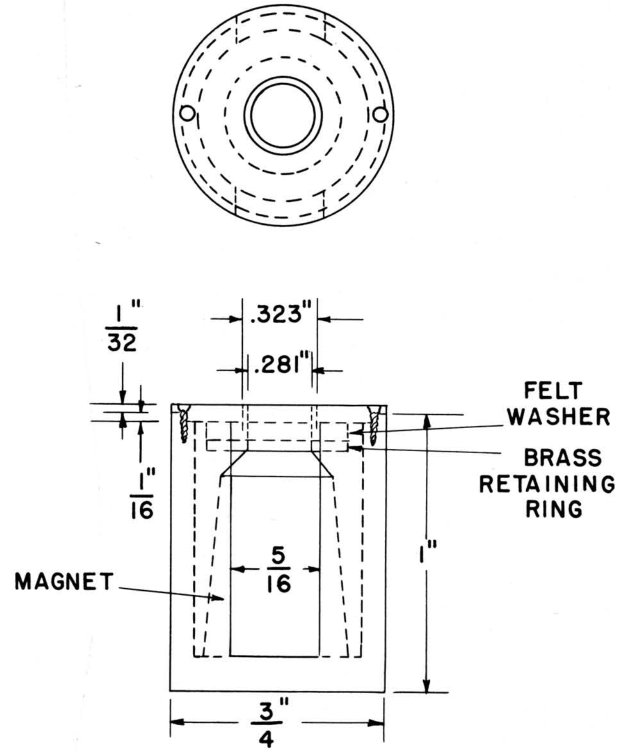

Fig. 4 - Details of the magnetic structure of the unobtrusive dynamic pressure microphone.

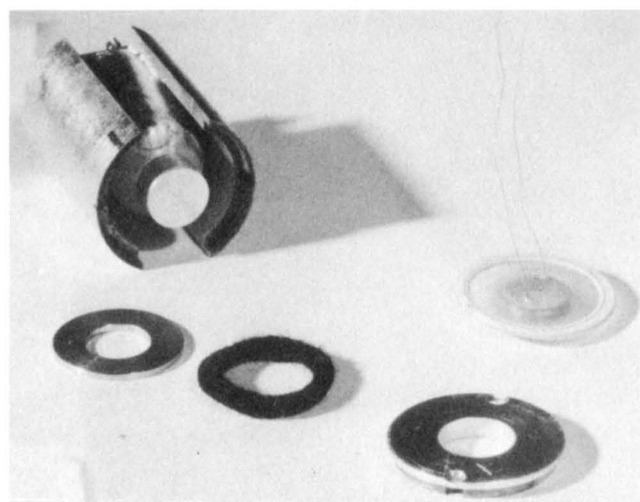

Fig. 5 - Magnetic structure with the top plate removed, felt washer for mechanical resistance, dishpan and diaphragm-voice coil assembly.

range. It will be noted that a circular compliance surrounds the dome. The addition of this ring increases the compliance without impairing the performance.

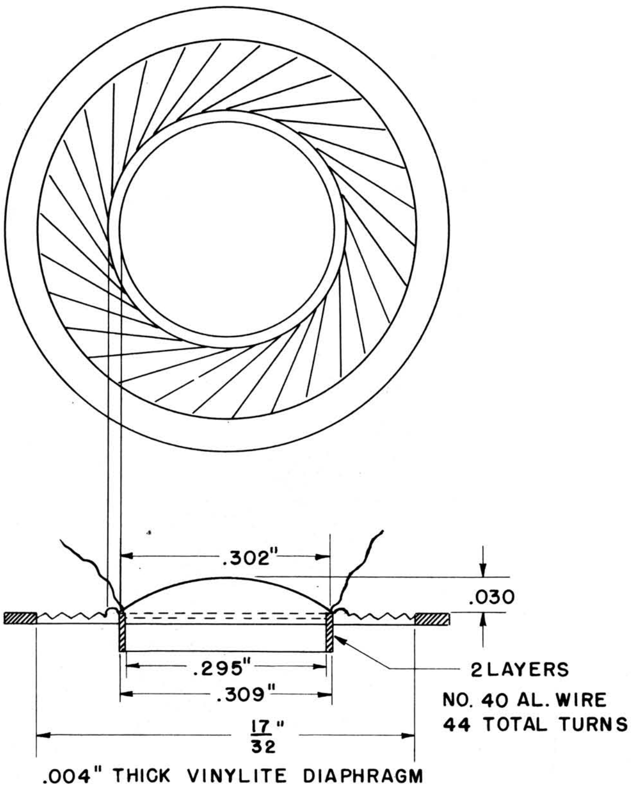

Fig. 6 – Details of the diaphragm suspension and voice coil assembly.

It appeared that aluminum would be a good material for the diaphragm and suspension system because of the stability of a metal system. However, for a diaphragm of this size it was found to be impossible to obtain a sufficiently low fundamental resonant frequency without using exceedingly thin aluminum. Optimum sensitivity conditions are obtained when the resonant frequency is located at the mid point of the frequency band. The thin aluminum diaphragm is so fragile that it will not withstand any direct force due to wind or shock. Forces of this type introduce a permanent set in the material. Paper was also tried. In this case it was found that the system was also very fragile when a suitable resonant frequency was obtained. The best results were obtained with a vinylite diaphragm and suspension system. The internal damping of the vinylite is desirable in adding to the mechanical resistance. In addition, a suitable resonant frequency can be obtained with a thickness of 0.0035 inch. A diaphragm and suspension of this thickness is very rugged and will not collapse or become permanently injured by shock or large steady forces. In the case of the vinylite system, it was found that the dome would not support high frequency vibrations. In order to improve the rigidity of the diaphragm, a paper dome was cemented to the center dome of vinylite.

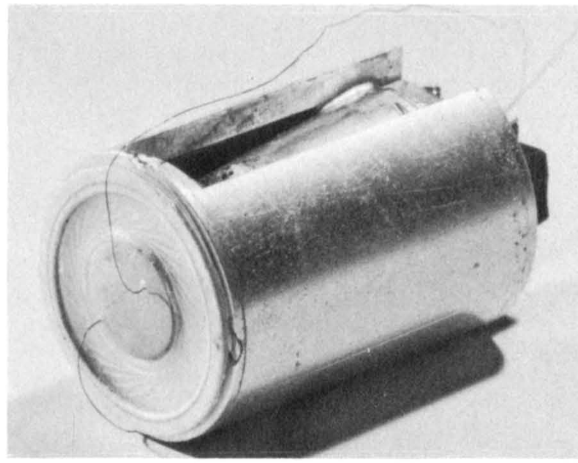

Fig. 7 – Complete motor assembly consisting of the diaphragm, mechanical resistance and motor.

The back of the diaphragm is terminated in a mechanical resistance in the conventional manner. The mechanical resistance is a ring of felt as shown in the photograph of Fig. 5. The mechanical resistance was adjusted so that a smooth response frequency characteristic was obtained.

The complete motor assembly consisting of the diaphragm, mechanical resistance and motor is shown in the photograph of Fig. 7.

Case

The case for this microphone is an aluminum shell with the motor housed in the upper portion of the shell and the transformer in the lower portion of the shell, (Fig. 8). The central portion was filled with cotton to prevent resonances in this space.

Transformer

A transformer is used to step up the impedance of the voice coil to 250 ohms or any other impedance suitable for transmission over a line. The details of the transformer are shown in Fig. 9.

Screen Resonator

It appears desirable to accentuate the response in the high frequency range in close talking microphones. The high frequency response in this microphone has been accentuated by the use of a truncated cone with slots. The reason the response is accentuated over a wide frequency range is that the truncated cone acts as a tapered line.

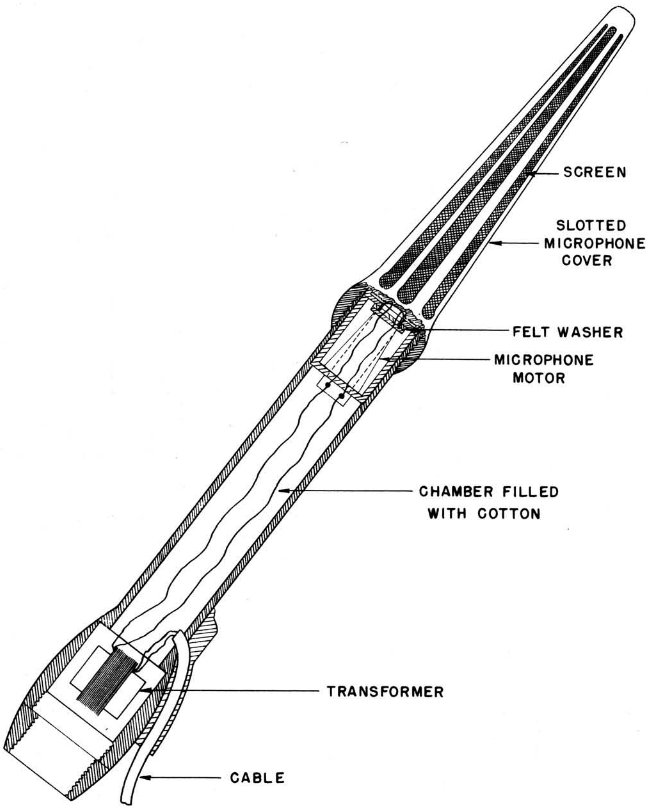

Fig. 8 - Sectional view of the complete microphone.

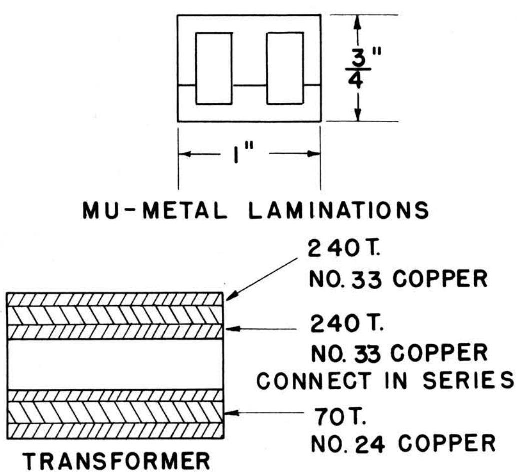

Fig. 9 - Details of the transformer.

Fig. 10- Unobtrusive dynamic pressure microphone held in the hand.

Complete Assembly

The complete microphone assembly is shown in Fig. 8. Photographs of the complete microphone are shown in Figs. 10 and 11.

Performance Characteristics

The response frequency characteristic of the unobtrusive dynamic pressure microphone is shown in Fig. 12. It will be seen that a very smooth response frequency characteristic is obtained with this microphone.

The response frequency characteristic of the unobtrusive dynamic pressure microphone with the slotted conical diaphragm cover is shown in Fig. 13. Comparing Figs. 12 and 13, it will be seen that a slotted truncated cone cover for the diaphragm accentuates the response uniformly over the frequency range from

2000 to 12,000 cycles. This is somewhat remarkble in view of the fact that this is $2\frac{1}{2}$ octaves.

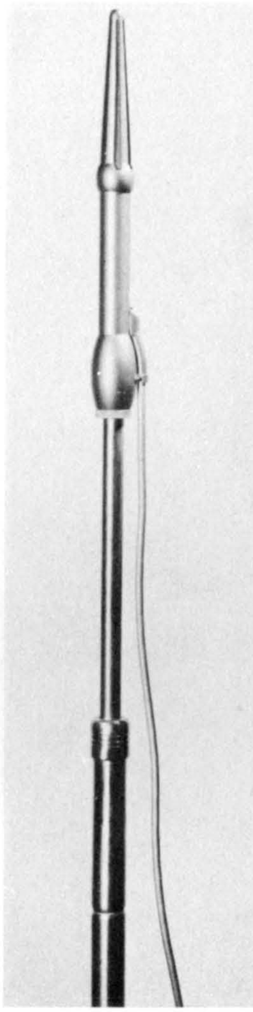

Fig. 11– Unobtrusive dynamic pressure microphone in a stand.

Conclusion

An unobtrusive dynamic pressure microphone has been developed with the following characteristics: Overall length $11\frac{1}{2}$ inches. Diameter of main portion of the body 7/8 inch. Vinylite fluted suspension and a composite vinylite and paper domed shaped diaphragm. A slotted tapered cover for the diaphragm which increases the response in the region from 2000 to 12,000 cycles. Weight one-half pound. Output 100 microvolts per dyne per square centimeter at an impedance of 250 ohms. Uniform response from 60 to 15,000 cycles.

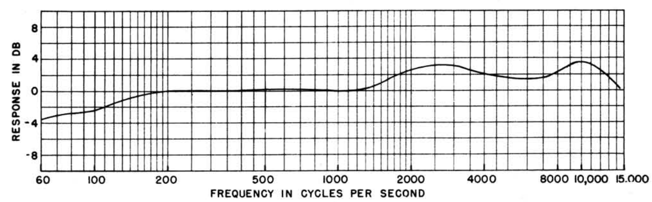

Fig. 12– Response frequency characteristic of the unobtrusive dynamic pressure microphone without the cover over the diaphragm. Output impedance = 250 ohms. 0 db microvolts per dyne per square centimeter.

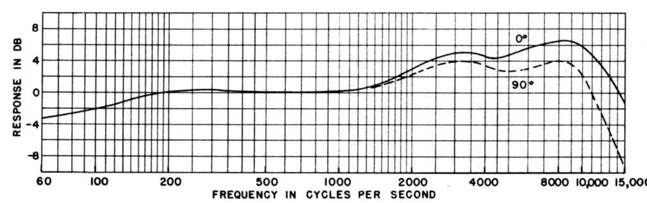

Fig. 13– Response frequency characteristic of the unobtrusive dynamic pressure microphone with the slotted truncated cone diaphragm cover for 0° and 90°. Output impedance = 250 ohms. 0 db = 100 microvolts per dyne per square centimeter.

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