TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 629

A SOUND PRESSURE-LEVEL METER WITHOUT AMPLIFICATION

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SUMMARY

The N.A.C.A. has developed a simple pressure-level meter for the measurement of sound-pressure levels above 70 db. The instrument employs a carbon microphone but has no amplification. The source of power is five flashlight batteries. Measurements may be made up to the threshold of feeling with an accuracy of ±2 db; band analysis of complex spectra may be made if desired.

GENERAL DESCRIPTION

For 3 years the N.A.C.A. has been using a very simple instrument for measuring sound pressures above 70 db. The circuit diagram of the pressure-level meter is shown in figure 1. The carbon microphone, being of the double-button type, requires a split reactor L, which in this case consists of the primary of an old microphone transformer with the secondary left open. The filter immediately adjacent to the microphone comprises three series inductors of 0.0015 henry each and two parallel condensers of 0.02 microfarad each. This filter prevents sticking of the carbon granules to one another when the off-on switch S is operated. The milliammeter M reads the direct current to both buttons and has a range of 100 millamperes. The transformer T serves to match the attenuator impedance of 200 ohms to the rectifier impedance of 3,500 ohms. The final output meter is a very sensitive microammeter.

Figure 2 shows the instrument opened to make observations of total sound; the microphone is seen hung in the enclosure at the end of the box toward the reader. The cords in the lid are for easy connection to the filters as shown in figure 3. The panel contains the switch S, the milliammeter M, the attenuator, and the output meter.

THE MICROPHONE

The microphone is of the double-button KK type made by the Universal Microphone Company with a stretched diaphragm gold-plated at the carbon contact. The sensitivity is about -30 db when supplied with 45 milliamperes or more direct current. This comparatively large output is partly responsible for the absence of amplification. The variation of sensitivity with current through the buttons is shown in figure 4; in practice, the current is simply kept in excess of 50 milliamperes and no corrections are applied. The 7-1/2 volt flashlight battery, which is the only power source required, is replaced when the current falls below this value.

THE ATTENUATOR

The attenuator is of General Radio design consisting of a T-section giving 45 db attenuation in steps of 3/4 db with a practically constant impedance of 200 ohms. The insertion loss is 6 db. Beyond 45 db the attenuation increases very rapidly to infinity.

THE OUTPUT METER

The output meter is the model JS microammeter supplied by the Sensitive Research Instrument Corporation. The resistance of the microammeter is 3,500 ohms, which gives an excellent match for the copper-oxide rectifier. The original scale of the instrument has been removed and a direct-reading decibel scale substituted. The calibration to determine points on the scale was effected by noting readings on the original scale with known frequency-modulated sound pressures impressed upon the carbon microphone, the attenuator being kept at zero. The new scale was then supplied by the makers of the instrument. The data necessary to obtain the new scale are shown in figure 5. A 12 db range, from 70 to 82 db, is marked upon the new scale. The actual sound pressure measured with the instrument is then the sum of the scale reading and the attenuator, giving a total range of from 70 to 127 db.

OVER-ALL CHARACTERISTICS OF THE INSTRUMENT

The over-all frequency characteristics of the pressure-level meter are shown in figure 6. This curve represents the mean of many checks against a moving-coil microphone over a long period. Disagreements with the laboratory intensity-level meter, when used in free space, amount to 2 db on the average. The day-to-day accuracy in repeating readings is also of this order. More accuracy is not required for loudness-level computation since the uncertainties in the Fletcher-Munson formula are about 2 db.

The over-all range of pressures covered has been seen to extend from slightly higher than conversational level (70 db) to the upper threshold (127 db), where the zero of the decibel scale is 0.0002 dyne/cm^2.

The filters used are those regularly employed in routine measurements of noise from propellers on a test stand, and cover the ranges 0-100, 100-500, 500-1,000, 1,000-5,000, and the range above 5,000 cycles per second. Their impedance is 3,000 ohms, and the insertion loss is 1.5 db.

The weight of the pressure-level meter is 20 pounds and of the filters, 35 pounds.

It is essential that the instrument be in a fixed position and level to within about 3° in order that the needle of the output meter may swing freely and about its normal zero. A slant of this amount is readily detectable by the eye so that no especial difficulty results from this feature.

The following procedure is carried out in making a measurement: (a) Instrument is leveled; (b) microphone door opened; (c) attenuator set at infinity; (d) needle of output meter released and adjusted to zero; (e) current to microphone turned on; (f) attenuation slowly decreased until needle reads on scale, and attenuator and scale reading noted; and (g) attenuator reset at infinity and current turned off.

THE INSTRUMENT IN USE

The pressure-level meter is well adapted to the measurement of high pressure levels, the portability of the instrument having proved to be one of the important features. Large changes in level, such as result from major alterations to the source of sound over a long period of time, are readily detectable with an accuracy or ±2 db; this accuracy is sufficient to permit loudness-level computations by the Fletcher-Munson formula whenever the appropriate band analysis is carried out. Smaller changes in level are, of course, detectable when the changes in the source can be more quickly made.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., November 11, 1937.

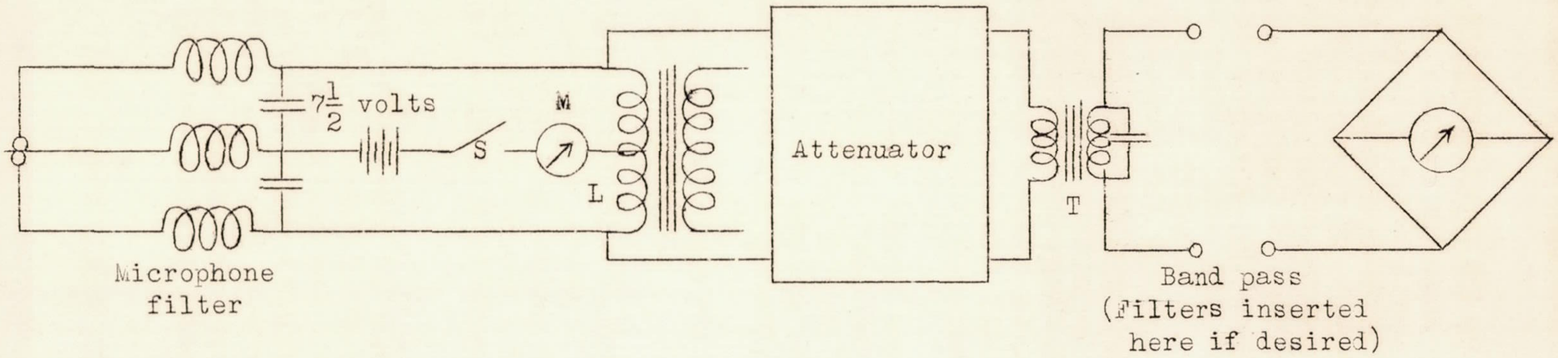

Figure 1.- Circuit diagram of pressure-level meter.

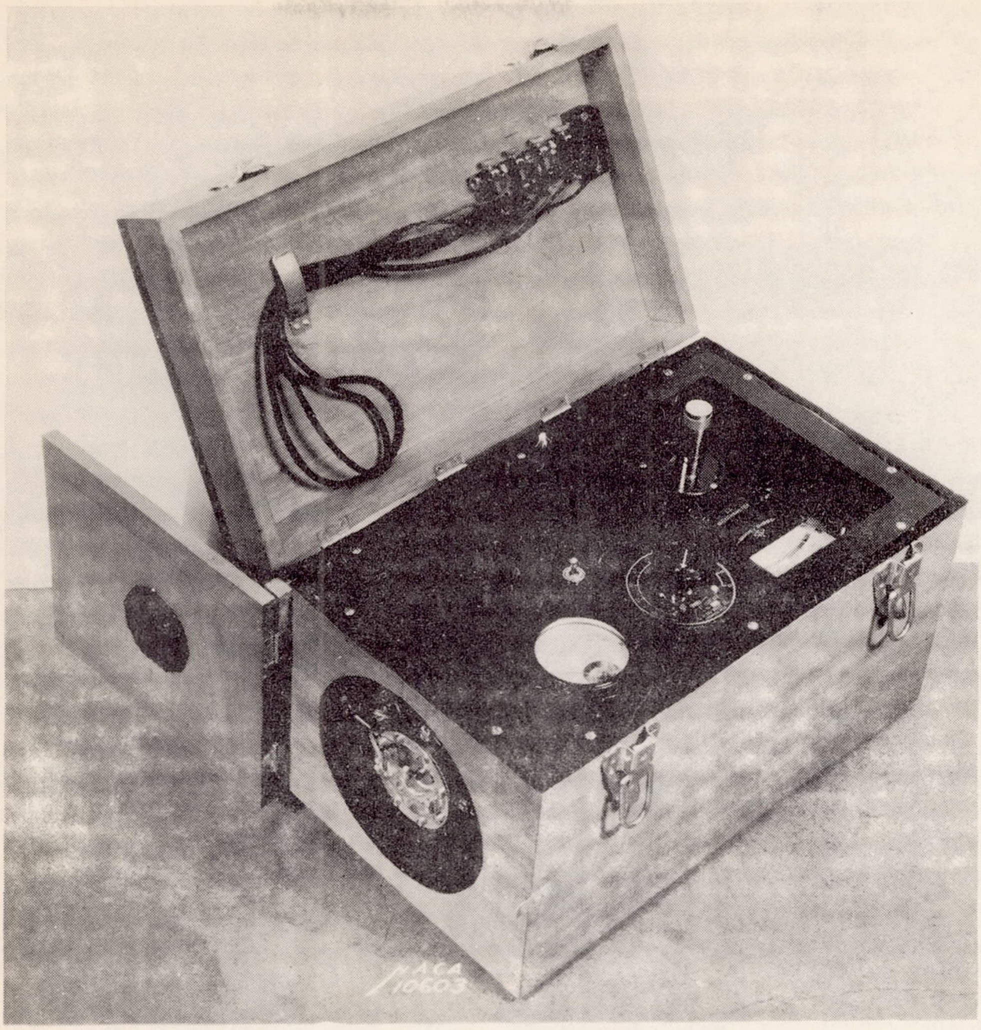

Figure 2.- Pressure-level meter open for making measurements of total sound.

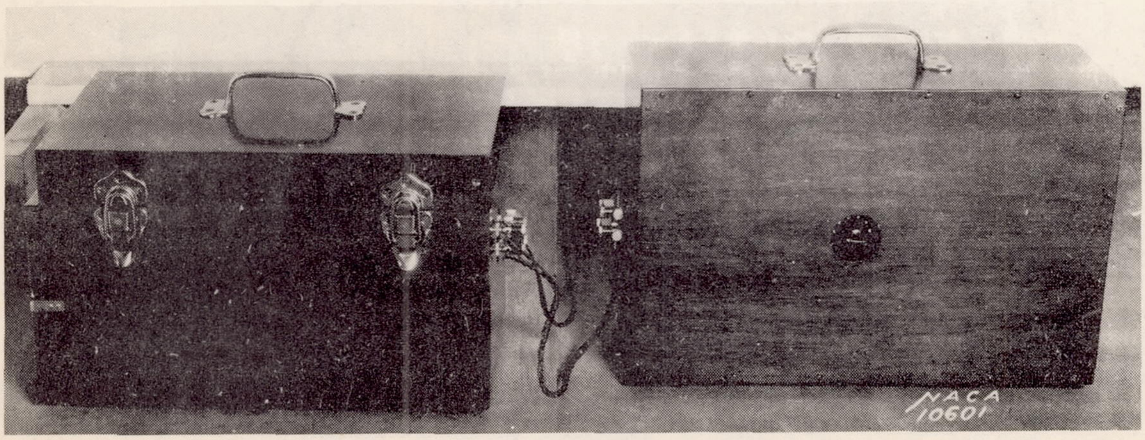

Figure 3.- Pressure-level meter with band-pass filters connected.

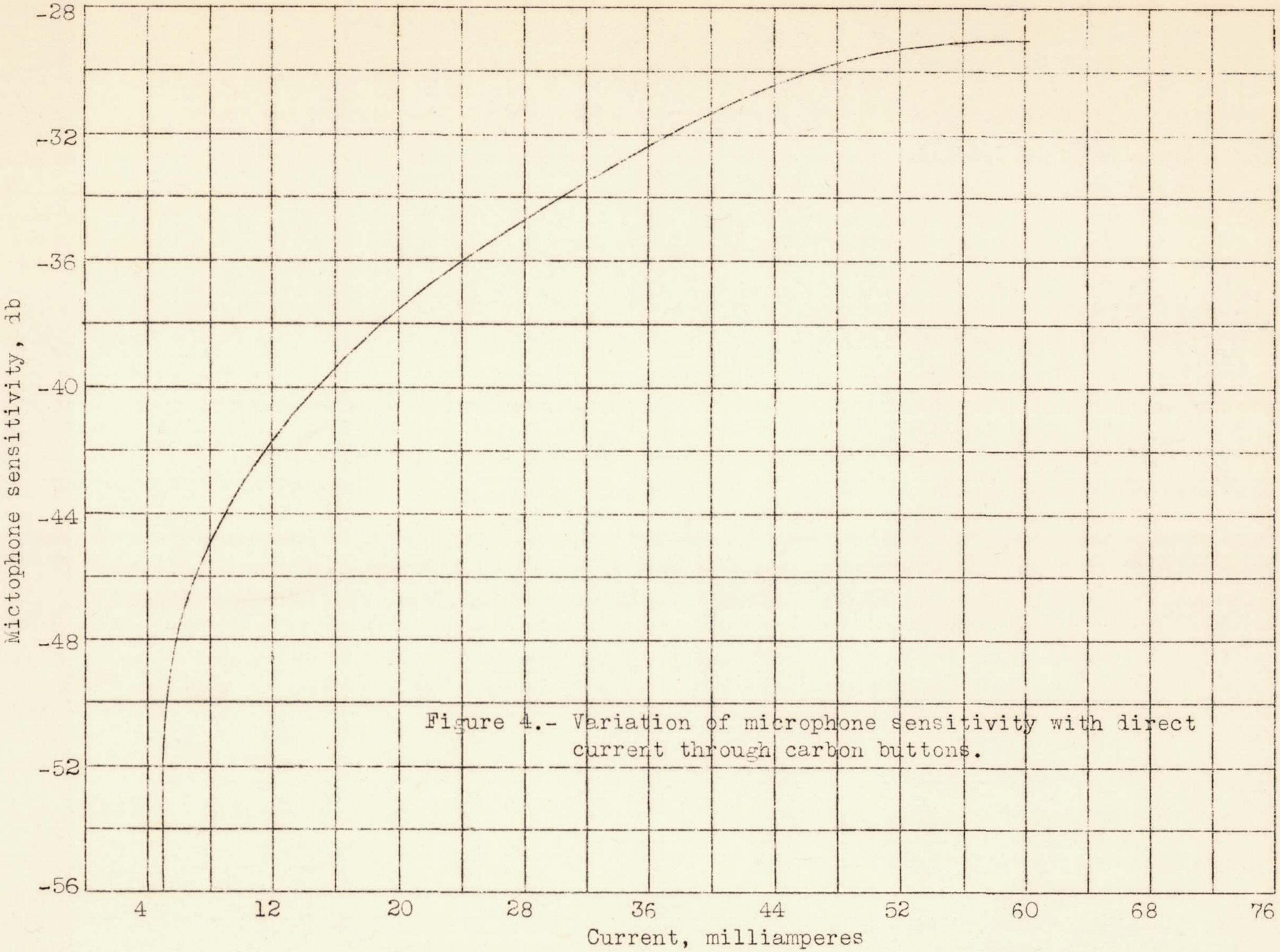

Figure 4.- Variation of microphone sensitivity with direct current through carbon buttons.

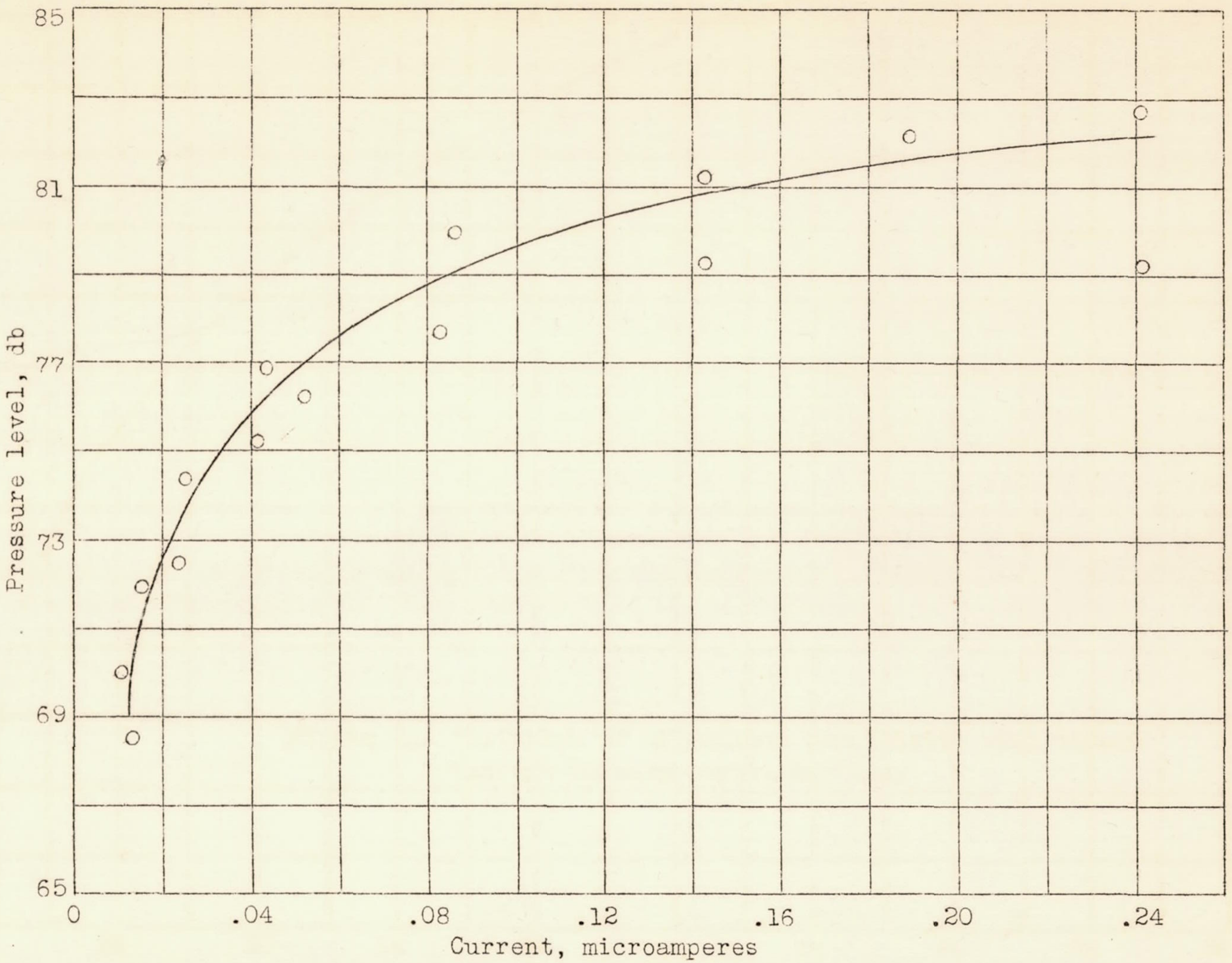

Figure 5.- Comparison of two scales for instrument.

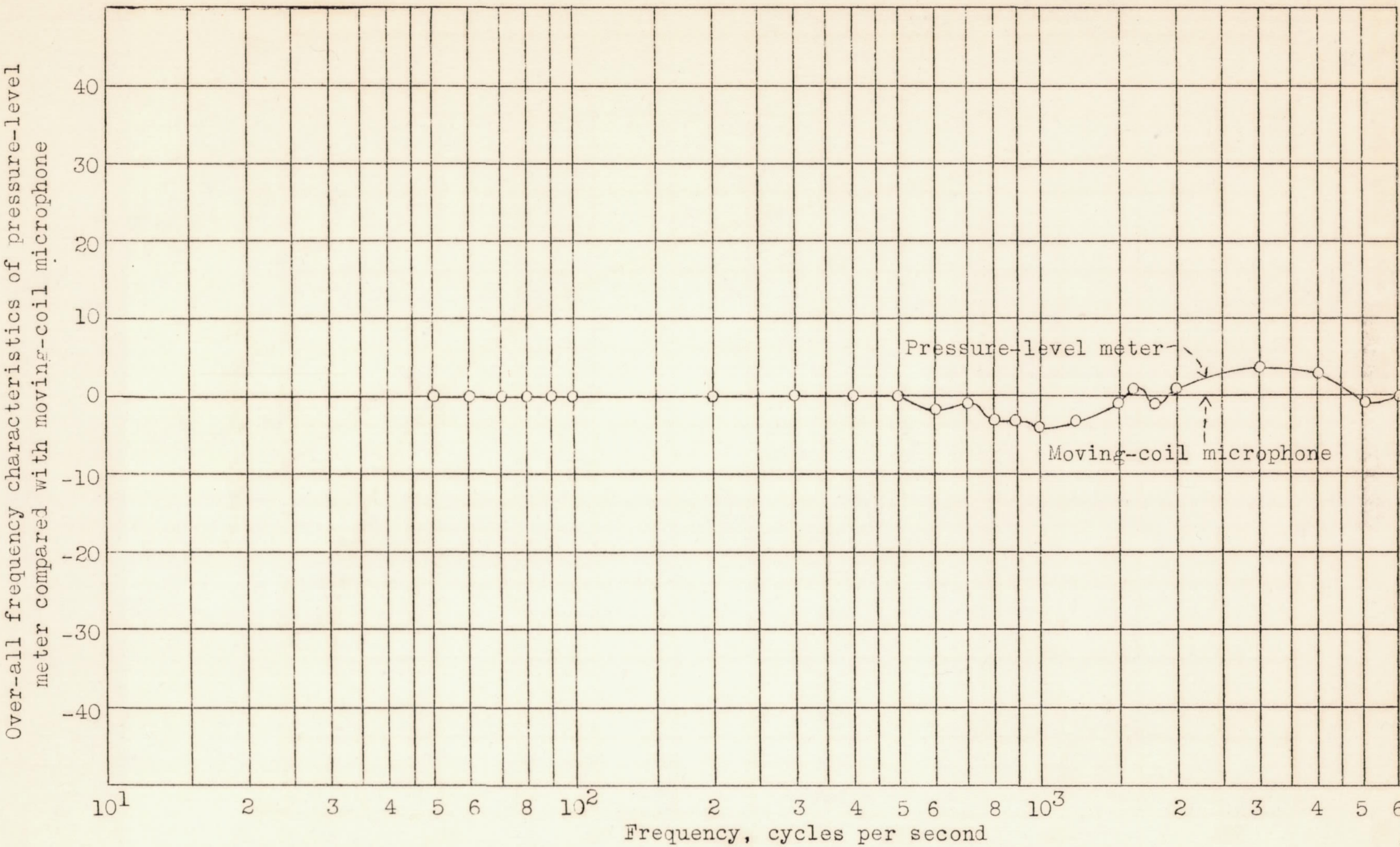

Figure 6.- Over-all frequency characteristics of pressure-level meter.