4152

Instructions and Applications

Artificial Ear Type 4152

For measurement on earphones as used in hearing aids and telephone communication systems. Provided with couplers made in accordance with the IEC Recommendation 126, and various American and German Standards.

BRÜEL & KJÆR

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Artificial Ear

Type 4152

December 1970

Contents

1. Description

General.

The Artificial Ear Type 4152 is designed to enable acoustical measurements on earphones to be carried out under well-defined acoustical conditions. It consists basically of a replaceable acoustical coupler, and two sockets for the mounting of a Condenser Microphone Cartridge Type 4144, and a Microphone Preamplifier Type 2619 or the Sound Level Meter Type 2203.

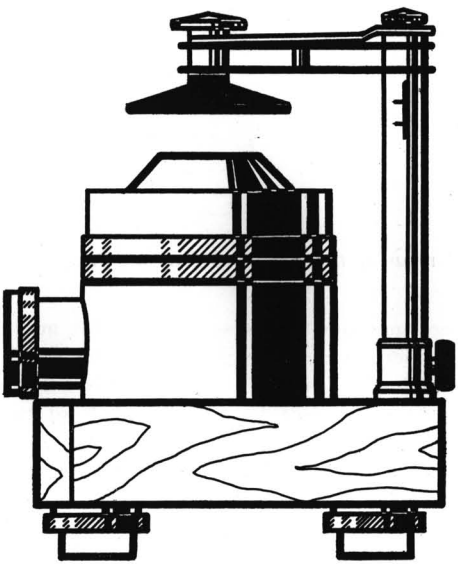

Fig. 1.1. The Artificial Ear Type 4152.

A spring arrangement is provided to fulfil certain Standards requirements regarding the force applied to the object under measurement. It can be adjusted to apply a force of 200 grammes to an earphone when using the 2 cm^3 Coupler, as prescribed in the earlier American Standard ANSI Z.

24.-9.-1949 (but not in the present 3.3-1960 ANSI Standard), and the German Standard DIN 45600, and when using the 6 cm^3 coupler, the force may be adjusted to 500 grammes as prescribed in ANSI Standard Z. 24.-9.-1949 Figs. 3 and 4.

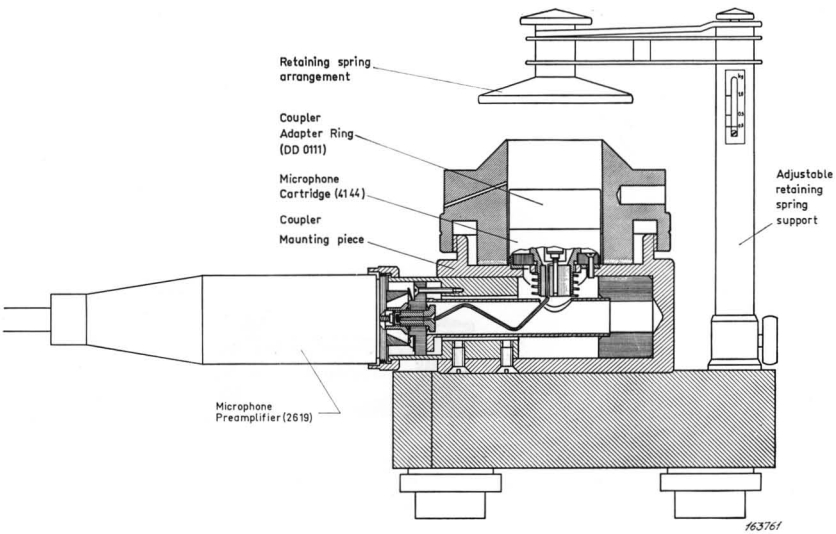

Fig. 1.2. Sectional view of the Artificial Ear and the Condenser Microphone.

Fig. 1.2 shows a sectional view of the socket with the mounting arrangement for the condenser microphone. The guard ring (internal shield) principle used in the Microphone Preamplifier Type 2619 is extended to include the socket which keeps the effective transmission loss of the 4152 as low as approximately 0.1 dB.

As indicating meter, the Microphone Preamplifier Type 2619 and the Measuring Amplifier Type 2606 can be used as well as the Sound Level Meter Type 2203. See Fig. 1.3.

The 2 cm^3 Coupler.

One of the couplers supplied with the Artificial Ear Type 4152 is a 2 cm^3 Coupler (DB 0138) which fulfils the requirement of International Standard (I.E.C. Recommendation Publication 126). A sectional view of the Coupler is shown in Fig. 1.4.

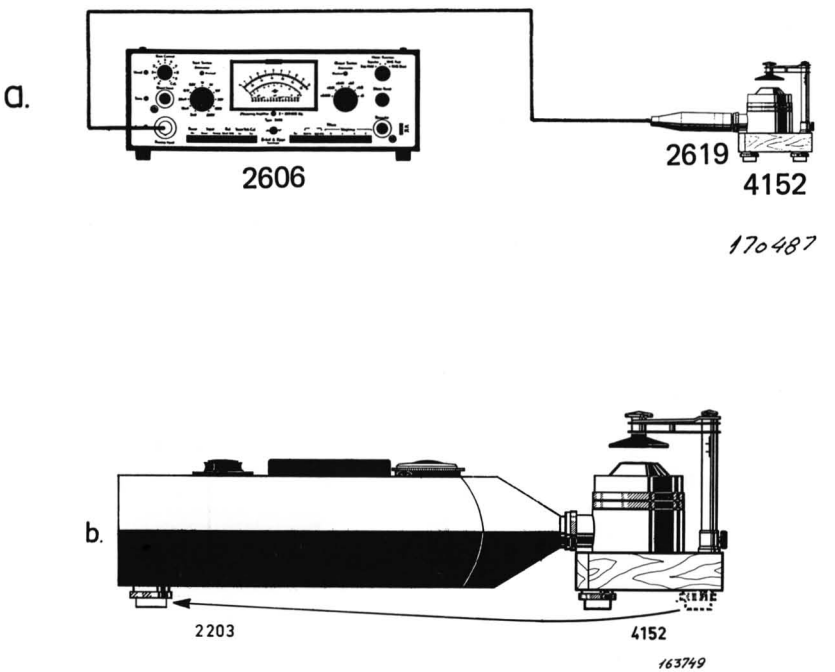

Fig. 1.3.

a) The Artificial Ear Type 4152, Microphone Preamplifier Type 2619 and the Measuring Amplifier Type 2606.

b) The Artificial Ear and the Sound Level Meter Type 2203.

It consists of a housing, a standardized 18 mm ear mould substitute, and an airtight screw seal. The housing is supplied with threads for mounting a Microphone Cartridge 4144 in one end and for the screw seal in the other. The screw seal is made airtight by means of a rubber ring, which is also used as a lock arrangement for the nub of the earphones for hearing aids. The 18 mm ear mould substitute is made removable to allow other adapters to be used, if required, as shown on p. 18.

When the Condenser Microphone cartridge is screwed into the coupler the effective volume (including the equivalent volume of the cartridge) is 2 cm^3, within the tolerances permitted by the standard.

To enable pressure equalization a capillary tube arrangement is included in the coupler, as shown in Fig. 1.2 and 1.4.

If desired the couplers can also be used screwed directly onto a Condenser Microphone as shown in Fig. 1.5. Fig. 1.5 shows also the exact dimensions

of the ear mould substitute for the convenience of the user who may wish to make his own special substitutes.

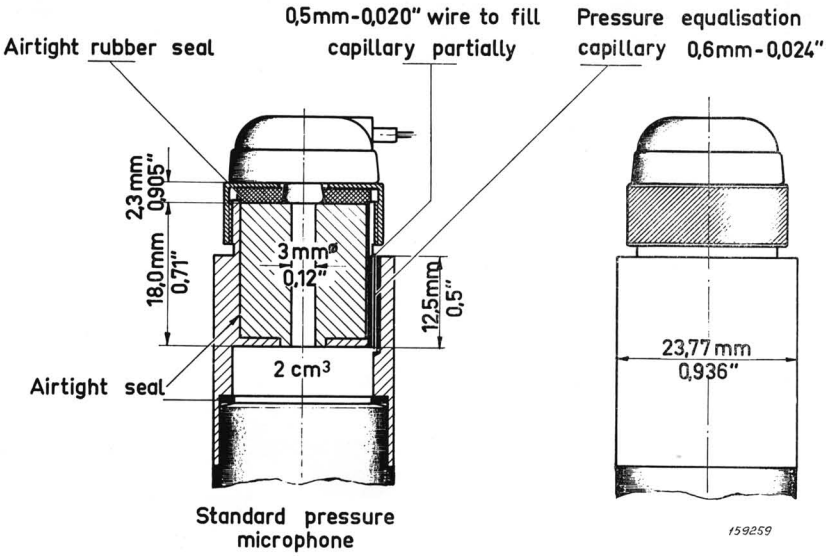

Fig. 1.4. The "normal" 2 cm³ Coupler DB 0138.

The 6 cm³ Couplers.

To enable acoustical tests to be made on headphones used in audiometers and in telephone systems, two 6 cm³ couplers are available for the Artificial Ear Type 4152. One of these couplers, the one normally included in the 4152 ear, fulfils the requirements of the N.B.S. 9A Coupler and ANSI Z. 24.5-1951, the other being in accordance with the requirements of the ANSI Z. 24.9-1949 Type 1 Coupler.

Sectional views of the couplers are shown in Fig. 1.6. According to the standards the couplers should be used in connection with microphones supplied with a front cavity. As the Microphone Cartridge Type 4144 is made with a flat front, a Coupler Adapter Ring DB 0111 is supplied with the couplers.

By unscrewing the normal protection cover from the microphone cartridge and mounting the coupler adapter ring instead, measurements can be made in complete agreement with the standards.

However, the openings of the couplers are big enough that, by accident a small object might be dropped into the cavity and damage done to the unprotected microphone diaphragm. To avoid this risk of damaging the

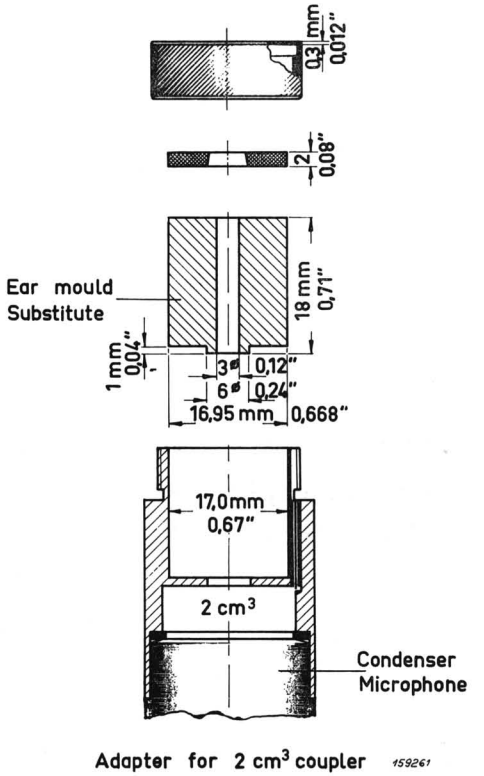

Fig. 1.5. Dimensional drawing of the 2 cm³ Coupler.

diaphragm it is recommended to place the microphone with its normal protecting cover in the coupler. (See Appendix).

Both the 6 cm³ and 2 cm³ couplers may be used directly on the Artificial Ear Type 4152, but if it should be desired to use the couplers directly on a microphone without the artificial ear, this may be done by employing the method described in the following. The method of mounting the 2 cm³ coupler is described above, but to mount the two 6 cm³ coupuers, the microphone cartridge is screwed off the preamplifier and the stop collar YO 2340, which is delivered with the couplers DB 0160 and DB 0161 but not with the Artificial Ear Type 4152, is placed on top of the preamplifier so that the preamplifier is recessed in the ring. By replacing the microphone cartridge on the preamplifier the stop collar is fixed in its position, and the respective coupler can be placed on the microphone as shown in Fig. 1.7. When the

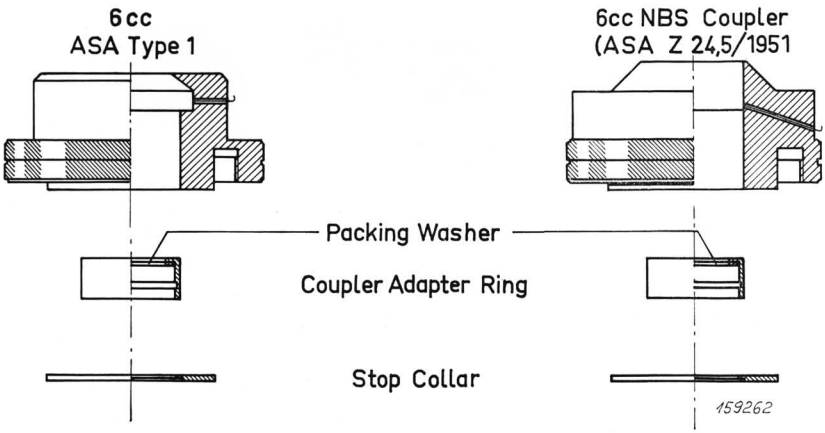

Fig. 1.6. Sectional views of the 6 cm³ Couplers.

couplers are used directly on the microphone it is recommended to use one of the B & K microphone stands.

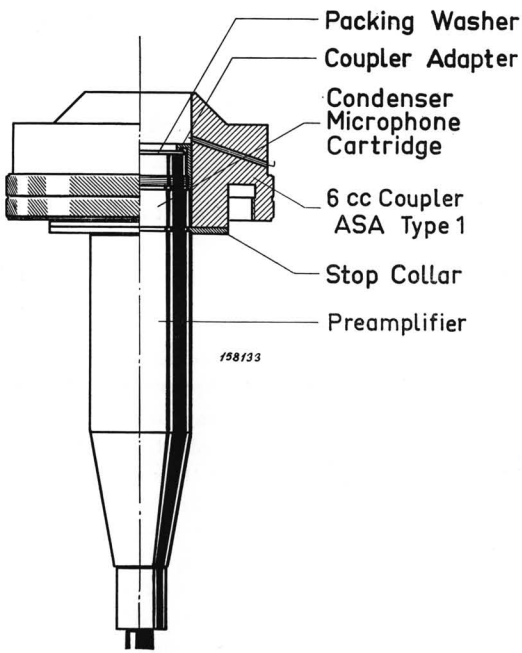

Fig. 1.7. Sketch showing how the 6 cm³ Couplers are mounted directly on the Condenser Microphone.

2. Operation

To carry out measurements by means of the Artificial Ear Type 4152, it must be fitted with a Microphone Cartridge Type 4144, a Microphone Preamplifier Type 2619 and an indicating instrument. It is possible to use the Sound Level Meter Type 2203 instead of the preamplifier and the indicating instrument. To make the Artificial Ear ready for use, proceed as follows:

Operation of the Artificial Ear.

1. Unscrew the coupler and if mounted, the Coupler Adaptor Ring.

2. Screw the Microphone Cartridge Type 4144, without protection grid, to the microphone socket.

2 cm³ Coupler	**6 cm³ Coupler**
3. If it is desired to use an adapter other than the standardized 18 mm ear mould substitute, then this should be replaced by the desired one, see page 18.	3a. Screw the Coupler Adapter Ring onto the microphone.*)
4. Screw the Coupler onto the microphone. NB! Take great care not to damage the diaphragm.	4a. Screw the Coupler to the Coupler Socket.

5. Mount the earphone to be tested on the top of the Artificial Ear.

6. If the spring arrangement is used, adjust the height of this arrangement until the correct force to the earphone can be read on the scale.

Now the Artificial Ear is ready for use, and the indicating instrument and signal to the earphone must be connected.

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*) If desired, the Front Cover DD 0015 may be screwed onto the Coupler Adapter Ring. (See Appendix).

Operation of a Complete Arrangement for the Testing of the Earphone.
Fig. 2.1 shows a typical measuring arrangement used to check the frequency characteristic of earphones.

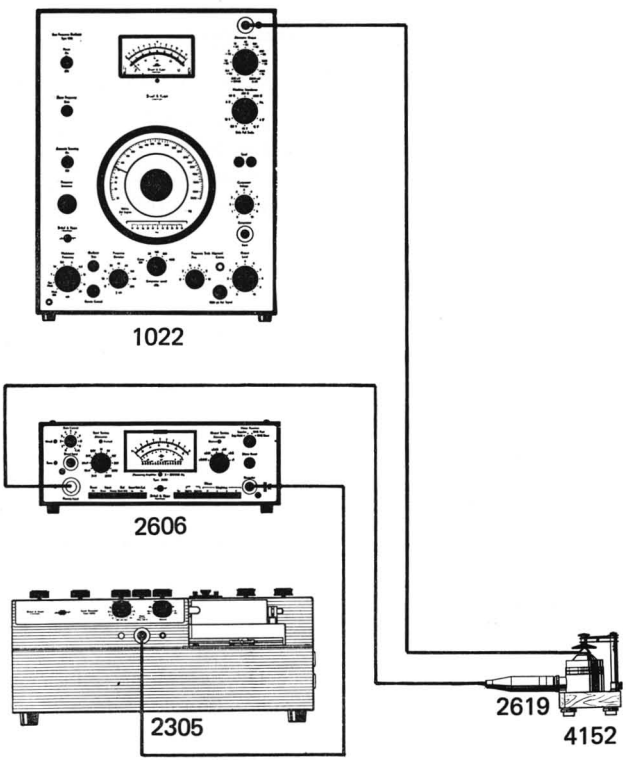


Fig. 2.1. Typical measuring arrangement for the production check of earphone characteristics.

It consists of a Beat Frequency Oscillator Type 1022 together with a Level Recorder Type 2305 and a Measuring Amplifier Type 2606. The adjustment of the different instruments are made as follows:

Adjustment of the Oscillator.

1. Turn the toggle switch marked POWER to "On" and adjust the frequency scale as described in the Instruction Manual for the Type 1022 under "Operation".
2. Set the frequency scale pointer to 1ooo Hz.

3. Turn the switch AUTOMATIC SCANNING to "Off".
4. Turn FREQUENCY INCREMENT knob until the pointer of the incremental frequency scale is at "0 Hz".
5. Set MODULATION FREQUENCY to "Mod. Off".
6. Set the COMPRESSOR SPEED switch to "Comp. Off".
7. Turn OUTPUT LEVEL until the pointer of the indicating meter is positioned at "12" at the upper scale.
8. Set MATCHING IMPEDANCE switch to "Att.".
9. Set ATTENUATOR to "120 mV", or another desired value.
   Connect the attenuator output to the input terminals of the earphone under test.
   Assemble the Artificial Ear as described under "Operation of the Artificial Ear page 10, and use the coupler suted for the earphone.

Adjustment of the Measuring Amplifier.

1. Connect the Condenser Microphone of the Artificial Ear to the Measuring Amplifier, as shown in Fig. 2.1.
2. Set the controls of the Measuring Amplifier:

INPUT	"Preamp."
METER FUNCTION	"RMS Fast"
INPUT SECTION ATTENUATOR	"0.1 V"
OUTPUT SECTION ATTENUATOR	"x 1"
Select the pushbuttons	"Ref 50 mV RMS"
	"22.4 Hz HP"
	"22.4 kHz LP"

   No weighting network should be selectel and the RECORDER output switch should be in position "AC".
3. Switch POWER "On" and allow 30 sec to warm up.
4. Determine the microphone Open Circuit Sensitivity from its calibration chart.
5. With meter scale SA 0039 fitted, the meter deflection produced by the reference voltage should be adjusted to indicate the open circuit sensitivity of the microphone in use on the auxilliary red scale "Micr. Sens» (Note that if a preamplifier other than the 2619 is used, it is necessary to correct the microphone sensitivity for the preamplifier gain and the capacitive loading of the preamplifier as described in the instruction manual for the preamplifier).
6. Cancel the selection of "Ref 50 mV RMS» and the Measuring Amplifier is ready for use.

The Level Recorder.

50 dB potentiometer is used.

1. POWER and MOTOR toggle switches to "On".
2. POTENTIOMETER RANGE to "50".
3. RECTIFIER RESPONSE to "RMS".
4. LOWER LIMITING FREQUENCY to "20 Hz".
5. WRITING SPEED:
   160 mm/sec (large figures) with 50 mm paper, or 315 mm/sec (small figures) with 100 mm paper.
6. PAPER SPEED to "3 mm/sec" (small figures).
7. Set the Synchronizing Gear Lever X in its outer position. Make sure that the Lever is pulled completely to the out position by moving the grooved finger wheel Z to and fro at the same time as pulling. (The actual paper drive speed now corresponds to the small figures marked around the PAPER SPEED knob). See Fig. 2.2.

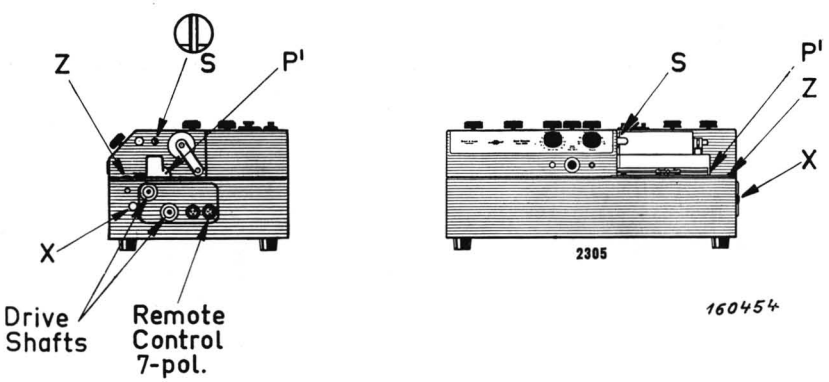


Fig. 2.2. Front and side view of the Level Recorder Type 2305.

8. PAPER DRIVE to "Start" and "Forward" commencing the paper to run, this will continue until the built-in automatic single chart stop switch declutches the drive mechanism (one chart length or less).
9. By means of the finger wheel Z (Fig. 2.2) adjust the paper until the recorder stylus is on the mark 20 Hz of the pre-calibrated recording paper.
10. Lower the pen.

Adjust the knob OUTPUT LEVEL on the Beat Frequency Oscillator until a sound pressure level of 100 dB in the Coupler can be measured on the Measuring Amplifier.

By means of INPUT POTENTIOMETER and INPUT ATTENUATOR of the

Level Recorder, the deflection of the pen is adjusted to the 40 dB line of the recording paper.

Turn the frequency scale pointer of the Oscillator to 20 Hz, that is to a position corresponding to the position of the recorder stylus on the pre-calibrated recording paper, and set AUTOMATIC SCANNING switch to "On". Now the recording can be started by pressing down the SINGLE CHART-CONT. RECORD. pushbutton for a short while and then release it, and the frequency characteristic will be recorded automatically on the paper strip.

Normally earphones are measured under the conditions described above which are constant voltage conditions. However, by connecting a resistor in series with the earphone and using the voltage drop across this resistor to control the compressor circuit of the 1022 constant current conditions can be obtained for the test.

Artificial Ear in Connection with the Precision Sound Level Meter.

As amplifier and indicating meter it is possible to use the Precision Sound Level Meter Type 2203. The Artificial Ear and 2203 make a very handy combination for audiometer control, and the measuring set up must be adjusted in the following way: Assemble the Artificial Ear as described under "Operation of the Artificial Ear" page 10 and use the coupler suited for the earphone. Feed the signal to the earphone, for example from an audiometer Fig. 2.3, or another generator. Connect the Artificial Ear to the Sound Level

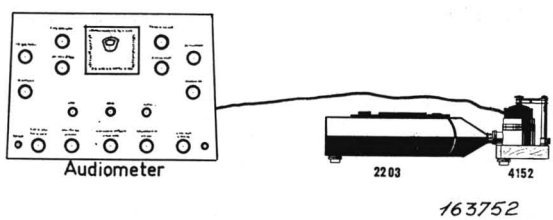


Fig. 2.3. Measuring set-up used for audiometer control.

Meter. See Fig. 2.4. Remove one of the rubber feet from the Artificial Ear and screw it under the Sound Level Meter (see Fig. 1.3b). Adjust the Sound Level Meter as follows (Fig. 2.5):

1. Pull out knob 1 and turn it to position "Batt".
   The meter pointer should now deflect to within the red area marked BATTERY indicating that the batteries are alive. If it does not, replace the batteries.
2. Turn knob 1 to "Lin".
3. Turn knob 2 fully anticlockwise.

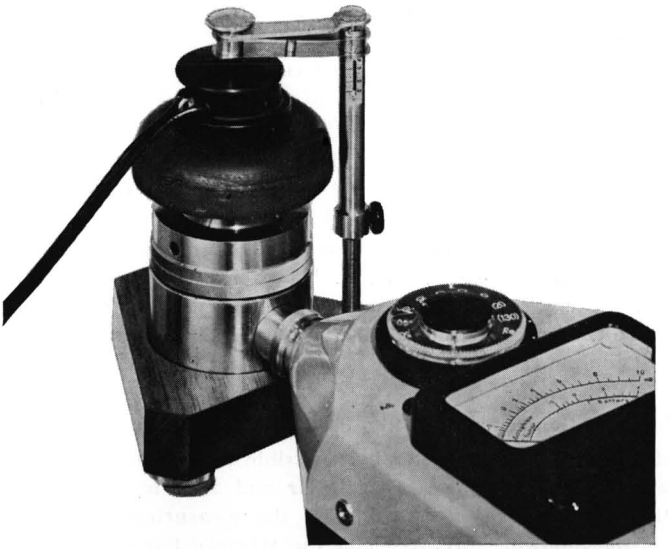


Fig. 2.4. Artificial Ear and Precision Sound Level Meter in combination.

4. Turn knob 3 fully clockwise.
   The mark "Ref" appears in the red circle to the right.
5. The meter pointer should now deflect to a value, on the upper red scale, equal to the k-value obtained from the microphone calibration chart. If it does not, adjust the SENSITIVITY ADJUSTMENT by means of a screwdriver, until the said condition is obtained.
   NOTE: The instrument should warm up for approximately 15 seconds before calibration.
6. Turn knob 2 clockwise until the meter pointer deflects between 0—10 dB, and the sound pressure level in the Artificial Ear is measured.
7. If the meter pointer does not deflect when knob 2 is fully clockwise, then turn knob 3 counter clockwise, until the pointer deflects between 0—10 dB, and the sound pressure level can be measured.
   Further it is possible to use the Sound Level Meter in connection with the Level Recorder Type 2305 for automatic recording of the frequency characteristic of an earphone. The Sound Level Meter must be adjusted as described above item 1 to 5, and knob 2 (Fig. 2.5) is turned clockwise until 100 appears in the red circle to the right. Operations of the Beat Frequency Oscillator Type 1022 and the Level Recorder Type 2305 are described under "Operation of a Complete Arrangement for the Testing of the Earphone".

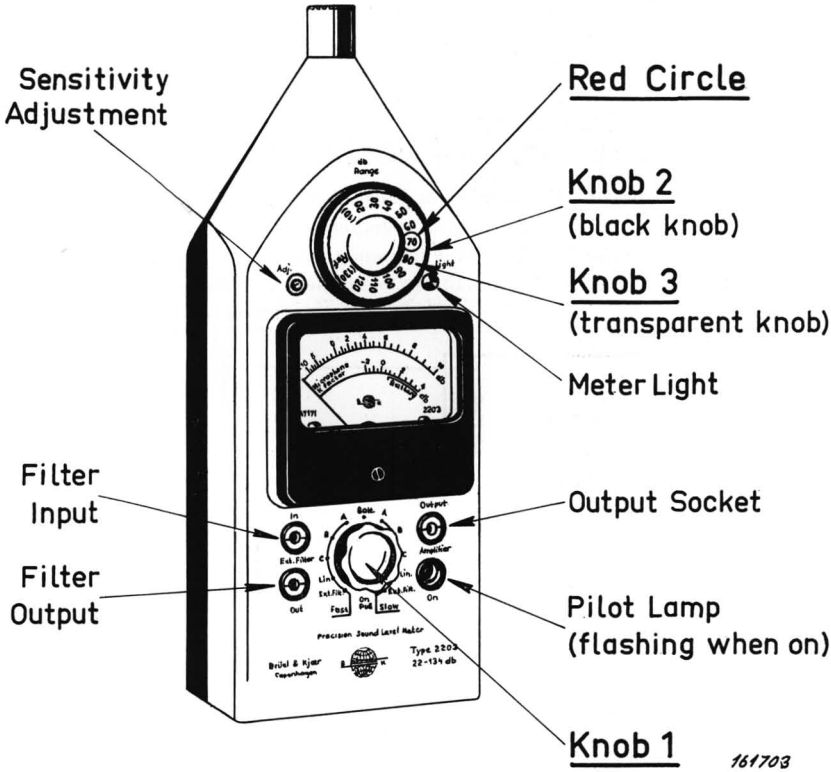


Fig. 2.5. The Sound Level Meter with identification of knobs.

3. Application

Automatic Recording of Harmonics in Earphones.

By using the Artificial Ear Type 4152 together with an oscillator with a low distortion, such as the B & K Beat Frequency Oscillator Type 1022, and the Audio Frequency Spectrometer 2113, an equipment is obtained for measuring harmonics produced in earphones. If the Spectrometer and the B.F.O. are

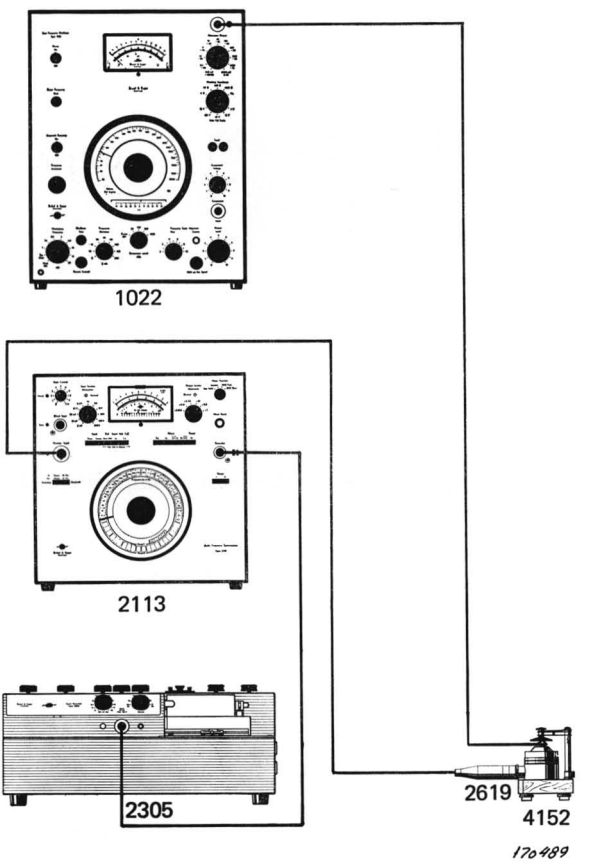


Fig. 3.1. Measuring arrangement for automatically measuring frequency characteristics and harmonic distortion of earphones.

combined with the B & K Level Recorder Type 2305 the measuring arrangement can now automatically record the harmonics of the device under test on frequency calibrated paper. A very common use of this combination is in the testing of freuency characteristics with associated harmonics produced in earphones. A measuring set-up suitable for this purpose is sketched in Fig. 3.1.

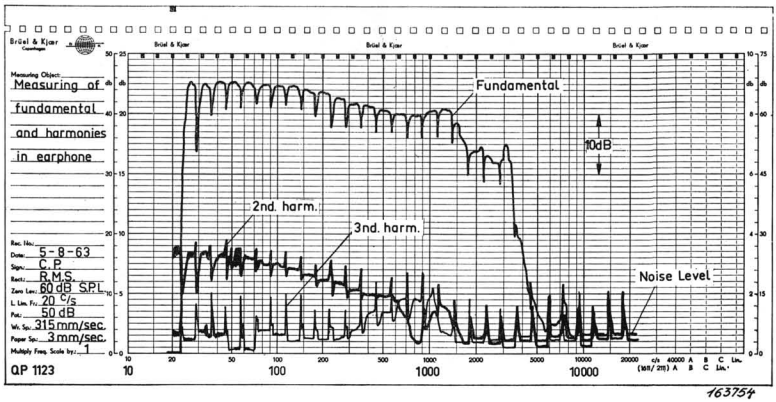


Fig. 3.2. Typical recording of frequency characteristics ("Fundamental") and harmonic signals in earphones.

In Fig. 3.2 are given the recorded results of measuring the fundamental together with the harmonics produced in an earphone measured by setting the filter switch on the Spectrometer so that it runs ahead of the frequency scanning of the BFO, the selected space difference being in accordance with the harmonic which is going to be measured. By means of the facility included in the Level Recorder Type 2305, which allows the recording paper to be reversed by one chart length without loosing the synchronization between the BFO and the Spectrometer, the harmonics are readily recorded on the same chart as the fundamental.

Some Typeical Examples of Coupler Adaptation.

As mentioned previously the ear mould substitute of the normal 2 cm^3 coupler may be replaced by special arrangements. Figs. 3.3 to 3.6 show some typical examples of this kind of adaptation.

Fig. 3.3 makes use of the ear mould substitute such as is used for the measurement of hearing aids with coupling pieces. The hearing aid shown is of the type fitted into spectacle frames.

In Fig. 3.4 the rubber seal is replaced by a special fitting for measurements on hearing aids when the coupling pieces are removed.

When hearing aid coupling pieces are provided with ear inserts an arrangement as shown in Fig. 3.5, may be used for the measurement.

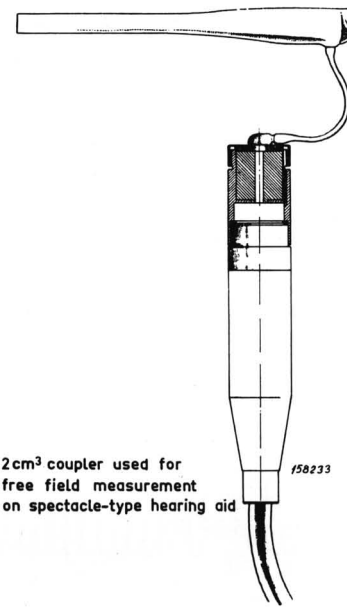
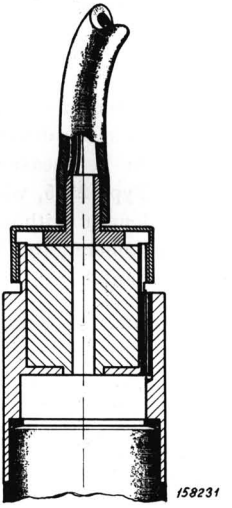


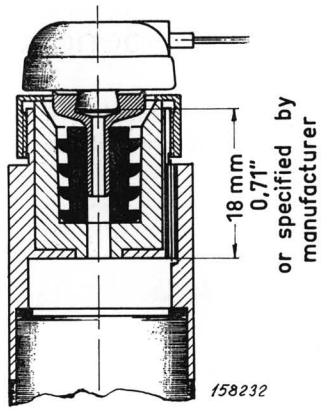
Fig. 3.3. Coupler mounting for measurements on hearing aid earphones with coupling pieces.



Flexible connecting tube mounted on adapter. The adapter is in this case replacing the ear insert

Fig. 3.4. Coupler mounting for measurements on hearing aids, spectable type, coupler directly attached to the sound tube.

Fig. 3.6 shows how another type of ear insert can be fitted to the coupler. The various special adapters shown in Fig. 3.4 to 3.6 are not supplied by B & K, but can easily be made by the user for his own special purposes.



Adapter provided with
hole for ear insert

Fig. 3.5. Coupler mounting for measurements on hearing aid earphones with special rubber inserts.

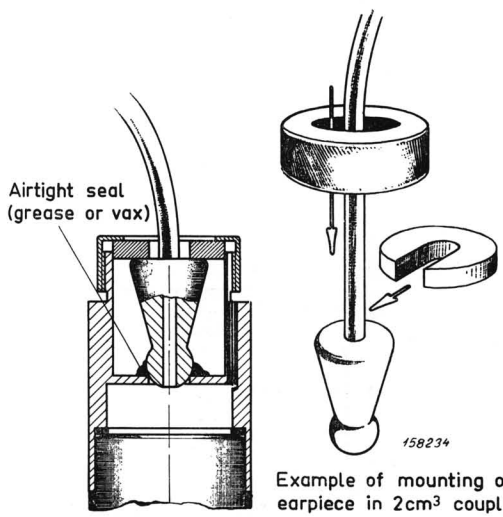


Fig. 3.6. Coupler mounting for measurements on hearing aid earphones with moulded ear insert.

4. Appendix

Influence of Vibration.

When acoustical tests are made on headphones, and the 6 cm^3 coupler is used, care should be taken to avoid vibration of the artificial ear. The instrument

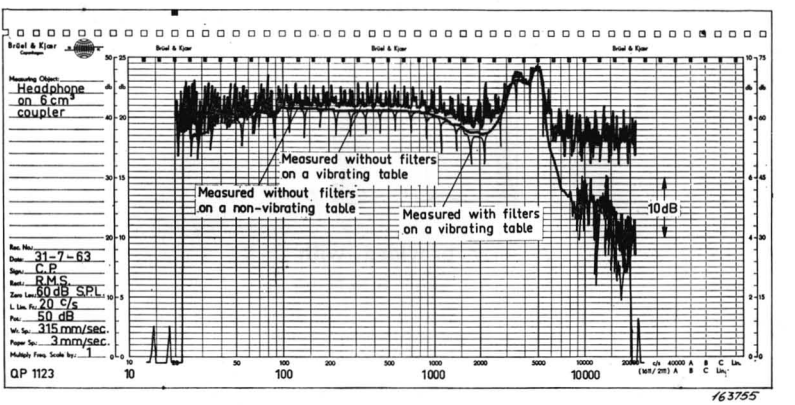


Fig. A1. Recording showing the influence of mechanical vibration.

is vibration and shock insulated by means of three soft rubberfeet, however, large vibration may cause error in the measuring result. See Fig. A1. Especially headphones having a soft rubber ring, to provide a good fit to the head

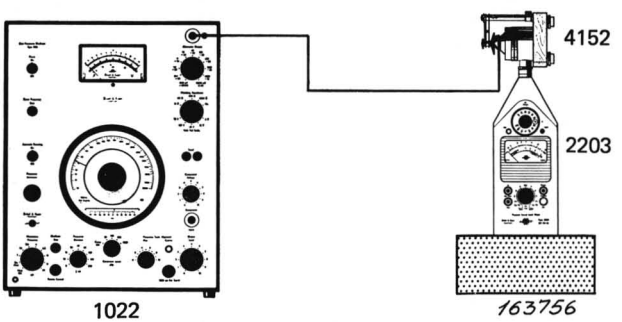


Fig. A2. Vibration insulating of the set-up consisting of the Sound Level Meter and the Artificial Ear.

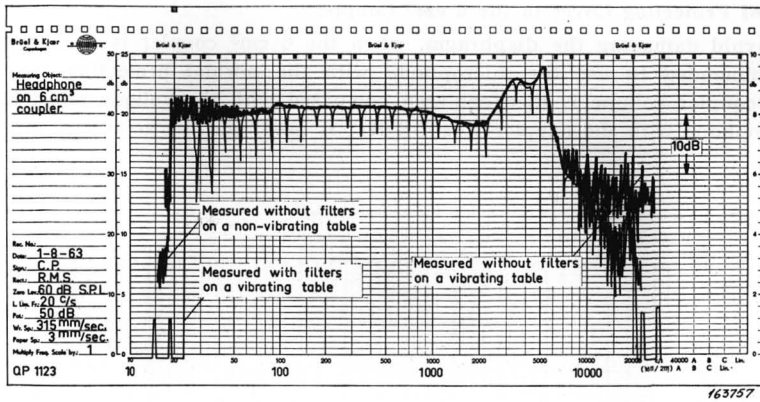


Fig. A3. Recording showing the influence of vibration isolation of the set-up as shown in Fig. A2.

of the listener, may be difficult to measure. The headphone may act as an "accelerometer", and great care should be taken to avoid this. One way to overcome the problem may be to place the combination Sound Level Meter Type 2203 + Artificial Ear Type 4152 perpendicular to the direction of the vibration on a piece of foam rubber (see Fig. A2 and A3) or use a narrow band filter. A selective measuring set-up for automatic recording is shown in Fig. A4a.

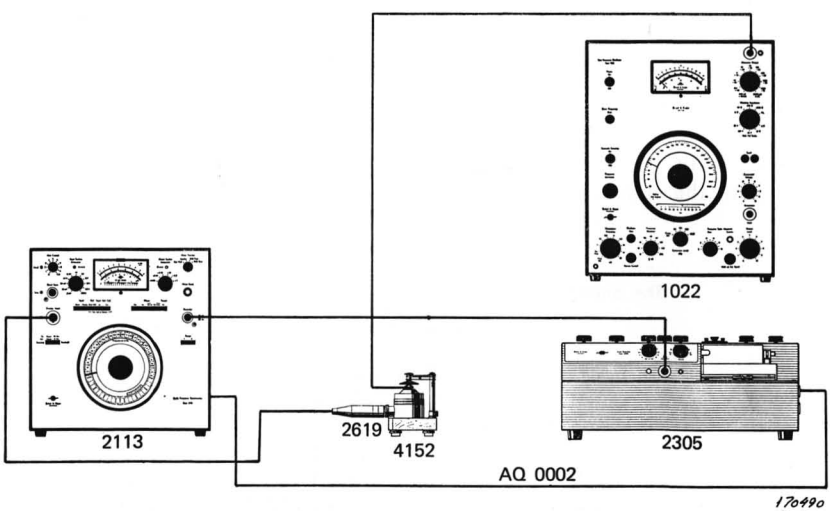


Fig. A4a. Set-up for selective measurement of the characteristic of an earphone.

Use of Protecting Cover in the 6 cm³ Coupler.

To avoid damaging the diaphragm, when the 6 cm³ coupler is used, it is recommended to use the microphone with the normal protecting cover. The coupler volume is then enlarged compared with the volume when the microphone with the adapter ring DB 0111 is used, and the acoustical effect

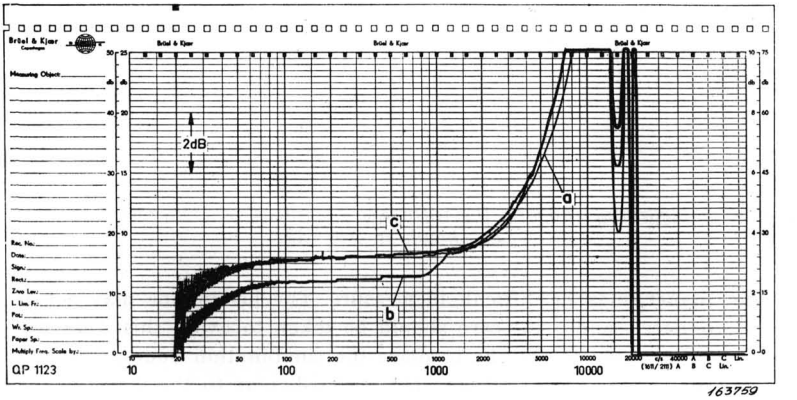


Fig. A5. Curves showing the effect of supplying the microphone with protection cover when used in the NBS type 9 A — Coupler.

a) No protection cover on the microphone.
b) Microphone supplied with the normal B & K protection cover.
c) Microphone supplied with the normal B & K protection cover and with vaseline between protection cover and microphone.

of this arrangement is a change in impedance of approx. o.8 dB of the coupler up to 1ooo Hz, and above that frequency, the curve corresponds within o.3 dB in the used frequency range to the curve recorded in agreement with the standard. The curves are shown in Fig. A5.

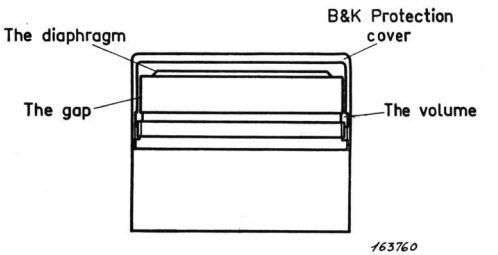


Fig. A6. Sectional view of the microphone.

The reason for the change in impedance at 1ooo Hz, when a microphone with protecting cover is used in the coupler, is the change in volume around that frequency. (See Fig. A6). If the gap between protecting cover and diaphragm ring is closed by means of vaseline, the volume will be cut off during measuring in the whole frequency range, and the obtained response will then correspond within ± o.3 dB in the used frequency range to the curve recorded with a set-up as described in the standard (Fig. A5). By using a B & K condenser microphone with its normal protecting cover and vaseline in the gap, in the Artificial Ear Type 4152, a measuring set-up is obtained, which does not completely look like the requirement in the standard, but the result by using that set-up will correspond closely to the standard.
Another way to protect the diaphragm, is to use the Coupler Adapter Ring DB 0111 and the perforated Front Cover DD 0015. The coupler volume is then reduced by approximately 8 %, and the impedance of the coupler will increase. The error will then be greater than the error obtained by the above mentioned method.

1	BB 0216	Instruction Manuel	Gebrauchsanweisung	Manuel d'instruction	Brugsanvisning	(engelsk)
1	BB 0501			" " (francaise)	"	(fransk)
1	BB 0502		" (Deutsch)		"	(tysk)
1	DB 1021	Guard ring adaptor	"Guard ring adaptor"	"Guard ring adaptor"	Skærmforlænger	

1 BB 0503 Brugsvejledning (russisk)

BX 0103

B & K INSTRUMENTS:

ACOUSTICAL....
Condenser Microphones
Piezo-Electric Microphones
Microphone Preamplifiers
Microphone Calibration Equip.
Sound Level Meters
(general purpose-precision-
and impulse)
Standing Wave Apparatus
Tapping Machines
Noise Limit Indicators

ELECTROACOUSTICAL....
Artificial Ears
Artificial Mouths
Artificial Mastoids
Hearing Aid Test Boxes
Telephone Measuring Equipment
Audiometer Calibrators
Audio Reproduction Test Equip.

STRAIN....
Strain Gauge Apparatus
Multipoint Panels
Automatic Selectors
Balancing Units

VIBRATION....
Accelerometers
Accelerometer Preamplifiers
Accelerometer Calibrators
Vibration Meters
Magnetic Transducers
Capacitive Transducers
Vibration Exciter Controls
Vibration Programmers
Vibration Signal Selectors
Mini-Shakers
Complex Modulus Apparatus
Stroboscopes

GENERATING....
Beat Frequency Oscillators
Random Noise Generators
Sine-Random Generators

MEASURING....
Measuring Amplifiers
Voltmeters
Deviation Bridges
Megohmmeters

ANALYZING....
Band-Pass Filter Sets
Frequency Spectrometers
Frequency Analyzers
Real-Time Analyzers
Slave Filters
Psophometer Filters
Statistical Analyzers

RECORDING....
Level Recorders
(strip-chart and polar)
Frequency Response Tracers
Tape Recorders

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