2407

INSTRUCTIONS AND APPLICATIONS

Audio Frequency Voltmeter Type 2407

A vacuum-tube voltmeter designed for voltage and current measurements in the audio frequency range as well as for level measurements. The instrument can be used as an AF amplifier with an amplification of 60 db.

BRÜEL & KJÆR

Nærum, Denmark · Phone Nærum 500 · Telegrams: BRUKJA, Copenhagen

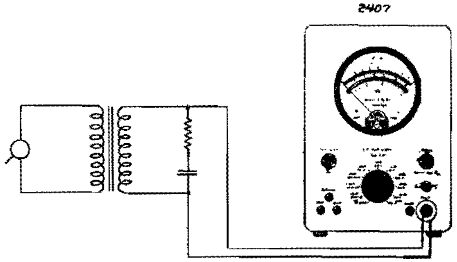


Fig. 3. Measuring the sensititvity and frequency characteristics of gramophone pick-ups.

characteristic is found by playing a good frequency record. Fig. 4 shows a typical measuring result for a pick-up without compensation. Fig. 5 shows the result of a measurement across A1 in the loudspeaker equipment of fig. 2. If one uses a frequency record in which the whole frequency range is traversed quickly, the method is admirably suited to the factory control of gramophone pick-ups.

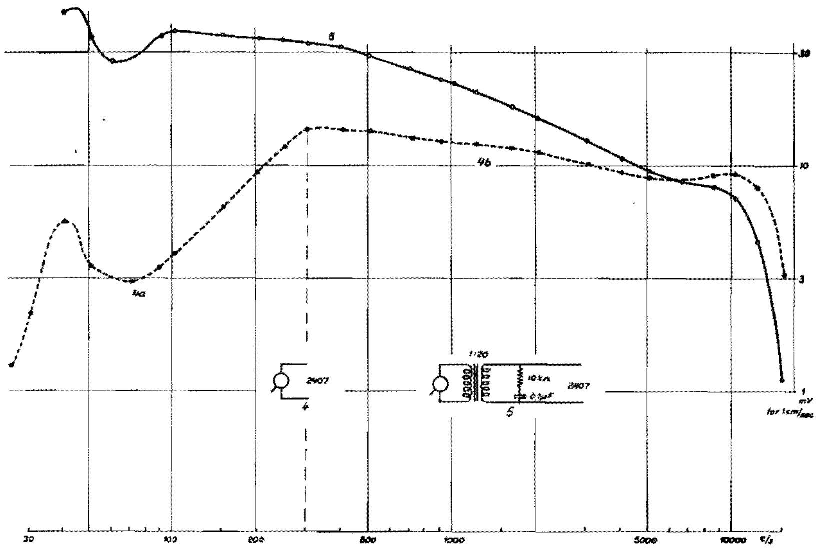


Fig. 4. Sensitivity and frequency characteristic for a pick-up without compensation:
a) constant displacement-amplitude under 300 c/s.
b) constant velocity-amplitude above 300 c/s.
Fig. 5. Same as fig. 4, with transformer load.

Check on Microphones.

The measurement of a microphone's frequency characteristic and absolute sensitivity is generally so big a job, that one prefers a level recorder equipment for that purpose. For comparison measurements and factory control, however, much benefit can be gained from using the vacuum tube voltmeter Type 2407. As a sound source one uses for example a loudspeaker supplied with a relatively low frequency, such as 500 c/s., from a beat frequency oscillator. To avoid the effect of reflexions from the walls of the room, the microphone is brought relatively close to the loudspeaker. On the vacuum tube voltmeter Type 2407 one can see immediately by how much the microphone voltage deviates from that of the standard microphone. (Fig. 6).

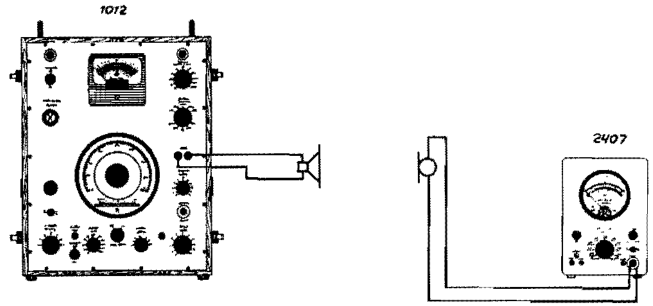


Fig. 6. Measurement of microphone sensititvity for comparison purposes.

Measurements on Audio-frequency Transformers.

The set-up is shown in fig. 7. A beat frequency oscillator with low internal resistance supplies the transformer primary through a resistance just equal to the primary impedance for which the transformer is intended. The transformer secondary is coupled to the vacuum tube voltmeter, and furthermore loaded with a resistance of such a size that the parallel value of this

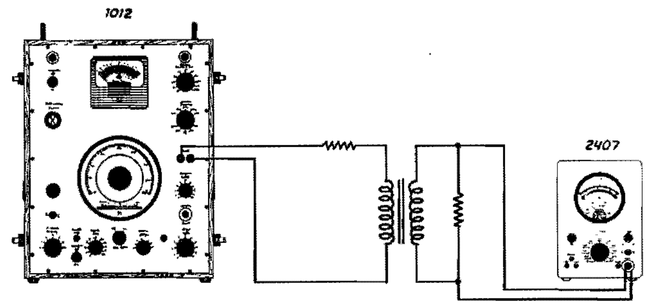


Fig. 7. Measurement of an A.F. transformer's frequency characteristic.

resistance and the instrument's input impedance is just equal to the transformer secondary's load impedance. If the beat frequency oscillator's output is now held constant, while varying the frequency, one can read off the trans-

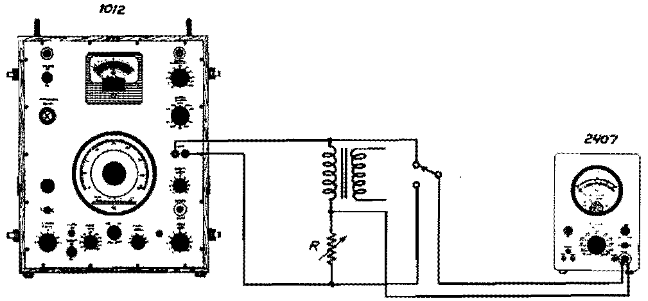


Fig. 8. Measuring the self-inductance of a transformer winding.

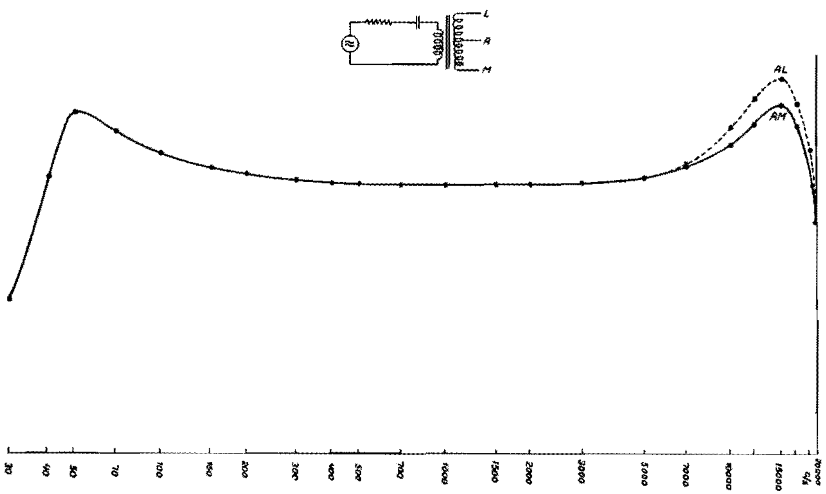


Fig. 9. Push pull transformer frequency response.

former's frequency characteristic on the vacuum tube voltmeter. One can also measure the transformer ratio with the vacuum tube voltmeter, this being the ratio between the voltages measured on the transformer's secondary and primary windings. With this measurement the two adjusting resistances should be omitted.

Applications.

In what follows, some typical uses of the vacuum tube voltmeter type 2407 are described, and as illustration, measurements on a loudspeaker equipment will be used. The equipment consists of microphone, gramophone pick-up, amplifier, a number of loudspeakers and the power supply. A simplified diagram is shown in fig. 2.

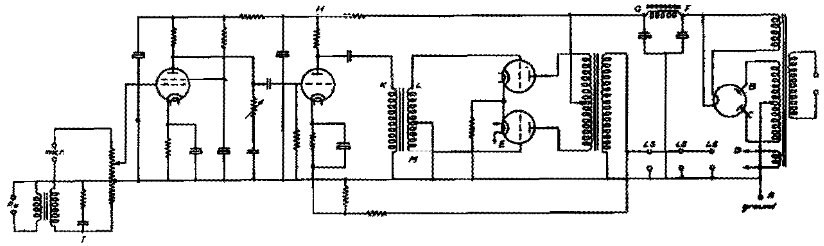


Fig. 2. Simplified diagram of loud speaker equipment.

Measurement of Voltages and Currents at low Frequency.

The following voltages and current were measured with the vacuum tube voltmeter: rectifier tube anode AB, 320 V, AC, 325 V. Amplifier tubes' filament voltage, AD, 6.2 V. Filament current to the one output tube, the instrument being inserted between A and E, 0.47 A. A.C. voltage across the first electrolytic condenser after the rectifier tube, AF, 8.3 V, and after the filter choke, AG, 285 mV.

Measurement and Check on Grammophone Pick-ups.

Fig. 3 shows the measuring set-up. The majority of electrodynamic and electromagnetic gramophone pick-ups are low-ohmed, and therefore used in connection with a transformer. The pick-up is usually loaded with a resistor in series with a capacitor, as recommended by the manufacturers. In this way a compensation is obtained for the gramophone record's falling frequency characteristic at low frequencies. The pick-up's sensitivity and frequency now adjusted with the help of another potentiometer, placed underneath the normal adjustment potentiometer, and which is only accessible for adjustment after one bas removed the apparatus' type plate.

To carry out repairs on the vacuum tube voltmeter, the front plate and chassis must be removed from the cabinet. First, the back plate is removed as described above. Then the two screws under the base plate which hold fast the terminal strip with voltage adjuster, are removed. The front plate and chassis can now be removed from the cabinet, and the front plate can be loosened most easily, by means of a light blow on the end of one of the four bolts. When the apparatus is taken to pieces in this way, all the components are easily accessible. With any possible repairs, care should be taken not to alter the cable system of the apparatus too much, as the amplifier's frequency characteristic can otherwise change considerably.

Self-inductance in a transformer winding can be measured with the set-up of fig. 8. For a definite frequency, adjust the resistance R so that the vacuum tube voltmeter shows the same reading for the two positions of the switch. At the frequency used we then have $\omega L = R$, whereby L can be found, as ω is known. On the loudspeaker equipment in fig. 2 the following transformer ratio was measured on the push-pull input transformer: $\frac{AL}{AK} = 2.08$, $\frac{AM}{AK} = 2.07$, at 1000 c/s. Fig. 9 shows the transformer's frequency characteristic in the given "Clough coupling". (If one wishes to measure the characteristic of the transformer while it is sitting in the amplifier, it is necessary to remove the influence of the negative feed-back, for example by removing the output tubes). It will be seen from fig. 9 that the push pull coupling is not wholly effective at the higher frequencies.

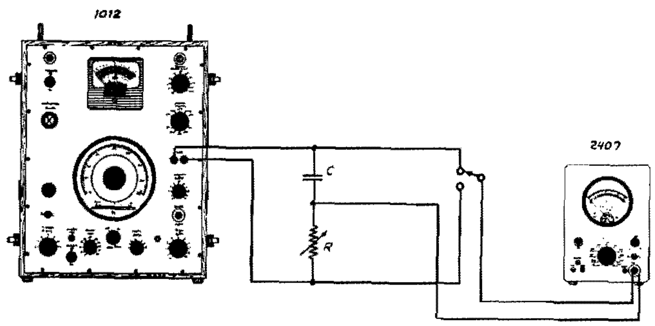


Fig. 10. Measuring capacities with the A.F. Voltmeter.

Measurement of Capacity.

In analogy to the set-up of fig. 8, one can measure the size of condensers as shown in fig. 10. When the vacuum tube voltmeter gives the same deflection for both positions of the switch, we have $\frac{1}{\omega C} = R$. Just as in fig. 8, it is a condition for reasonable measuring accuracy that R is small in comparison with the vacuum tube voltmeter's 1.5 MΩ.

Measurement of Impedance.

The set-up in fig. 8 and fig. 10 is a simplified form for Grützmacher's bridge, shown in fig. 11. Using the vacuum tube voltmeter, resistance R is adjusted until the voltages ab and ac are equal. The numerical value of the impedance X will then be equal to the resistance R. If one further measures the voltages ad and bd, one can find the phase angle φ for the impedance X from the equation $\tan \varphi/2 = \frac{ad}{db}$. (d is the electrical mid-point of the transformer secondary).

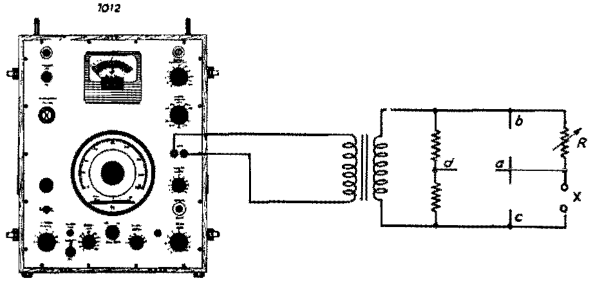


Fig. 11. Grützmacher bridge.

Measurement of Distortion.

Audio Frequency voltmeter Type 2407 is very useful as a nul indicator for all bridge measurements in the audio frequency range. As an example, fig. 12 shows a measurement of distortion factor with the help of Frequency and Distortion Measuring Bridge Type 1602. This has a parallel-T filter, with which the fundamental can be blocked, so that only the harmonics are meas-

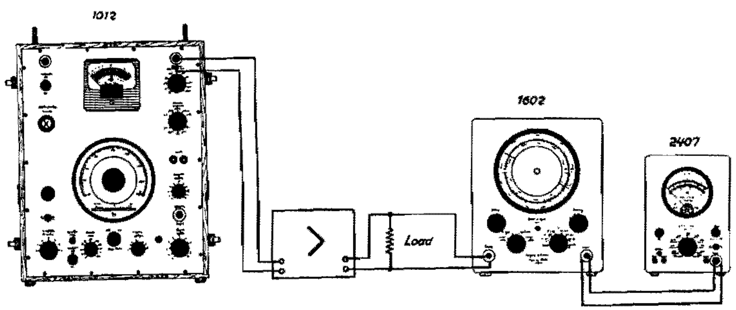


Fig. 12. Measurement of distortion factors.

ured on the vacuum tube voltmeter. The distortion factor is the ratio between voltage of the harmonics and the voltage of the fundamental plus harmonics. Fig. 13 shows the distortion factor for the amplifier in fig. 2 as a function of the output. The output power of an amplifier can also be found with the help of

with the meter and rectifier, which also measures the average value of the voltage. This relationship is of interest when the vacuum tube voltmeter is run with the help of a vibrator from an accumulator or a d. c. supply, as the curve form of the a. c. voltage hereby produced usually diverges considerably from a sine-wave.

Where possible, it is recommended that the apparatus be earthed with all measurements. The one of the nuts holding on the back plate has a side hole which corresponds to the normal banana-pin, and is intended for earthing. For many measurements, where it is impossible to use a screened input cable to the apparatus, it is recommended that the instrument and the measuring object be placed on a table which is covered above or below with metal foil, earthed.

Service.

To replace the amplifier tubes or the lamp illuminating the instrument scale, the cabinet must be opened. This is carried out as follows: the 4 nuts holding the back plate on are removed; then the back plate is removed, this being done by inserting a sharp screwdriver in the join between the back plate and the cabinet case, preferably at the base of the cabinet. When the back plate has been removed, the tubes are accessible for shifting out. The instrument lamp is screwed onto a small stand-off piece on the flange of the moving-coil meter; the lamp-holder can be loosened by a screwdriver and removed, then the lamp shifed out. (As previously mentioned, the fuse can be changed out without removing the back plate).

When a tube has been shifted out, it is only necessary in most cases to carry out the simple control check with the help of the apparatus' reference voltage, described above. Only if the tube characteristics of the new tube vary considerably from normal will irregularities greater than the above mentioned tolerances arise. After shifting out the amplifier input tube, the hum level of the vacuum tube voltmeter should be checked, to make sure that the meter gives at the most a deflection of 1 % of its scale length for all positions of the range switch, when no voltage is fed to the input socket.

At times it might be desirable to adjust the instrument so that it shows the same value as another instrument used as a standard voltmeter. This can be simply done by comparison between the two voltmeters, adjusting the sensitivity of the vacuum tube voltmeter with the potentiometer which is accessible at the back, as described above. If a direct comparison is only occasionally possible, the vacuum tube voltmeter can be completely re-adjusted so that the AF voltmeter's own reference voltage is used afterwards, without available standard voltmeter, to attain again concordance between the two instruments. Thus, one first adjusts the vacuum tube voltmeter by direct comparison with the standard voltmeter. Then one connects the vacuum tube voltmeter's reference socket first with the apparatus' input socket, and notes the deflection, and then with the apparatus' output socket. The deflection on the meter is which gives a deflection lying in the upper two-thirds of the scale. When reading, use the meter's outer scale for the measuring ranges 1 - 10 - 100 mV and 1 - 10 - 100 - 1000 V, and the middle scale for the other measuring ranges. The meter's decibel calibration can be used on all ranges; if the db number on the range switch is added to the db reading on the meter, the voltage expressed in db above 1 V is obtained.

For current measurements use the built-in 1 Ω shunt. This is coupled in across the screened input by means of the toggle switch to the right, this being put on "Current". By using a double set of contacts in this switch, possible contact resistance has been ensured against. The shunt will stand a maximum load of 1 A.

The precision of the vacuum tube voltmeter at 1000 c/s, when correctly adjusted as described above, is better than 2 % of the fullscale deflection. A 10 % change in the supply voltage will cause an approx. 2 % change in the voltmeter's sensitivity. Fig. 1 shows a typical frequency characteristic for the instrument. As will be seen, the frequency characteristic is flat within ± 2 % over the whole audio frequency range from 20—20000 c/s, and the instrument can be used with somewhat reduced precision right down to approx. 5 c/s. For frequencies above 20000 c/s the precision is poorer because of capacity in the input voltage divider.

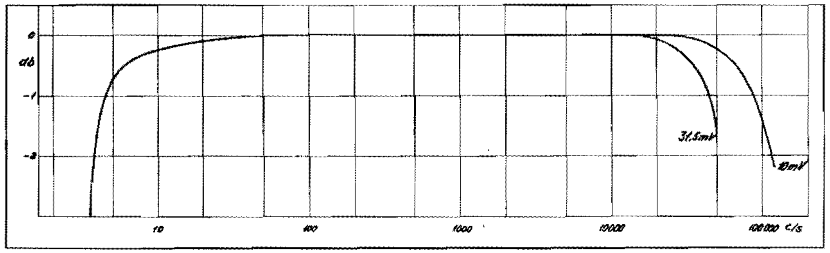


Fig. 1. Frequency Response of the A.F. Voltmeter Type 2407.

A headphones, oscillograph, or similar instrument can be connected to the output sockets on the left hand side of the front plate. If the apparatus should at the same time be used as a vacuum tube voltmeter, the load impedance should be great by comparison with the resistance of the meter and rectifier, this being 10 kΩ, as the load is in parallel with the meter and rectifier.

The vacuum tube voltmeter measures the average value of the a. c. voltage but is calibrated in r. m. s. values for a sine-shaped voltage. If the instrument's own reference voltage is used to check the adjustment, the curve shape of the supply voltage does not play an important part, as the same voltage is measured both with the vacuum tube voltmeter as a whole and

the vacuum tube voltmeter, as one measures the output voltage E, and has therefore $W = \frac{E^2}{R}$, where R is the load impedance, which is known in most cases. If R is not known, it can be measured with a set-up analogous to fig 8 or fig. 10.

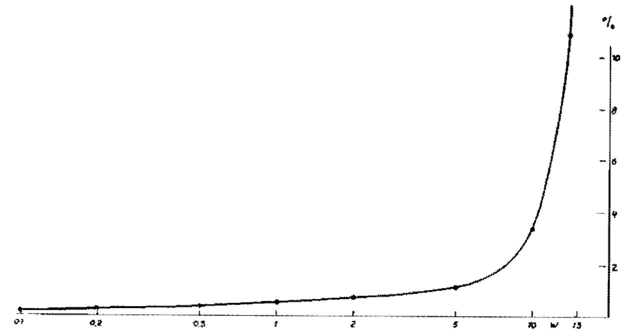


Fig. 13. Distortion as a function of the output of an amplifier.

Measurements on Amplifiers, Filters, Lines etc.

The amplification or damping in an amplifier or filter is found with the tube voltmeter by measuring the input and output voltages and finding their ratio. If one keeps the input voltage constant, varies the frequency and

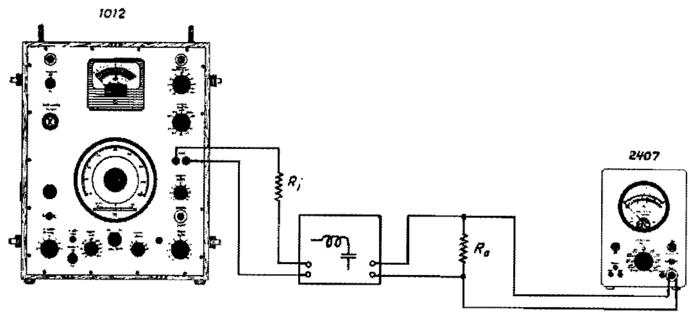


Fig. 14. Measurement of amplification or damping, with the aid of Type 2407.

measures the output voltage, one obtains the frequency characteristic of the amplifier or filter. The measuring set-up is shown in fig. 14. The two resistances R_i and R_o correspond to the amplifier's or filter's input and output impedance, it being a condition that the beat frequency oscillator has a low internal resistance. As an example of the measuring results, fig. 15 shows the frequency characteristic for a blocking filter type 1602.

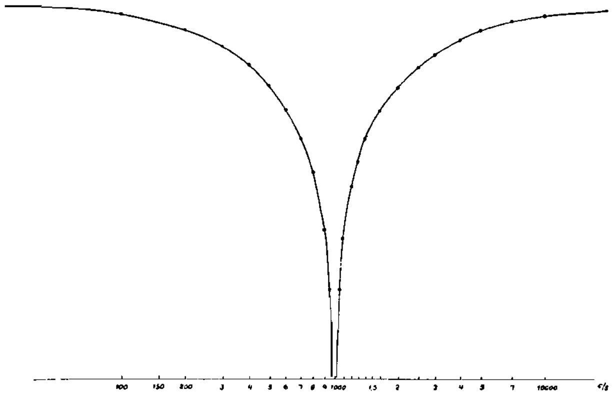


Fig. 15. Damping as function of frequency for a blocking filter Type 1602.

Measuring the Quality Factor of Inductances.

The quality factor Q of a self-inductance is of interest in many cases, for example when developing audio frequency filters. Fig. 16 shows how it can be measured with the vacuum tube voltmeter Type 2407. With the old of a low-loss condenser C the measuring circuit it brought into resonance with the measuring frequency used. The ratio of the two voltages, measured in the two positions of the switch, is the desired Q-value, $Q = \frac{V_1}{V_2}$ .It is a condition that $Q \cdot \frac{1}{\omega C} \ll 1.5\ M\Omega$.

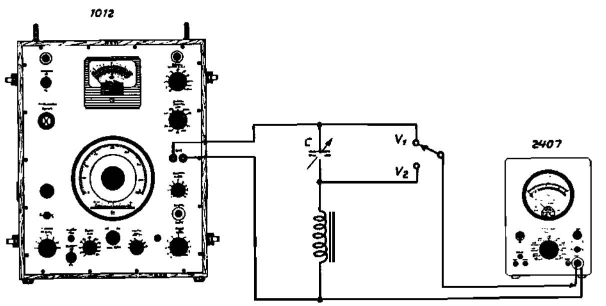


Fig. 16. Resonance method for the determination of the quality factor Q of a self-inductance.

Operation.

After making sure that the apparatus is adjusted to the proper supply, connect the apparatus to the power supply and start it with the switch to the left marked "Main Switch". The scale should now light up, and the meter will give a momentary deflection, due to the capacitor in the apparatus charging up. After about 10 sec. a new momentary deflection is noted, due to the amplifier cathodes warming up, and finally after 20—30 sec. the apparatus is ready for use.

If one wishes to make sure that the apparatus has the correct sensitivity, a check is made in the following way: the toggle switch to the right is set to "Voltage" and the range switch in the middle to the range "10 V". By means of a short connection join in the socket marked "Output" with the socket marked "Reference". A deflection will now be obtained on the meter of between 6 and 7 volts. Note this value, and then join the "Reference" socket to the input socket of the instrument instead of the output socket. The deflection on the meter should now be the same as before, and possible variations can be corrected means of the potentiometer accessible through a hole in the middle line of the apparatus' back plate, and operated by a screwdriver.

If the power supply voltage is very unstable, the reference voltage, which is the same value as the amplifier tubes' filament voltage, will be just as unstable. However, it is usually possible to carry out a satisfactory adjustment of the apparatus by the method described. Otherwise, an outside source of constant voltage of approx. 6 V must be used, instead of the apparatus' own reference voltage.

With voltage measurements the screened input socket marked "Input" is used, and the toggle switch to the right is placed on "Voltage". (N.B.: if the toggle switch is placed on "Current" the input voltage will be shortcircuited through the built-in 1 Ω shunt). Possible d. c. components in the measuring voltage are blocked by means of a built-in capacitor which can stand 1000 V. The input resistance is 1.5 MΩ, and the input capacity, which usually is without significance compared with the capacity of the screened input cable normally used, is 15 pF. Now choose a range with the apparatus' range switch and the principle is that one first measures an a. c. voltage by means of the meter (with rectifier) alone, and then with the whole vacuum tube voltmeter. A potentiometer is then so adjusted that the two readings on the meter are identical. Approximately 6 volts should be used, and the amplifier's filament voltage is brought out to a special socket for that purpose.

Power supplies.

The vacuum tube voltmeter is operated from the usual 50 or 60 c/s supply. Consumption is approx. 12 Watts, and a. c. voltages of 115, 127, 150 or 220 V can be used. Switching between the different voltages is done by means of a built-in selector, operated by means of a screwdriver through a hole in the back plate of the apparatus. An indicator disc coupled to the selector shows which of the voltages the instrument is adjusted to. The power supply section of the apparatus is protected by a fuse placed in the transformer's primary. The fuse is placed above the voltage selector, and can be replaced via a hole in the back plate, after the fuse cover has been removed.

If it is wished to run the apparatus from the d. c. supplies or from an accumulator, a rotary converter should be used, delivering one of the above mentioned voltages. Because of the low power consumption, a vibrator is also well suited to this purpose.

Noise and Vibrations Measurements.

For measuring sound pressure, one can sometimes manage with vacuum tube voltmeter Type 2407 in combination with a good crystal microphone, whose sensitivity is known. The sensitivity S is given in db above 1 volt per μ bar. If one wishes the sound pressure measured in db above the usually used reference value, $2 \cdot 10^{-4}$ μbar, the vacuum tube voltmeter's calibration in db above 1 volt is used. If one has read off a voltage which lies A db above 1 volt, this corresponds to a sound pressure of 74—S+A decibels. With a sensitive microphone, e.g. where S = —50 db, it will be possible to measure sound pressures down to approx. 55 db.

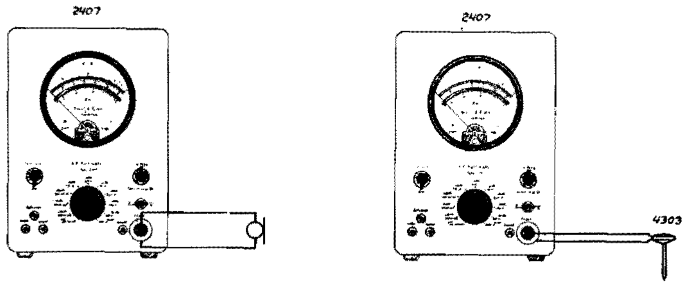


Fig. 17. Noise measurement with a crystal-microphone and vibration measurement with a pick-up Type 4303, using A.F. Voltmeter Type 2407 as reading instrument.

At low frequencies, the crystal microphone's impedance is not small in relation to the vacuum tube voltmeter's 1.5 MΩ. The lower limiting frequency, defined as the point where the frequency characteristic has fallen 3 db, lies approx. 10^5/C c/s, where C is the microphone capacity in pF. (It is a condition that leakage in the microphone is without significance by comparison with 1.5 MΩ). If one wishes to measure noise in phons according to DIN 5045 or ASA Z 24.3, one can use the falling characteristic at low frequencies to produce curve B in ASA Z 24.3 or the 60-130-phon curve of DIN 5045. The microphone is shunted with a resistance which, in parallel with the tube voltmeter's 1.5 MΩ, gives a value of R MΩ, where R = approx. 1300/C. The noise level is now found from the same equation which was used above to give the sound pressure in db.

Vibration measurements can be carried out with a piezo-electric vibration pick-up, for example type 4303, which has a sensitivity of approx. 70 mV for 1000 cm/sec^2, and with which one can consequently measure accellerations down to approx. 5 cm/sec^2. The lower limiting frequency is approx. 20 c/s, as Type 4303 has a capacity of approx. 5000 pF.

The set-ups for measuring noise and vibrations given here can only be recommended when one not interested in great sensitivity and precision. For finer measurements Frequency Analyzer Type 2105 or AF Spectrometer Type 2109 should be used, in conjunction with condenser microphone Type 4111 and vibration pick-ups Type 4303 or 4304, with integration filters Type 1605 or 1604.

Measurement of D. C.

Inverter Type 4610, used when it is wished to record d.c. with the level recorder Type 2304, can also be used in connection with the vacuum tube voltmeter Type 2407. The Inverter contains a vibrator, which transforms the d.c. to be measured into a 400 c/s a.c. voltage. The method of connecting up is shown in fig. 18. The measuring voltage is led to the inverter's screened jack marked "Slider", and the vacuum tube voltmeter is connected to the jack marked "Amplifier Input". The effective input resistance for d.c. voltage is approx. 2 MΩ.

Fig. 18. Measurement of d.c. voltages by means of Inverter Type 4610.

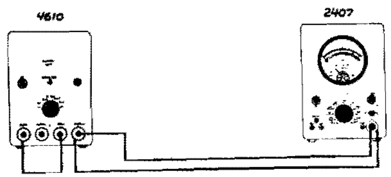


Fig. 19. Sensitivity measurement using the Inverter's bias voltage as reference value.

As the vibrator does not give a sine-shaped voltage, and is further single-poled, the deflection on the meter with d.c. voltage is about haft as great as for an a.c. voltage with the same r. m. s. value. If a direct reading is therefore required, it is necessary to increase the amplification with the help of the potentiometer in the mid line of the apparatus' back plate. The amplification is increased to that amount needed so that the meter shows the same voltage as a d.c. meter used as a standard. If such a meter is not available, calibration can alsa be undertaken with the aid of "Bias" voltage in Type 4610. The vacuum tube voltmeter is connected as usual with "Amplifier Input", and a

Description.

General.

The Audio Frequency Voltmeter Type 2407 is a universal instrument for all who work with measurements in the audio frequency range. It has a moving coil meter with germanium rectifier and a two-stage amplifier, stabilized by means of a powerful negative feed-back. With the amplifier a high input impedance has been obtained, together with a straight-lined frequency characteristic over the whole frequency range, a high sensitivity, complete safety against overload and a linear scale on the moving coil meter. A built-in control arrangement ensures furthermore that the measuring accuracy is the same as with the meter without amplifier.

Circuit Description.

The voltage to be measured is led from the screened input socket of the apparatus to a voltage divider, which has 11 steps with 10 db. jumps. The input resistance of the apparatus is just equal to the total resistance of the voltage divider, 1.5 Mohm, and a capacitor blocks possible d. c. components in the measuring voltage, the capacitor standing 1000 V. The eleven measuring ranges for the voltage are: full deflection for 10 mV, 31.5 mV, 100 mV, and so on, up to 1000 V. After the voltage divider follows a two stage resistance coupled amplifier with an amplification of 1000 (60 db). A moving coil meter with germanium rectifier is coupled to the output of the amplifier, and the degree of amplification is stabilized by means of negative feed-back, proportional to the current through the meter. With current feed-back high impedance is obtained in the voltmeter circuit, and a linear scale is thus obtained. The amplifier output is also led to a pair of sockets on the front plate of the instrument, whereby it is possible to use the amplifier in connection with a telephone, oscillograph, or similar device.

Current measurements in the audio frequency range can be carried out, as the apparatus contains a 1 Ω shunt. The measuring ranges are: full deflection for 10 mA, 31.5 mA, 100 mA, 315 mA and 1 A. The amplifier's degree of feed-back is adjustable with the help of a potentiometer. This is used to adjust the amplification, so that the vacuum tube voltmeter's sensitivity is correct,

Contents.

connection is made from the central contact in the "Slider"-jack to the outer connector (the metal collar) of the socket marked "Input". (See fig. 19). The vacuum tube voltmeter is then adjusted so that it shows the same voltage as that given by the "Bias"-switch on Type 4610. When an adjustment is to be carried out in this way, one should first let Type 4610 work for a few minutes with the switch in position "1 V", on account of a leakage current in an electrolytic condenser which smoothes the "Bias" voltages.

Specification.

Frequency Response: Flat to less than 2 % between 20 and 20000 c/s.

Voltage Ranges: Full deflection for 10—31.5—100 and 315 mV and for 1—3.15—10—31.5—100—315 and 1000 V.

Input Impedance for Voltage Measurements: 1.5 megohms in parallel with 15 micromicrofarads.

Current Ranges: Full scale for 10—31.5—100—315 mA and 1 A.

Input Impedance for Current Measurements: 1 ohm.

Control: The instrument is supplied with a reference voltage, led to a jack on the front plate.

Scales: Voltage and current scales are graduated from 0 to 10 and from 0 to 31.5. Decibel scale from 0 to 20 decibels. The meter's decibel calibration can be used on all ranges; if the db number on the range switch is added to the db reading on the meter, the voltage expressed in db above 1 V is obtained.

Accuracy: Better than 2 % of full scale at 1000 c/s.

Amplification: Maximum 60 db.

Impedance of Output Terminals: 2,5 kiloohms.

Stabilisation: The instrument is stabilized for variations of supply voltage.

Tubes: 2×EF 40.

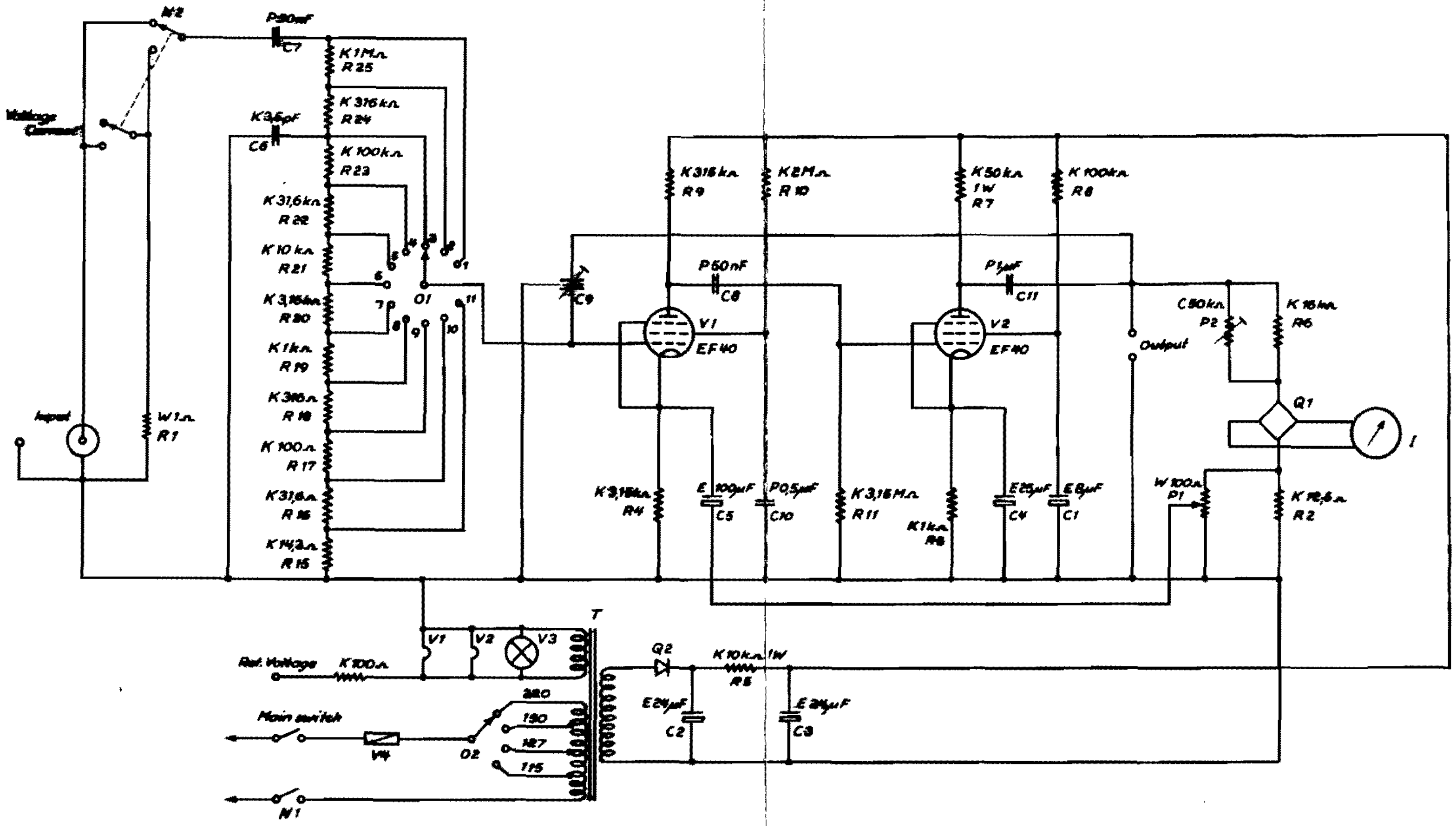
Power Supply: 115—127—150—220 V a.c. 40—120 c/s Watts.

DIMENSIONS excl. dials and knobs	HEIGHT	WIDTH	DEPTH
Centimetres	26	18	16
Inches	10	7	$6^1/_2$
WEIGHT	4 kg	9 lbs	

Audio Frequency Voltmeter.

Type 2407

DECEMBER 1956



Correction dates						Audio Frequency Voltmeter	Brüel & Kjær Copenhagen.
						Type 2407	p. Date 17-9-53.

TROUBLE SHOOTING 2407

Symptom and Condition	Defect	Cure
Apparatus dead, no scale light.	Defective switch N1, voltage switch O2, Transformer T	Repare or replace
Apparatus dead, scale light working.	Defective winding in T, defective rectifier Q2, electrolytic condenser C2—3, resistor R5	Replace
Apparatus alive on output jacks, but no deflection on meter.	Defective meter, rectifier Q1, resistors R6—P2	Repair meter, replace components
Meter shows too small deflection, but output voltage normal.	Fault in Q1	Replace germanium rectifiers
Amplification reserve on control P1 too small, frequency characteristic bad.	Fault in amplifier tubes or components Too small anode voltage	Replace Replace rectifier Q2 or condenser C2
Apparatus' sensitivity a little too low.	Wear and age, too low a voltage on supply	Apparatus checked with help of reference as described in instructions for use
Apparatus' frequency characteristic outside tolerance.	Amplification has changed, or wiring displaced	C9 adjusted so that frequency characteristic is the best possible on all ranges
Apparatus reads incorrectly on certain ranges.	Fault in resistors R15—25 Grid current in V1 Fault in R4—C5—R10—C10	Replace Replace V1 Replace
Meter shows small deflection, without applied voltage.	Leakage in C11 Hum voltages from V1—V2	Replace Replace
Apparatus reads incorrectly on current ranges.	Defective R1	Replace or adjust
Amplifier is unstable.	Fault in C8—C11—C5—C9	Replace Replace or adjust

OCTOBER 1956

Parts-List
and
Trouble Shooting

AUDIO FREQUENCY VOLTMETER
Type 2407

Brüel & Kjær

B K

DENMARK

PARTS-LIST 2407

Component Type	Stock Reference	Diagram Reference
Power cable	AN 0001	
Rubber foot	DF 7008	
Pentode	EF 40	V 1—2
Meter	IM 2407	I
Coaxial jack, input	JJ 0014	
Meter lamp socket	JO 0001	
Coaxial plug	JP 0014	
Banana plug socket	JT 8344	
Tube socket	JV 8400	
Cabinet	KQ 2407	
Main switch	NT 0563	N1
"Voltage-Current" switch	NT 0564	N2
Power line voltage selector	OA 0003	O2
Range selector	OR 2407	O1
Selenium rectifier	QV 0002	Q2
Germanium diode (IN 34)	QV 0050	Q1
Bakelite knob	SN 0986	
Power transformer	TN 4056	T
Fuse 0.35A	VF 0001	V 4
Meter lamp 6.3/0.3	VS 8024	V 3
Condensers.		
» 25 µF/25	CE 2002	C4
Electrolytic 8 µF/450	CE 2012	C1
» 100 µF/6	CE 2016	C5
» 2×24 µF/450	CE 2216	C2—3
Ceramic	CK 3.5 pF	C6
Paper 400 V 1 µF	CP 0627	C11
» » 0.5 µF	CP 0633	C10
Paper 400 V 50 nF	CP 0654	C7—8
Trimmer	CV 0004	C9
Potentiometers		
Potentiometer, lin. 50 kΩ	PD 3500	P1
» , miniature 100 Ω	PQ 1100	P2

PARTS-LIST 2407

Component Type	Stock Reference	Diagram Reference
Resistors.		
Karbowid ½ W	RK 12.5 Ω	R2
» » »	RK 1 kΩ	R3
» » »	RK 3.15 kΩ	R4
» 1 »	RK 10 kΩ	R5
» ½ »	RK 16 kΩ	R6
» 1 »	RK 50 kΩ	R7
» ½ »	RK 100 kΩ	R8
» » »	RK 315 kΩ	R9
» » »	RK 2 MΩ	R10
» » »	RK 3.15 MΩ	R11
» ⅓ »	RK 100 Ω	R12
Precision Resistors.		
Wire wound 3 W ± 0.5 %	RW 1 Ω	R1
Karbowid ½ W ± 0.5 %	RK 14.6 Ω	R15
» »	RK 31.6 Ω	R16
» »	RK 100 Ω	R17
» »	RK 316 Ω	R18
» »	RK 1 kΩ	R19
» »	RK 3.16 kΩ	R20
» »	RK 10 kΩ	R21
» »	RK 31.6 kΩ	R22
» »	RK 100 kΩ	R23
» »	RK 316 kΩ	R24
	RK 1 MΩ	R25