

RADIOMETER

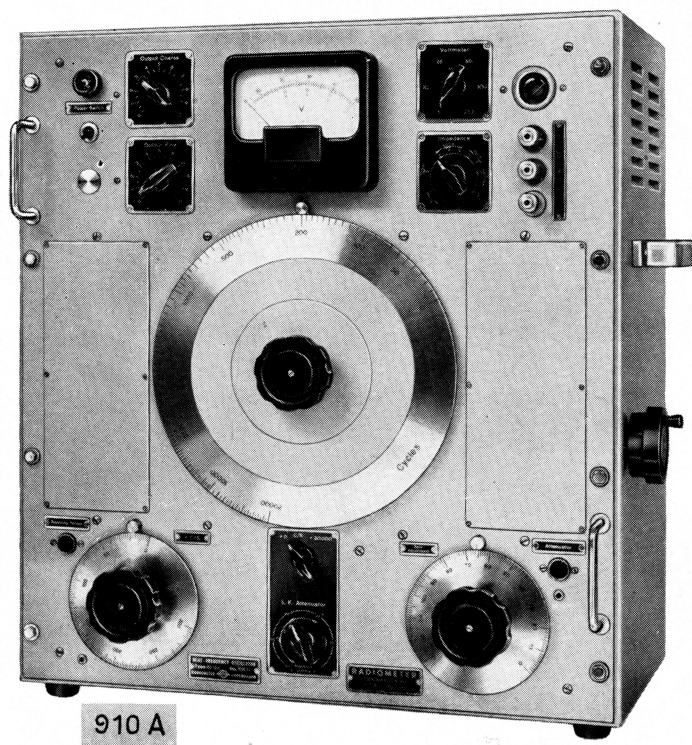
Beat-Frequency Oscillator

type H012

Elektriske måleapparater

**til videnskabelig og
industriel anvendelse**





Beat-Frequency Oscillator type HO12

0-40,000 cycles

Introduction :

This instrument is a high-performance oscillator, designed to meet even severe requirements for stability, accuracy, and good waveform. The large main dial carries a 50-cm individually engraved frequency scale 0-20,000 cycles which in conjunction with the specially designed precision condenser gives a remarkable accuracy of the frequency. The main dial is supplemented by an incremental-frequency dial 0-300 cycles and a switch for adding 20,000 cycles to the main dial reading. A magic eye provides for zero setting. The maximum output power amounts to 6 watts, and a built-in ladder attenuator provides for dependable output voltages as low as 10 microvolts. The frequency response is essentially flat within the greater part of the AF-range. The output voltage is read directly on a built-in meter. Provision has been made for remote output control. These properties make the type HO12 a versatile precision instrument suitable for all kinds of AF-work.

Description :

The Beat-Frequency Oscillator type HO12 employs the conventional heterodyne principle: The signals from two HF-oscillators are fed through buffer amplifiers into a frequency converter. One oscillator operates at a fixed frequency, 200 kc, while the other is variable between 200 and 180 kc. The frequency of the variable oscillator is varied by means of the specially designed precision-condenser, fig. 2. This condenser is driven from the main frequency dial, and its plates are shaped to give

a linear scale from 0-100 cycles and a logarithmic scale above 100 cycles. The 20 to 40 kc range is brought about by changing the fixed-oscillator frequency from 200 to 220 kc. The fixed-oscillator frequency can be varied by 300 cycles by means of the incremental frequency dial. The difference (beat) frequency is selected from the frequency converter by means of a low-pass filter. The beat-frequency signal is then fed through the output controls and is finally amplified in the output amplifier. To this brief description of the working principle the following comments may be added: Buffer amplifiers between the oscillators and the converter are used in order to avoid locking phenomena and resulting deterioration of the waveform at low frequencies. Remote control of the output is accomplished by impressing a d-c voltage upon the grid of one of the buffer amplifiers. The grid is connected to a separate jack. The output amplifier consists of a pre-amplifier stage and a push-pull power stage. The harmonic distortion is reduced to a minimum by means of negative feedback. Fig. 1 shows the distortion as a function of the frequency for different outputs. The rise in distortion at low

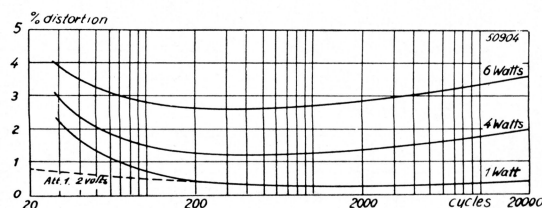


Fig. 1: Typical curves showing the distortion as a function of the frequency for different outputs.

frequencies is due to the output transformer. This distortion can be avoided by R-C coupling the attenuator to one of the output tubes, as shown by the dotted-line curve of fig. 1.

Adequate regulation of the heat distribution inside the instrument minimizes frequency drifts, and a stabilized power supply provides for good stability against line voltage variations.

Special designs:

Type HO12W This instrument incorporates a wobblers and is especially designed for room acoustics.

Type HO12H incorporates a 1-Mc generator which can be AM-modulated from the oscillator. This design is intended for fidelity measurements on radio receivers.

Type HO12WH is a combination of the two types mentioned above.

These special designs are described in detail in our leaflet 15102.

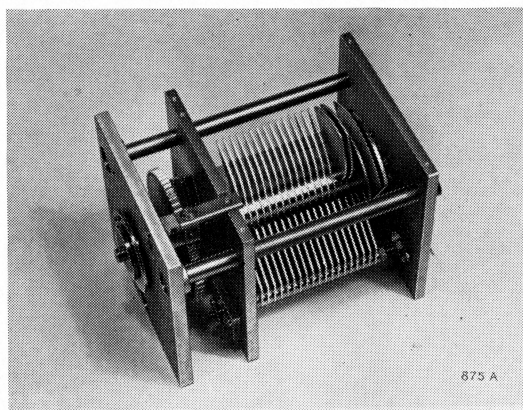


Fig. 2: Precision condenser type VK1 as used in the Beat-Frequency Oscillator type HO12.

SPECIFICATIONS:

Frequency range:

0 to 40,000 cycles in two ranges, 0 to 20,000 cycles and 20,000 to 40,000 cycles. The main dial is engraved from 0 to 20,000 cycles, linear from 0 to 100 cycles, and logarithmic from 100 to 20,000 cycles. The incremental dial is linear and covers 300 cycles, with divisions for every 2 cycles. Above 20,000 cycles this dial is inoperative.

Frequency calibration:

From 0 to 20,000 cycles the accuracy of the frequency calibration is within 0.5% + 1 cycle. Above 20,000 cycles within 1%.

Frequency response:

At an output of about 1 watt in 600 ohms the frequency response is within 0.2 db from 30 cycles to 20 kc.

Frequency stability:

After a warm-up period of 5 minutes the drift caused by the temperature rise is less than 3 cycles per hour provided that the room temperature will remain fairly constant. — Line voltage variations are practically without influence on the frequency. A voltage variation of 5% will cause a frequency variation of less than 1 cycle.

Output power:

From 30 cycles to about 10 kc the maximum output power is 6 watts, gradually decreasing to 2 watts at 40 kc.

Output stability:

±5% line voltage variation will cause less than ±0.5% variation in the output voltage. ±10% causes less than ±2%.

Output impedance:

A built-in output transformer provides for impedance matching to the following load impedances: 5, 25, and 150 ohms, either free or one terminal grounded, 600 ohms free, one terminal grounded or symmetrical, 2500 ohms one terminal grounded, and 10,000 ohms symmetrical. The 2500 and 10,000 ohm taps are on the transformer primary. Coupling condensers prevent the plate voltage from reaching the output binding posts.

Meter:

The output voltage is read directly on a meter with the voltage ranges 5, 10, 25, 50, 100, and 250 volts, on one scale. The accuracy of the meter is within 2% from 20 cycles to 10 kc.

Attenuator:

A built-in attenuator, in parallel with the meter, with the division ratios 1, 10, 10², 10³, 10⁴, and 10⁵ provides for exactly known output voltages from 50 volts down to 10 microvolts. The attenuator output voltage is fed to a shielded jack. The relation between the division ratio and the output impedance is:

ratio:	1	10	10 ²	10 ³	10 ⁴	10 ⁵
ohms:	300	100	10	10	10	10

one pole grounded.

To ensure especially low distortion at low frequencies the attenuator can be R-C coupled (att. 1) to one of the output tubes. Maximum voltage 2.5 volts. At transformer coupling (att. 2) the maximum voltage is 50 volts.

Waveform:

At 1000 cycles and resistive load the harmonic contents are

less than 3 % at 5 watts,
less than 2 % at 4 watts, and
less than 0.5 % below 1 watt.

See fig. 1 for typical curves.

Hum:

For outputs over 0.02 watt the hum level is below -60 db. Lower outputs should preferably be drawn from the attenuator.

Power supply:

110, 127, 150, 200, 220, and 240 volts, 50-60 cycles. Consumption 100 watts.

Mounting and finish:

The instrument is mounted on a 19" x 21" standard rack and is generally supplied in a metal cabinet. Panel and cabinet are finished in grey enamel.

Overall dimensions inclusive of cabinet:

H: 560 mm, W: 580 mm, D: 310 mm.

Weight:

32 kilos.

Data subject to change without notice.



Type H012

BEAT-FREQUENCY OSCILLATOR

Standard design

The Beat-Frequency Oscillator operates on the heterodyne principle as the audio frequency is generated as a beat between two h-f oscillators of which one can be varied between 200,000 and 180,000 cycles while the other operates on 200,000 cycles or 220,000 cycles.

By means of the dial "Zero Adjustment" the frequencies of the two h-f oscillators can be made to coincide, when the other dials are set to 0 cycle. The zero beat is watched on a cathodoscope. x) The frequency error is less than 0.5% + 1 cycle when the zero adjustment is correct. The error is less than 1% over 20,000 cycles.

The frequency of the variable oscillator, and consequently the audio frequency furnished, is set on the main dial which is divided from 0 to 20,000 cycles. 20,000 cycles can be added to any scale reading by setting the switch "+0kc, +20kc" to position "+20kc". The main dial is coupled to a knob on the right-hand side panel by means of a worm gear having a gear ratio of 1:62. This knob is for fine adjustment. When the knob is removed automatic recorders or the like can be coupled instead.

By means of the dial "+c/s" up to 300 cycles can be added to any frequency between 0 and 20,000 cycles. When the switch is in position "+20kc" the +cycle dial does not operate.

From the two h-f oscillators the two h-f voltages are fed to two buffer amplifiers and from there to a mixer tube. The h-f modulation products are filtered in the following low-pass filter, and only the audio-frequency is passed on to an R-C link for correction of the frequency response. From here it is passed to the output control knobs ("Output fine" and "Output coarse").

One stage of l-f amplification and a phase inverter follows the power control and finally two output pentodes in push-pull coupling.

The output terminals marked "1" and "2" can be connected to various windings of the output transformer by means of the impedance selector located to the left of them, or they can be connected to the anodes of the output tubes through two condensers of 2 μ f. By this means matching is obtained to the following load impedances: 5 ohms, 25 ohms, 150 ohms, 600 ohms, and 10 kilohms. In all positions marked "U" the output voltage is unsymmetrical, and the lower terminal 2 is connected to chassis. The secondary winding is free in position "F", and in the positions "S" the output voltage is symmetrical referred to chassis. The frequency response depends on the output impedance chosen and also depends somewhat on the output voltage. In the frequency range 30 to 20,000 cycles it is less than ± 0.2 db in the 600 ohm position with 600 ohm ohmic load at 1 watt output.

x) which starts operating when the main-dail is set to zero.

By means of negative feedback the output impedance of the amplifier is set to the same value as that of the matching impedance. The maximum output of the amplifier in the matching resistance is about 6 watts in the frequency range 30 to 10,000 cycles. A 1 kilocycle and 600 ohm ohmic load the distortion inclusive of hum voltage is:

at 0.1 watt:	less than	0.5%	hum	0.1%
" 1	"	"	"	0.1%
" 2	"	"	"	0.1%
" 4	"	"	"	0.1%
" 5	"	"	"	0.1%

The distortion is essentially due to the 3rd harmonics and 2nd harmonics as the higher harmonics are negligible. Typical values are found in the following table:

at 0.1 watt:	0.1%	2nd harmonics	0.15%	3rd harmonics	0.03%	hum
" 1	"	0.1%	"	0.2%	"	0.06%
" 4	"	0.2%	"	1.2%	"	0.07%
" 5	"	0.3%	"	2.4%	"	0.08%
" 6	"	1.7%	"	4.5%	"	0.08%

At low frequencies the distortion increases owing to the output transformer. At 30 cycles it is about 3% at an output between 0.1 and 4 watts. At 5 watts it is about 3.5% and at 6 watts about 4%.

A built-in ladder attenuator is connected when the "Impedance" switch is set to one of the two positions "Att.". From the jack "Attenuator" can be furnished the voltage read on the meter multiplied by 1, 10^{-1} , 10^{-2} , 10^{-3} , 10^{-4} , and 10^{-5} respectively, when the unloaded attenuator is set to the corresponding positions. The output impedance of the attenuator is 0, 100, 10, 10, 10, and 10 ohms respectively and is stated on the name plate of the switch. An output impedance of zero ohms is only had (with the attenuator in position x_1) when the output voltage is kept constant even if the load varies. Otherwise the output impedance is 300 ohms. The input voltage of the attenuator is had at the output terminal 1. Terminal 2 is connected to chassis in position "Att.". With the switch in position "Att. 2" an input voltage of 50 volts is permitted. With the switch in position "1" the highest voltage available is 2 volts, but the frequency range is extended downwards to approximately 2 cycles, and the distortion at frequencies down to 30 cycles is less than 0.5%. When low voltages are required at low frequencies use the position "Att. 1".

The built-in copper-oxide rectifier meter has 6 measuring ranges with joint scales. It is directly connected to the terminals 1 and 2. With terminal 2 to chassis (i.e. in all positions marked "U" on the impedance selector) the accuracy in all ranges is 2%, full scale, in the frequency range 20 to 10,000 cycles, and 3% in the range 20 to 20,000 cycles.

In the position "S" the meter reads about 10% high at 20,000 cycles on the 100 volt range. On the 250 volt range (and with the impedance selector in position "10 kilohms S") it will read about 10% high at 10 kilocycles, about 35% high at 20 kilocycles, and about 100% at 40 kilocycles. In position "F" the error depends on the character of the external load.

The Beat-Frequency Oscillator is stabilized for line voltage fluctuations by means of a special coupling. In general a sudden line surge of 5% will cause a momentary change in the output voltage of about 2%. After about 30 seconds the deviation from the original output voltage is about 0.5%. Line voltage variations of 10% will cause a permanent change in the output voltage amounting to about 2 or 3%.

The output voltage of the Beat-Frequency Oscillator can be varied between plus 6 dB and about minus 35 dB by feeding a negative voltage varying between about 3 to 4.5 volts to the jack "Reg. Voltage". 0 dB equals the output without regulation. The limits of the range of regulation depend on the distortion arising when regulating upwards and the hum arising when regulating downwards. At the limits of the range mentioned neither the distortion nor the hum exceeds 2% at 1 kc.

The "Tone" switch provides for clickless disconnection of the output at a speed of about 600 dB per second. Measurements of reverberation time of even heavily damped rooms will therefore be possible. With the switch in position "Autom." the output is automatically attenuated heavily in the range from 20,000 cps to 20 cps.

Special design with wobbler

At the type HO12W with built-in wobbler the fixed oscillator can be frequency-modulated by means of a reactance tube. A ladder attenuator provides for adjustment of the frequency deviation to ± 20 , ± 25 , ± 32 ± 400 , each step adding about 20%. The said frequency deviations can be multiplied by 1, 0.5, or 0.2 by setting a switch accordingly. The Beat-Frequency Oscillator can operate either at a constant frequency deviation being independent of the frequency furnished, or at a frequency deviation being approximately proportional to the frequency furnished, as the detent spring of the ladder attenuator can be put out of action so that the fine adjustment knob turns both the tuning condenser and the ladder attenuator by means of two worm gears. The modulating frequency that determines how many times a second the frequency furnished oscillates about the medium value can be adjusted to one of the following frequencies: 3.2 - 4 - 5 - 6.3 - 8 - 10 - or 12.5 cycles. The modulating voltage is sinusoidal.

Special design with 1-megacycle oscillator

A 1-megacycle oscillator is incorporated in the type HO12H Beat-Frequency Oscillator. The oscillator can be modulated from 0 to 100% from the Beat-Frequency Oscillator proper when the impedance switch is set at position "600 U". At 50 volts 1-f the modulation is 100%. As the modulation percentage and the modulating voltage are proportional, any modulation percentage can be read directly on the scale. The distortion of the modulation is very small at low modulation percentages and is less than 2% at 95% modulation. A ladder attenuator gives off voltages of approx. 1, 10, 100, 300, or 1000 millivolts and the corresponding output load has to be greater than 100 ohms in position "1 V" so as to avoid distortion of the modulation. The frequency modulation is negligible, being only about 200 cycles at 100% modulation.

Conversion

All Beat-Frequency Oscillators supplied can be provided with wobbler and/or 1-megacycle oscillator when they are sent to the factory, and any type of H012 Beat-Frequency Oscillator can be mounted with a type NS3 Logarithmic Frequency Response Recorder in a joint cabinet. Both the Beat-Frequency Oscillator and the Recorder can be mounted on 19" relay racks.

Directions for normal design

Before connecting the instrument to the power line set the line voltage selector to the line voltage available. The line voltage selector is located behind the plate screwed on to the back panel of the instrument and it can be set to 110, 127, 150, 200, 220, 240 volts, 50 to 60 cycles a-c. A 3 amp, a 200, and a 100 milliamp fuse (for protecting the rectifier tubes from a short-circuit, if any, in one of the electrolytic capacitors) are mounted beside the built-in line voltage selector.

Switch on the instrument. In about 1 minute the cathodoscope will start lighting. Set all frequency dials (main dial, +c/s dial, and +0kc, +20kc switch) to zero and set the zero adjustment dial so that the cathodoscope starts flashing when turning to either side.

The output voltage is available either across the binding posts 1 and 2 (located to the upper right on the instrument) or from the attenuator jack (located to the lower right on the instrument). By means of the impedance selector the following matching impedances can be chosen: 5 ohms - 25 ohms - 150 ohms - 600 ohms - 10 kilohms. In the 10 kilohm position the matching impedance between the chassis jack and one of the binding posts 1 and 2 is 2.5 kilohms. In positions "U" (unsymmetrical secondary) the binding post 2 is connected to chassis. In position "F" (free secondary) the secondary winding is free from chassis connections. In positions "S" the output voltage is symmetrical referred to chassis. In position "600 Ω S" the center of the secondary winding is connected to chassis. In positions "10 k Ω S" the anodes of the output tubes are connected to the binding posts 1 and 2 through two condensers of 2 μ F.

With the impedance selector in position "Att.1" or "Att.2" the attenuator is connected to the binding posts 1 and 2, and at the jack "Attenuator" can be furnished the voltage read on the meter multiplied by 1, 10^{-1} , 10^{-2} , 10^{-3} , 10^{-4} , 10^{-5} . The output voltage must not exceed 50 volts when the attenuator is in position 2, and 2 volts in position 1. In position 1 the distortion at low frequencies is lowered and the frequency range is extended downwards to about 2 cycles.

The voltmeter is always connected to the binding posts 1 and 2. It has 6 measuring ranges with a joint scale, and the accuracy is 2%, full scale, on the range 20 to 10,000 cycles and about 3% on the range 20 to 20,000 cycles in all positions "U" of the impedance selector. In positions "F" and "S" the error in indication increases with the frequency and is greatest on the highest ranges (see description).

It is well to ground one of the chassis binding posts of the Beat-Frequency Oscillator in order to avoid capacitive hum voltages, if any, in the output transformer.

Directions for wobbler

In the type HO12W Beat-Frequency Oscillator the built-in wobbler is started by setting the switch immediately below the main frequency dial in position "+0kc, Wobbler on" and the switch "Modulating Frequency" to one of the seven (sinusoidal) modulation frequencies between 3.2 cycles and 12.5 cycles. Adjust to the desired frequency deviation on the ladder potentiometer "Frequency Deviation $\pm c/s$ " and on the switch "x1, x0.5, x0.2". The frequency deviation is had as the product of the two readings. If the Beat-Frequency Oscillator is to operate with a frequency deviation independent of the audio-frequency the detent spring of the ladder potentiometer is put in action by setting the switch "Const.-Variable" to position "Const.". If, however, the Beat-Frequency Oscillator is to operate with a frequency deviation that amounts to a certain percentage of the scale frequency the switch is set to position "Variable". The potentiometer arm and the main condenser are then operated by the fine adjustment knob on the right-hand side panel of the instrument. If for instance the frequency deviation is to be 5% of the scale frequency the main dial is set to 500 cycles and the potentiometer to 25 cycles. For increasing scale frequency the frequency deviation will then be approximately 5% up to about 8000 cycles, after which it becomes constantly ± 400 cycles. The frequency deviation also becomes constantly equal to ± 20 cycles at frequencies below 400 cycles, as it has proved to be most expedient to operate with constant frequency deviation at low frequencies.

Directions for modulated 1-megacycle oscillator

In the type HO12H Beat-Frequency Oscillator the built-in 1-megacycle oscillator is started by setting the switch "Off-On" to position "On". The output voltage is at the jack "HF Output" and by means of the ladder attenuator it can be adjusted to one of the following values: 1 mV - 10 mV - 100 mV - 0.3 V - 1 V.

The output impedance is about 25 ohms in the "0.3 V" position and about 10 ohms in the other positions.

In the "1 V" position the load impedance should be high in proportion to the attenuator impedance so as not to introduce modulation distortion. The 1-megacycle generator is modulated directly from the Beat-Frequency Oscillator when the impedance selector is set to "600 Ω U". At 50 volts output voltage the modulation is 100% and it decreases proportionally to the output voltage. The modulation distortion is about 2% at 95% modulation with 1000 cycles.

Replacement of tubes

Tube 1 is a type EF40 which operates as a variable oscillator. The h-f voltage on the grid point of the coil should be about 2.2 volts. In general the tube can be replaced right away, but some tubes may give rise to too much hum (as the h-f voltage proper may be modulated with 50 cycles) or to unstable frequency.

Tube 2 is a EF40 operating as a buffer amplifier for the variable oscillator and furnishing a h-f voltage of about 10 volts to the third grid of the mixer tube. Tube 2 can be replaced right away. Only very few tubes give too much hum.

Tube 3 is a type EF40 operating as a fixed h-f generator. The h-f voltage at the grid point of the coil should be about 2.2 volts. A poor tube may produce hum and also cause the oscillator frequency to make small jumps.

Tube 4 is a type EF40 operating as a buffer amplifier for the fixed oscillator. The amplification of the tube and consequently the output of the Beat-Frequency Oscillator can be altered by altering the negative voltage to the first grid of the tube. This voltage can either be an external voltage fed to the jack "Reg.Voltage" or an internal voltage developed across a dropping resistor placed in the minus lead of the d-c power supply and named "Compensation of line voltage variation" in the diagram because the output of the Beat-Frequency Oscillator is almost independent of line voltage variations of maximum $\pm 10\%$ if this resistor has the right value.

Tube 5 is a type ECH42 operating as a mixer tube. Check distortion and hum when the tube has been replaced. By varying the screen grid voltage the distortion is brought to a minimum. The potentiometer for adjustment of the screen grid voltage is mounted on the shelf beneath the main condenser. The 50 c/s hum of the output has to be brought to a minimum by means of the potentiometer named "Min. of 50 c/s hum" at the diagram. The potentiometer is located just beside the tube No. 1. If this hum can not be decreased to 0.05% at 25 volts output use another tube.

Tube 6 is a EF40 as an l-f amplifier, and it can be replaced right away. Only a few tubes cause too much hum.

Tube 7: type EF40 as a phase inverter can be replaced right away in most cases. Only very few tubes cause hum.

Tubes 8 and 9: 2 type EBL21 operating as output pentodes. Should have the same characteristic to avoid 2nd harmonics. When the tubes have been replaced connect two milliammeters between the jacks located at the tubes, and adjust the anode current plus screen grid current of the two tubes to the same value by means of the potentiometer between the tubes.

Tube 10: type EM34 as a null indicator can generally be replaced right away. The highest sensitivity is obtained by matching the cathode resistor.

Tubes 11 and 12 are type EZ40 rectifier tubes and can be replaced right away. Tube 12 should be replaced if the current through tube 14 (4687) is less than about 10 milliamps at a line voltage that is 10% below the nominal value. Tube 11 should be replaced if the anode voltage measured directly on the type EBL21 tube is less than 235 volts at nominal line voltage, as otherwise the distortion will increase heavily at great outputs.

Tubes 13 and 14: type 4687 glow-discharge voltage regulator tubes for stabilizing the anode voltage. Should be replaced if their voltage drop changes more than 1 to 2% when the line voltage varies 10%. The tubes should also be replaced when they start burning irregularly, as this irregularity may give rise to small jerky changes of the output frequency (1 cycle or less), which may be inconvenient at bridge measurements.

Tube 17 is a type EF40 operating as a reactance tube that can frequency-modulate the fixed oscillator. This tube is only employed in the Beat-Frequency Oscillator with wobbler. The tube should be selected as some tubes may cause the oscillator frequency to become unstable. When a new reactance tube has been inserted check the adjustment of the trimmer (which is directly connected to the grid of the tube) in the following way: Make the Beat-Frequency Oscillator furnish 5000 cycles and about 9.5 volts with the voltmeter in the 10 volt range. Set the switch "Frequency Deviation $\pm c/s$ " to 400 cycles, and the modulating frequency to 3.2 cycles. The meter needle must now rest completely. If not, find the setting of the trimmer where this is the case. Then the frequency deviation should be so regulated that the scale gives true readings. The easiest way to do so is by synchronizing the sweep generator of an oscillograph from another (stable) Beat-Frequency Oscillator at for instance 10 kilocycles. Feed 10 kilocycles from the H012 to the Y plates of the oscillograph so that a resting sinusoidal curve is had. Then adjust to a frequency deviation of ± 40 cycles and a modulating frequency of 12.5 cycles, and set the potentiometer in the anode of tube 18 so that an equally lighted area is had with one sinusoidal curve on the screen of the oscillograph. The sinusoidal curve must neither consists of a broad translucent band nor have an adjoining dark band. Both trimmer and potentiometer are mounted on the knee carrying the tubes 17 and 18.

Tube 18 is also a type EF40. The tube operates as an RC generator of 3.2 - 4 - 5 - 6.3 - 8 - 10 - 12.5 cycles. When tube 18 has been replaced check the adjustment of the potentiometer in the anode of tube 18 as for tube 17.

Tube 15 is a type EF42 and tube 16 is a type EF40, and they are only mounted in the Beat-Frequency Oscillators with built-in 1 Mc oscillator. EF42 operates as a 500 kc oscillator by means of the grid and the screen grid. In the anode of the tube there is a 1 Mc circuit feeding the grid of the EF40 operating as a triode. In the anode of EF40 there is another 1 Mc circuit feeding the attenuator. The d-c anode voltage of EF40 is fed from a potentiometer with slotted shaft located aside tube No. 15. When replacing one of the tubes 13, 14, 15, or 16 an adjustment will generally be necessary. The potentiometer is set so that the modulation is 100% when the output voltage of the Beat-Frequency Oscillator is 50 V with the impedance switch in position 600 Ω U. After replacement of tube 15 and 16 check the negative voltage at the grids of the tubes. They should be about minus 6 and minus 5 volts, respectively. Also check the frequency of the 500 kc oscillator. Trimming of the frequency is possible through the middle of the three holes in the bottom of the unit. The 1 Mc pentode circuit has to be adjusted so that the negative voltage at the grid of EF40 is maximum (about 5 volts). Trimming is made through the farthest hole in the bottom of the unit as reckoned from the front plate.

Finally the compensating trimmer and the iron core of the 1-Mc triode circuit are adjusted so that the distortion of the modulation is minimum at 100% modulation at which the modulation trapezium has to be a triangle with straight lines. this provides a coarse control.

Adjusting the silent range

The main tuning condenser carries an adjustable disk at the rear end of its shaft. The disk actuates a micro-switch by pressing a flexible lever. When the micro-switch is actuated, a voltage of about minus 6 volts is fed to the regulating tube (No. 4) providing for a very great attenuation of the output if the "Tone" switch is set to position "Autom". The operating range of the micro-switch can be adjusted by adjusting the opening angle of the disk.

The type H012 Beat-Frequency Oscillators supplied together with type NS3 Logarithmic Recorders carry an additional micro-switch fixed with the same screws as the first mentioned micro-switch. The second switch provides for switching off the motor of the Logarithmic Recorder after the completion of each recording in order to secure a minimum wear of the Teflon disks. The micro-switch is actuated by an adjustable clamp at the end of the peg protruding from the adjustable disk. The lever of the first mentioned micro-switch is connected to a part of the grid leak of the first output (No. 6) of the Logarithmic Recorder. When the lever is connected to chassis by means of the adjustable disk, the pen of the Recorder moves to the left-hand stop. The frequency at which this happens can be chosen at will within certain limits by loosening the adjustable disk and fixing it at the proper position. The adjustment is generally so made that the Recorder is inoperative when the dial of the Beat-Frequency Oscillator is turned beyond the 20 kc line. However, the Recorder is released again at 20 cps.

If the NS3/H012 is to be used in a Microphone Measuring Equipment, the limits are set at 16 kc and 20 cps because the condenser microphone supplied with the equipment does not operate properly at frequencies higher than 16 kc. In order not to overload the loudspeaker employed at microphone response recordings the adjustable disk is provided with an adjustable clamp of insulating material by means of which it is possible to keep the output attenuating micro-switch depressed until the bass resonance frequency of the loudspeaker has been passed. The output of the H012 Beat-Frequency Oscillator, however, is only attenuated when the "Tone" switch is at position "Autom".

