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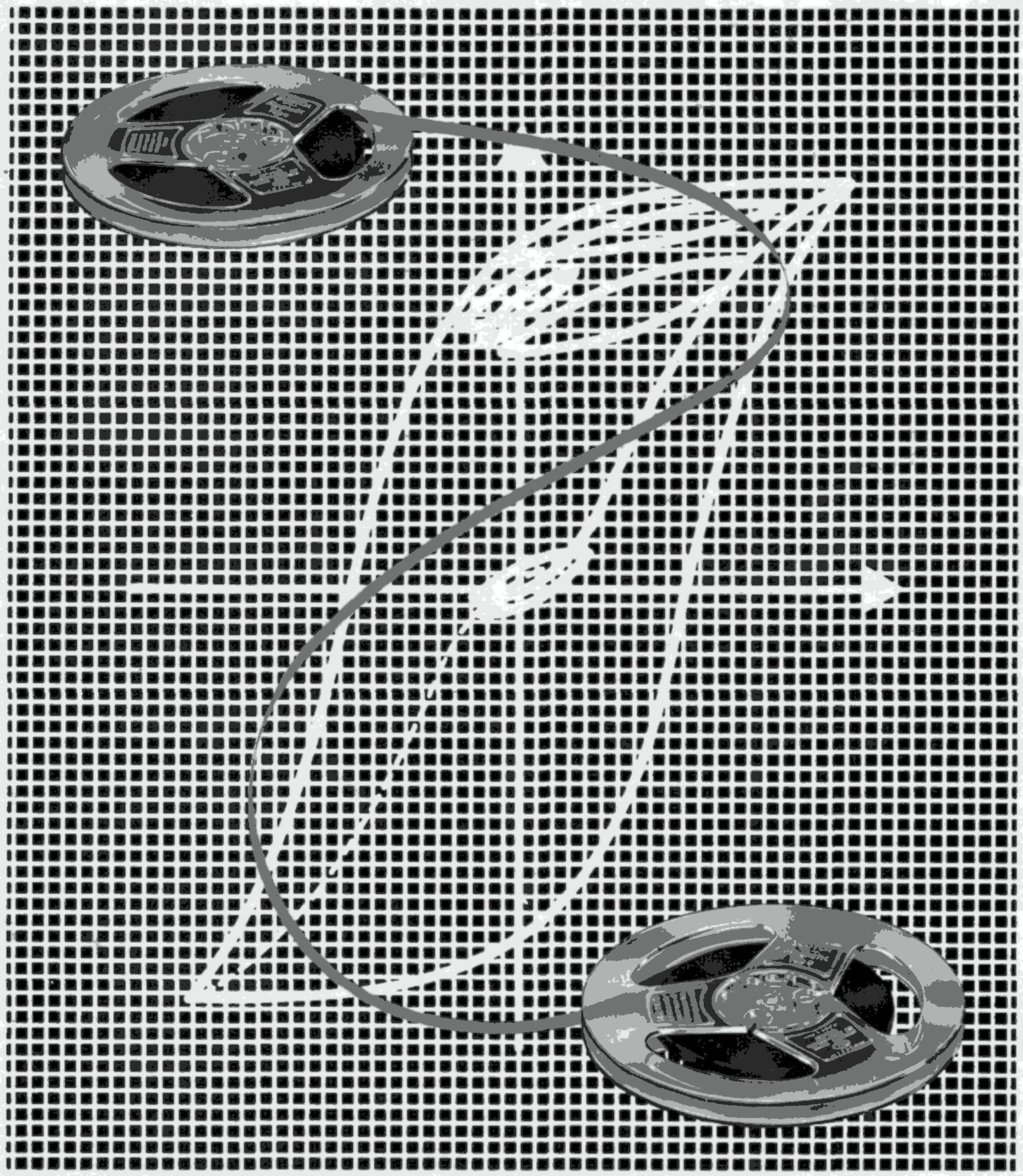

MEASUREMENTS ON TAPE RECORDERS

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# Measurement on Tape Recorders.

by

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**Summary.**

The endeavour of this article is to describe how measurements and recordings of the most characteristic properties of Tape Recorders and Heads for Tape Recorders may be carried out. The article includes recording of frequency characteristics, analysis of harmonic distortion, recording of wow and vibration of motors.

The main instrumentation for the recordings and measurements is:

The A.F. Response and Spectrum Recorder Type 3321, consisting of a Beat Frequency Oscillator Type 1014, an Audio Frequency Spectrometer Type 2109, and a Level Recorder Type 2304.

# Messungen an tonbandgeräten

**Zusammenfassung.**

Der folgende Aufsatz behandelt die Frage, wie die wesentlichen Eigenschaften eines Tonbandgerätes meßtechnisch erfaßt werden können. Er enthält Beispiele über die Messung bzw. Registrierung der Frequenzkurven, Oberwellenanalyse, Tonhöhenschwankungen und Motorschwingungen.

Das Hauptmeßgerät des Messungen ist:

Der NF-Frequenzgang- und Spektrumschreiber Type 3321, der von dem Schwebungssummer Typ 1014, dem Terzfilter-Analysator Type 2109 und dem Pegelschreiber Typ 2304 besteht.

# Mesures sur des enregistreurs sur bande

**Résumé.**

Le but de cet article est de décrire comment on peut procéder aux mesures et aux enregistrements de la plupart des caractéristiques des enregistreurs sur bande.

L'article traite de l'enregistrement des caractéristiques de fréquence, de l'analyse de la distorsion harmonique, de l'enregistrement du pleurage et des vibrations des moteurs.

L'appareil le plus important pour les mesures est:

L'enregistreur automatique de réponse en fréquence et de spectre type 3321, composé de l'oscillateur basse-fréquence 1014, de l'analyseur de fréquences 2109 et de l'enregistreur de niveau 2304.

**Tape Recorders.**

The Tape recorders on which the different recordings are taken were: Type E with combinated record-reproduce head and two tape speeds: $3^3/_4$″/sec and $7^1/_2$″/sec.

Type L with separated record and reproduce head and two tape speeds: $1^1/_2$″/sec and 15″/sec.

**Frequency Response.**

The frequency response of any tape recorder may be recorded by means of the set-up shown in fig. 1. From the Beat Frequency Oscillator (B.F.O.) in the

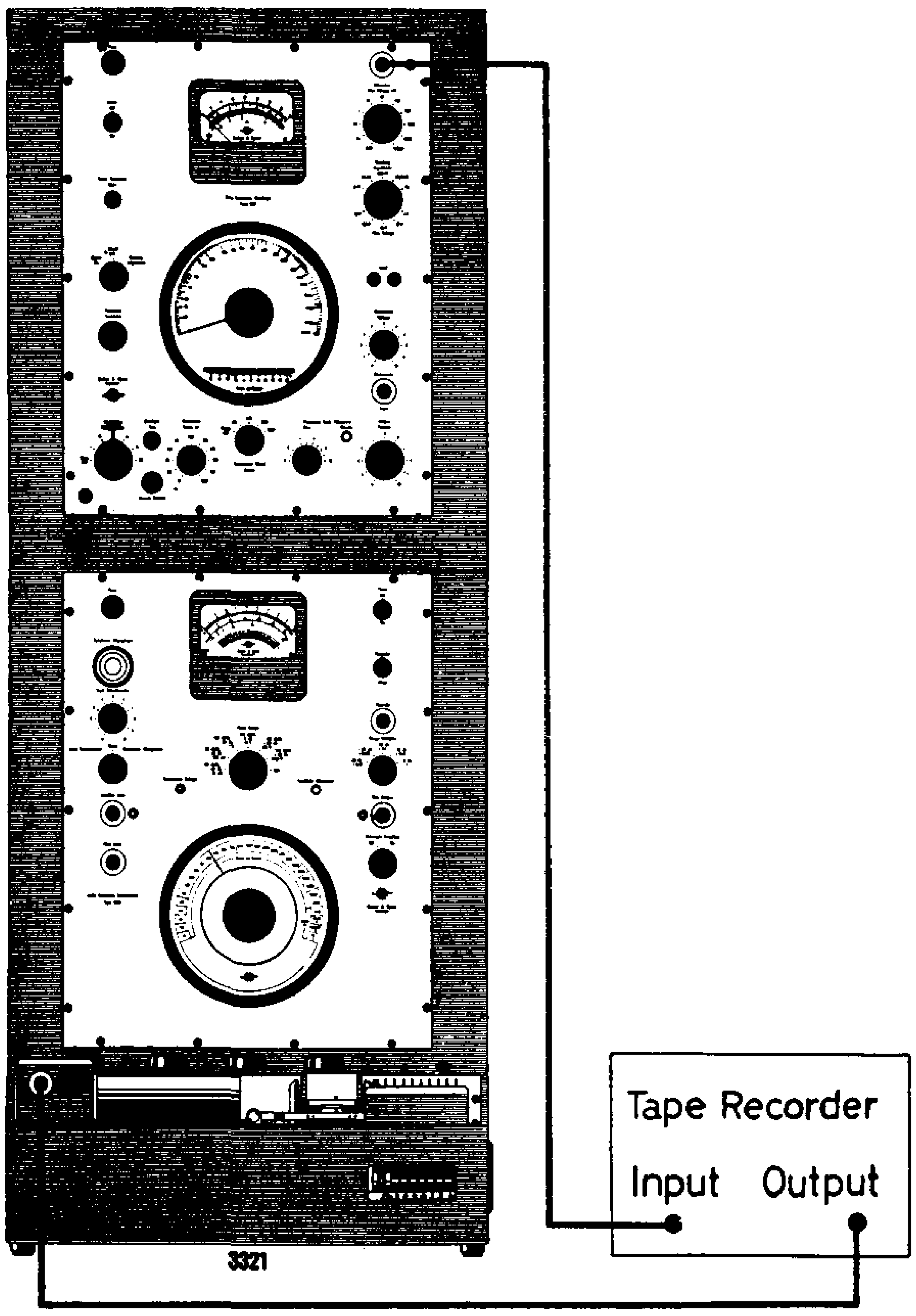



*Fig. 1. Set-up for recording of frequency characteristic, using the A.F. Response and Spectrum Recorder Type 3321.*

A.F. Response and Spectrum Recorder Type 3321 the input signal which automatically sweeps the frequency range 20—20.000 c/s is taken. The output signal from the tape recorder is recorded by the Level Recorder in 3321 on preprinted recording paper, the abscissa of which has a logarithmic frequency scale from 20 c/s to 20.000 c/s and with a linear db-scale as axis of ordinates.

For this recording the Automatic Frequency Response Recorder Type 3302 may be used as well. Fig. 2 shows the apparatus which consists of the B.F.O Type 1014 and the Level Recorder Type 2304.

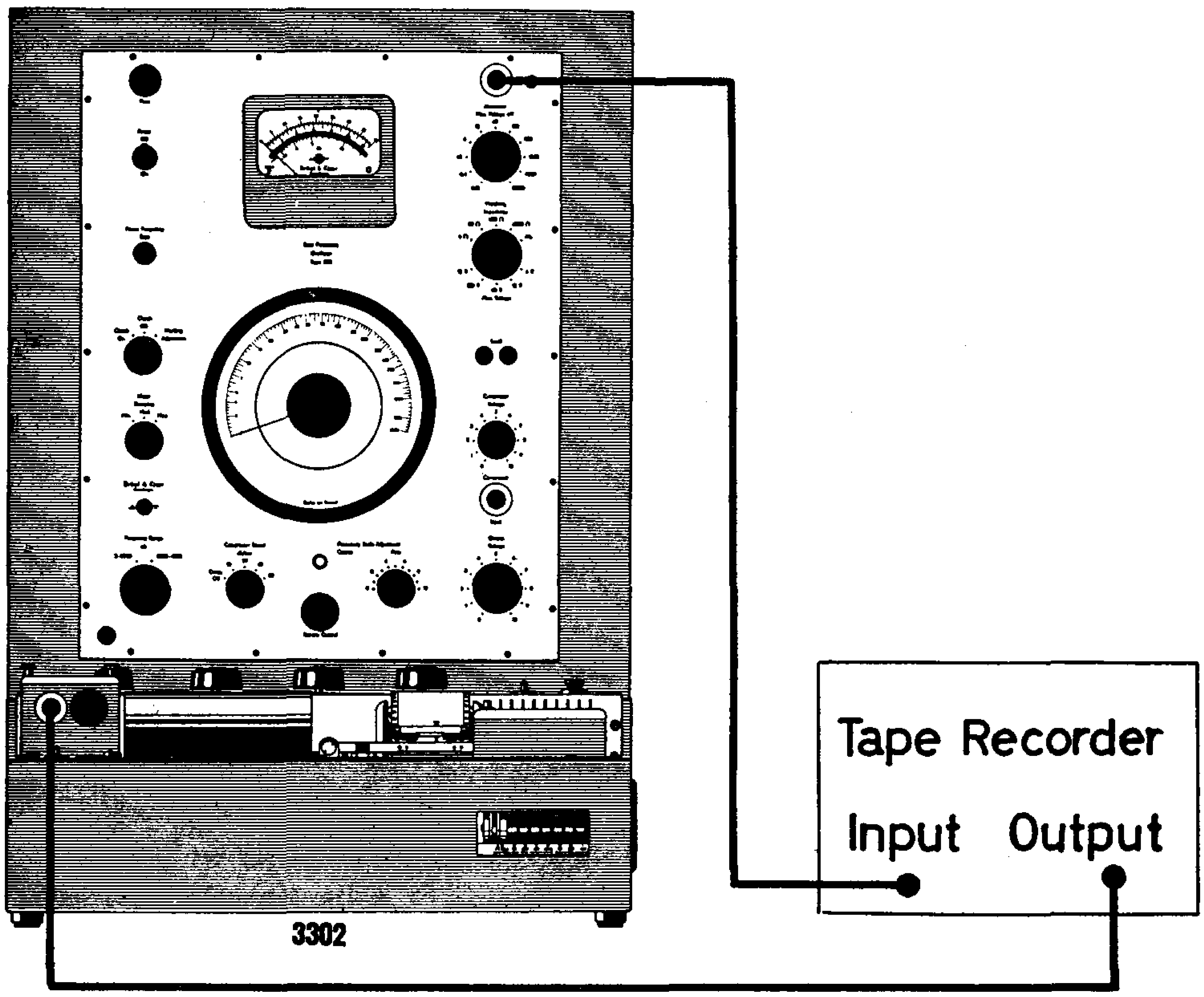



*Fig. 2. Same as fig. 1, but using the Frequency Response Recorder Type 3302*

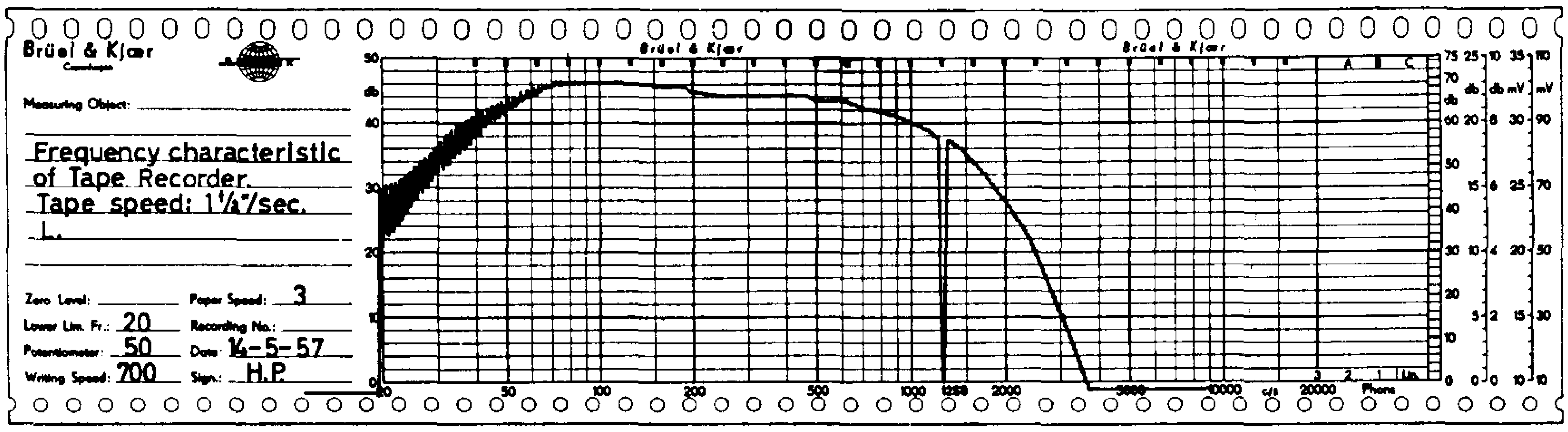
The problems concerning the synchronization of the output signal from the tape recorder and the paper drive of the Level Recorder must be considered with respect to the two different types of tape recorders:

1. Tape recorders with separated record head and reproduce head, and
2. Tape recorders with a single record-reproduce head.

When measurements are taken on the tape recorders group 1 attention must be paid to the delay-time due to the spacing between the record head and the reproduce head. As this delay-time is constant within the same type of tape recorders the adjustment of the set-up, once carried out, holds good for all succeeding tape recorders under test.

The adjustment may be carried out by first measuring the delay-time expressed in "frequency displacement" and then accomplishing the correction. This may be done by marking a predetermined frequency by means of the "Marking Adjustment" of the BFO, and turning the frequency scale pointer of the BFO to that position which corresponds to the stylus position of the

Level Recorder. With the clutch operation knob of the BFO in position "Clutch on" a frequency response as shown in fig. 3a is recorded. As the marked frequency is $f_0 = 1.000$ c/s the delay-time is found to be $f_1 - f_0 =$



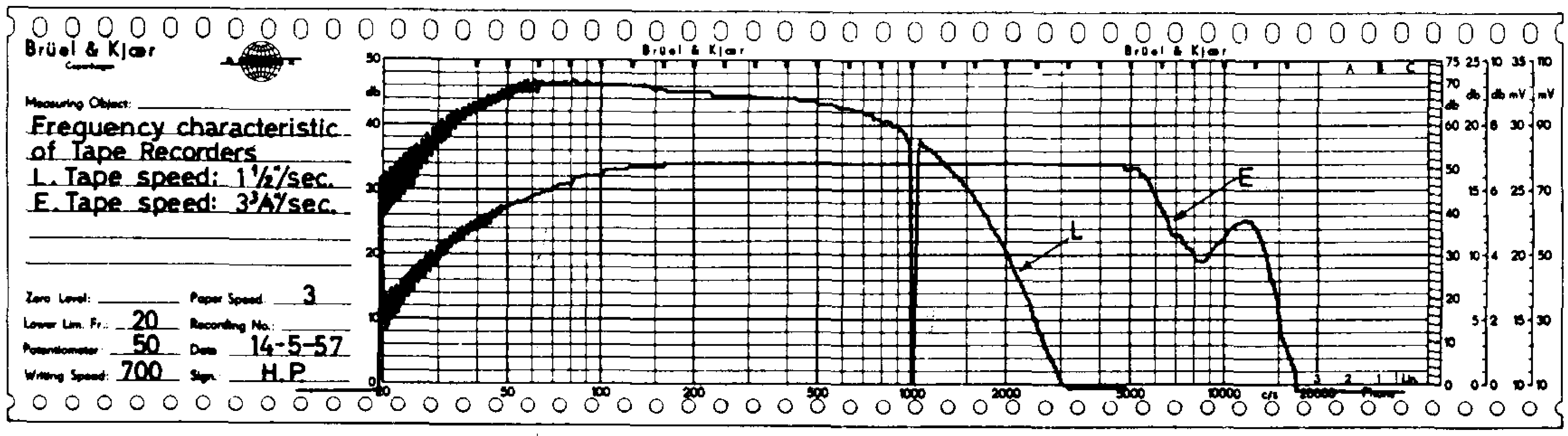




*Fig. 3. a) Frequency characteristic recorded by means of the set-up in fig. 1. No delay-time correction is carried out.*
*b) Same as a) with correction for delay-time.*

(1.250 — 1.000) c/s. The actual correction is now made by turning the frequency scale pointer of the BFO clockwise an angle "a" between $f_0 = 1.000$ c/s and $f_1 = 1.250$ c/s on the frequency scale. The adjustment has been carried out on the frequency response shown in fig. 3b.

When recordings of the frequency characteristics of tape recorders with only one head are taken, no delay-time correction is possible. The desired synchronism between the magnetic tape and the Level Recorder may then be obtained complying with the following procedure.

A frequency $f_2$ is recorded for 1 minute. The oscillator of the BFO is stopped by pressing the button marked "Oscillator Stop" and the automatic sweep is clutched in 30 sec. later. When reproducing, the signal $f_2$ is used for level adjustment of the Level Recorder, the 30 sec "dead-time" for making the set-up ready for use, and then the motor of the Level Recorder is started exactly at the end of the "dead-time". For checking purpose use a marked frequency. As the frequency sweep starts at 20 c/s the recording paper naturally must be adjusted to start at the 20 c/s point on the axis of abscissa. In fig. 4 a frequency characteristic obtained according to this procedure is shown. The marked frequency is $f_0 = 1.000$ c/s.

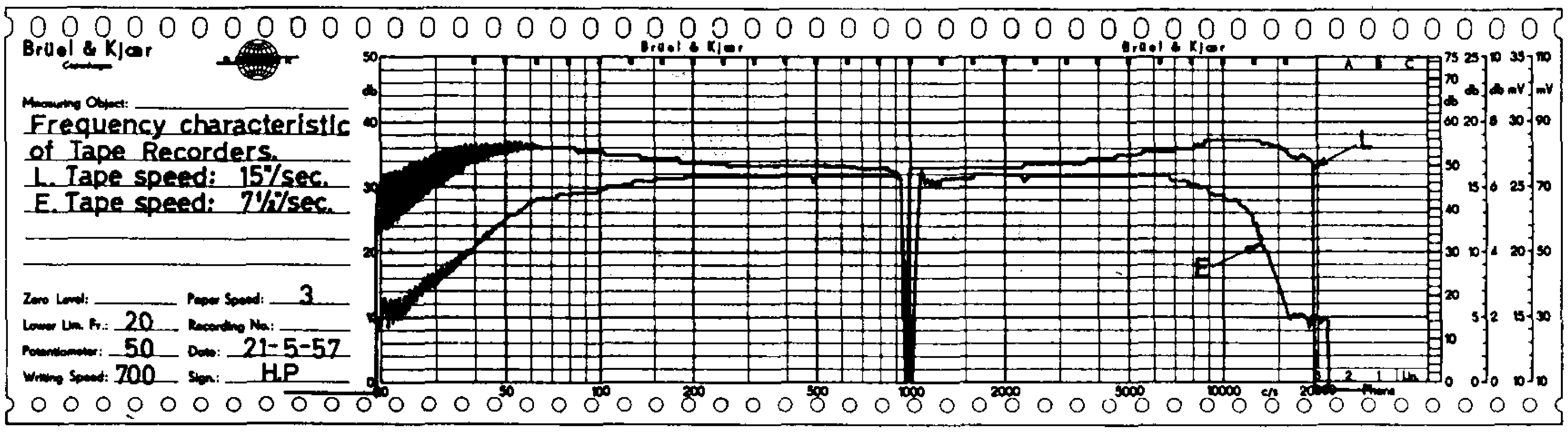



*Fig. 4. Frequency response recorded by means of the set-up shown in fig. 1 using a tape recorder with combinated record-reproduce head.*

For production control where no printed recordings are wanted, the Frequency Response Tracer Type 4707 (fig. 5) may be used. The Response Tracer mainly consists of a beat-frequency oscillator and a long persistent cathode ray tube on which the frequency characteristic of the object under test is drawn. The cathode ray tube is supplied with a rectilineal axes of coordinates, the abscissa has a logarithmic frequency scale and the ordinate has a linear db scale covering the range from 0—50 db.

**Distortion.**

The frequency response of the tape recorder may also be recorded as shown in fig. 6. Furthermore, this set-up enables recording of the content of harmonics versus frequency to be carried out. As before, the BFO is used as signal source sweeping the a.f. range. The output of the tape recorder is fed to the "Input" terminal of the Audio Frequency Spectrometer in the A.F. Response and Spectrum Recorder Type 3321. From the Spectrometer the signal consisting of the frequencies within one third-octave around a mid-frequency selected by the filter switch of the Spectrometer is fed to the Level Recorder. The Audio Frequency Spectrometer mainly consists of 27 fixed third-octave band-pass filters for the standardized main frequencies and two low-noise amplifiers. Successively, the filters can be switched in, either automatically by means of the motor in the Level Recorder in type 3321, or manually.

Where measurements on tape recorders group 1 (separate heads) are carried out, the correction obtained by the set-up shown in fig. 1 holds good also for this set-up. Thus the recording procedure is firstly to synchronize the BFO, the Spectrometer and the Level Recorder, and next to turn the frequency

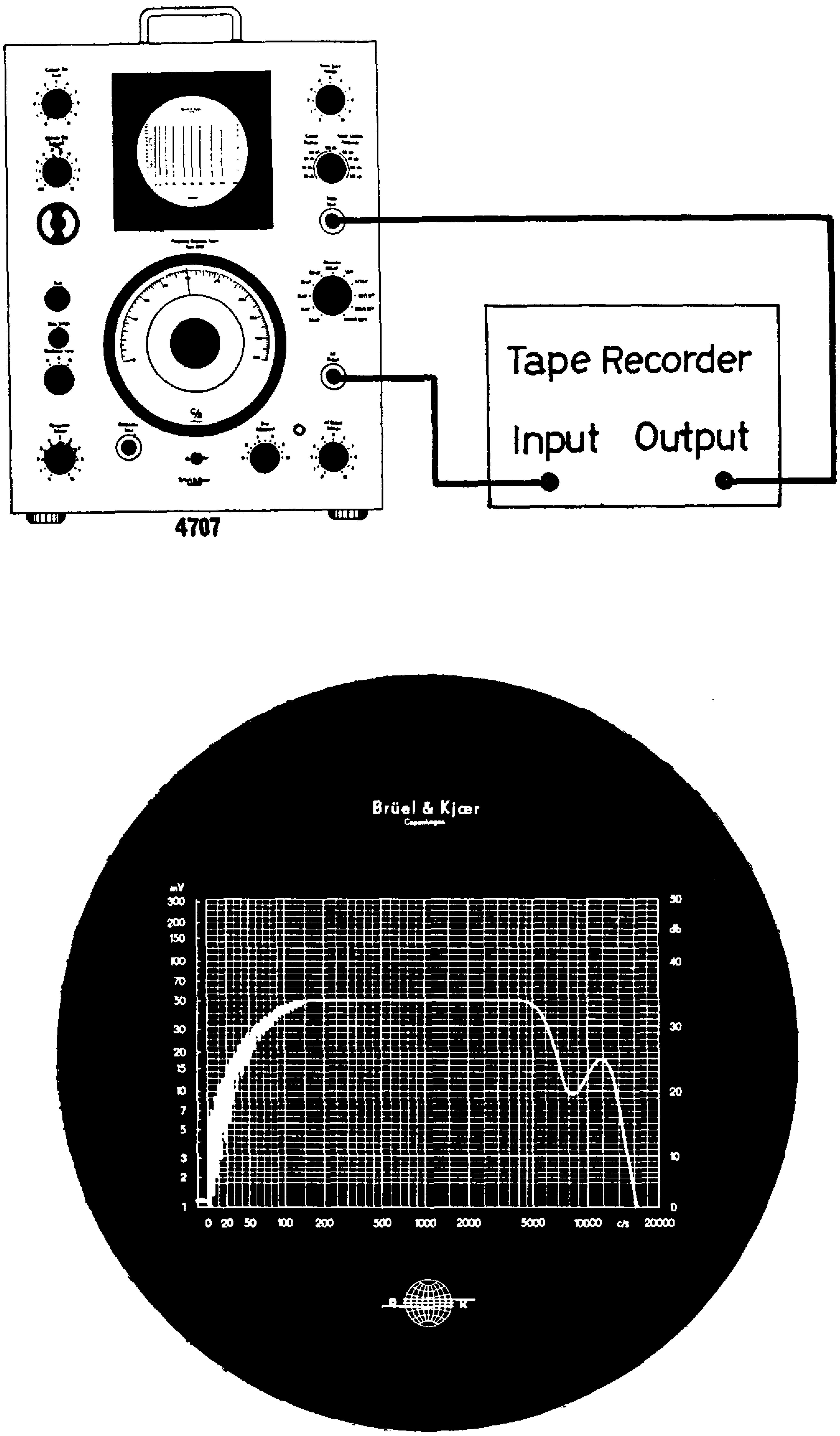



*Fig. 5. Set-up showing the Frequency Response Tracer Type 4707, and enlarged a picture of the screen with a typical response curve.*

dial pointer of the BFO clockwise the known correction. When synchronizing the BFO, the Spectrometer and the Level Recorder the most convenient

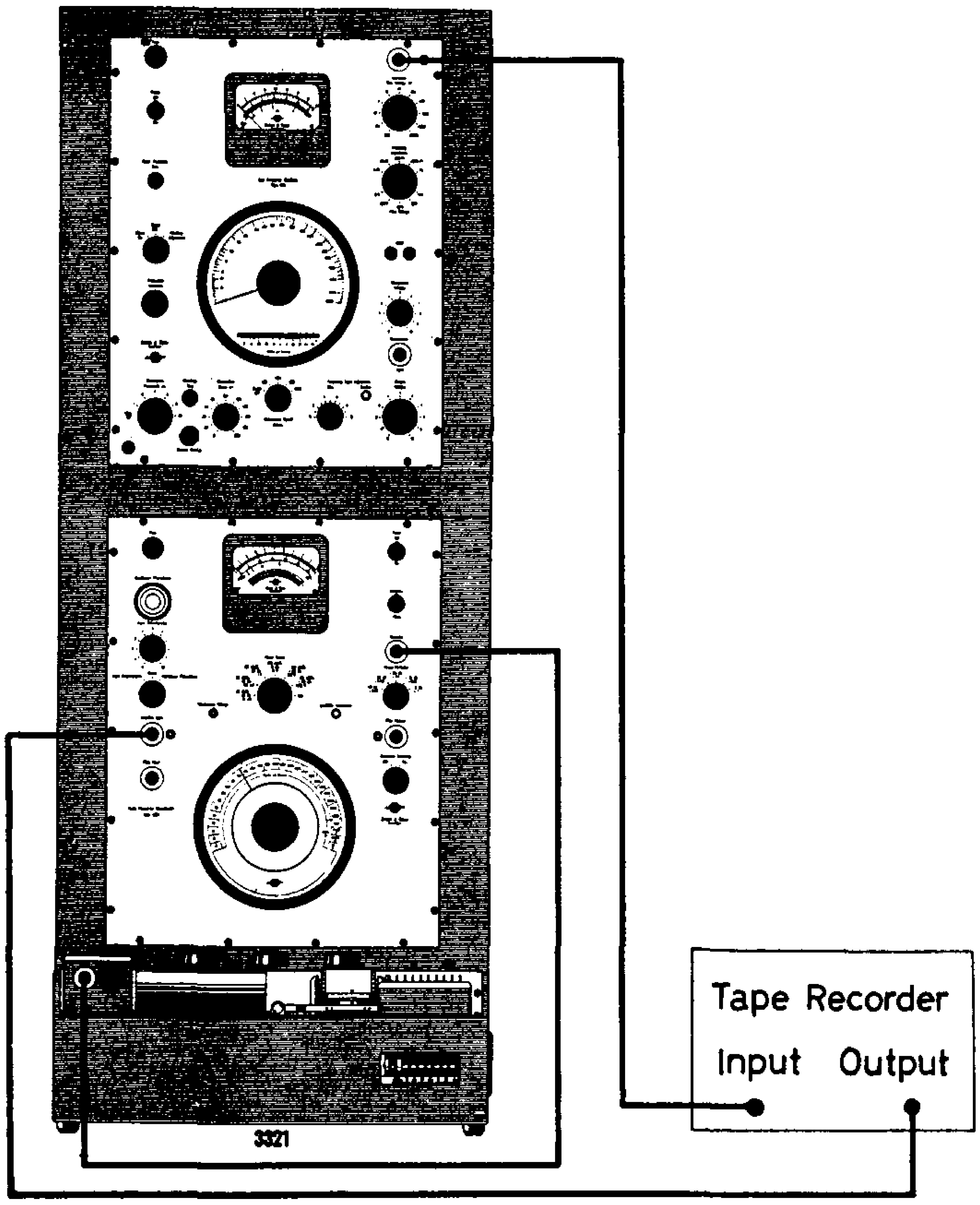



*Fig. 6. Set-up for recording of frequency response and harmonic distortion.*

procedure is to synchronize the BFO and the Spectrometer by altering the actual position of the Frequency scale pointer of the BFO, until the filter curves are recorded correctly. It is very important that the adjustment of the BFO itself is carried out very carefully. The motor of the Level Recorder is

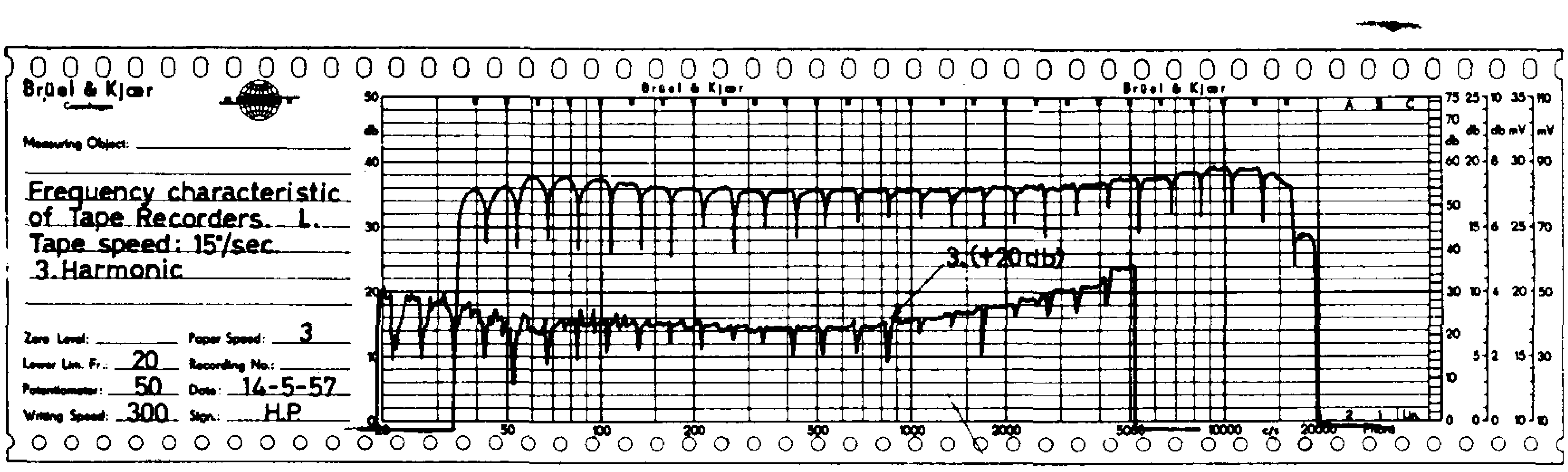



*Fig. 7. Frequency characteristic and third harmonic recorded by the set-up shown in fig. 6. The zero level of the third harmonic is raised 20 db re the zero level of the fundamental.*

stopped and the recording paper is placed so that the position of the stylus corresponds to the position of the frequency pointer of the BFO. As the distance between two holes in the perforation of the recording paper differs from the paper shift corresponding to the distance between two teeth on the thooted wheels of the gear-box, it is possible to find a combination which gives the correct position of the recording paper. According to this procedure a frequency response as shown in fig. 7 is obtained. The influence of the third-octave filters is seen.

If the filter-switch of the Spectrometer is now turned clockwise 3 positions (f. inst. from the 50 c/s to the 100 c/s filter) the frequency recorded by the Level Recorder is the second harmonic of the output signal from the tape recorder. By turning the filter switch clockwise 5 positions and readjusting the frequency scale pointer of the BFO (the mid-frequency of the filter 5 positions up on 50 c/s is 160 c/s and not 150 c/s), recording of the 3. harmonic is obtained. Fig. 7 shows the third harmonic of the output voltage from

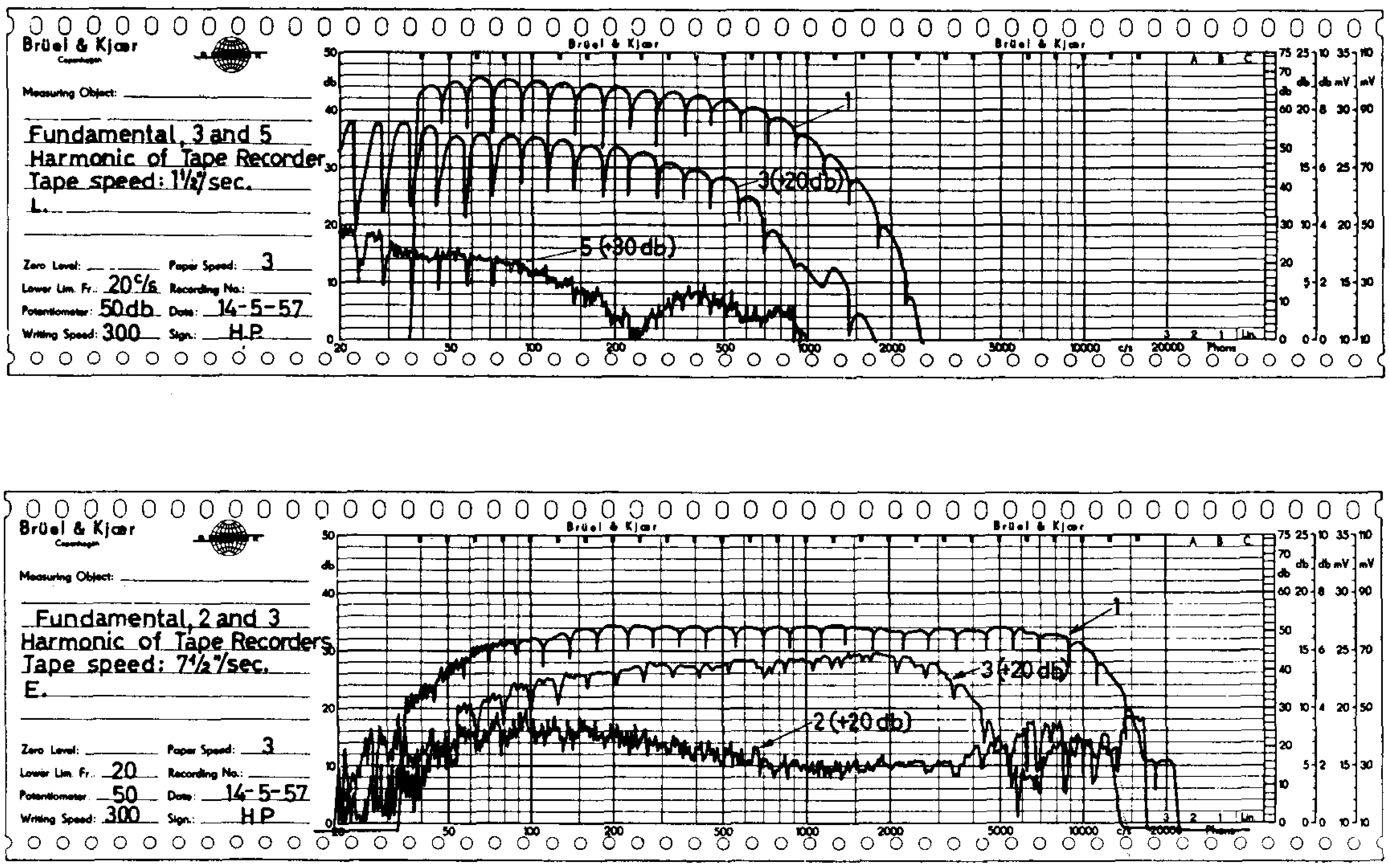



*Fig. 8. Recording of a frequency response and harmonics obtained by the set-up shown in fig. 6.*

a tape recorder. The zero level of the 3. harmonic is raised 20 db compared with the fundamental. No recording of the even harmonics is shown, as the relative level of these were too small to be recorded. Measurements of these small harmonics are discussed below. Furthermore, the level of the 5. harmonic was lower than the noise level.

To obtain synchronism for the similar recordings carried out on tape recorders with only one head, the procedure described on page 4 is followed, and in fig. 8 is shown the frequency response, the third and the fifth harmonic, the zero levels of which are increased 20 db and 30 db respectively.

As mentioned above, the relative level of the harmonics may be too small to be recorded. If the filter switch is turned clockwise 3 positions the mid-frequencies are displaced 1 octave in the direction of higher frequencies. As may be seen from fig. 9 which shows a detailed filter characteristic of the

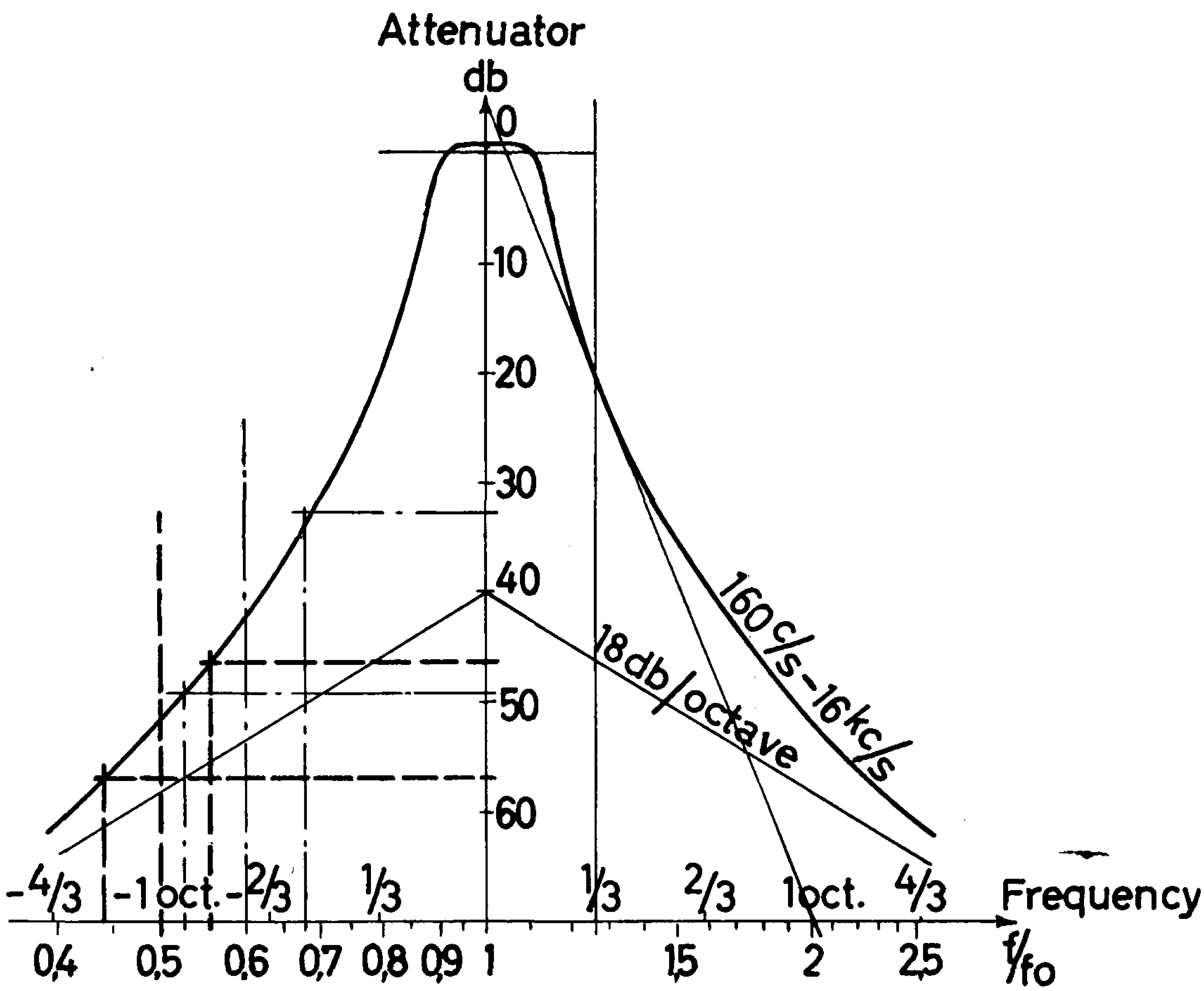



*Fig. 9. Detailed filter characteristics of the Spectrometer Type 2901.*

Spectrometer, this displacement [dotted lines] causes an attenuation of the fundamental of about 50 db, whereas the value of the second harmonic is not decreased. As each filter is $^{1}/_{3}$ octave the minimum attenuation of the fundamental is seen to be 45 db and the maximum value 57 db. Consequently, if the fundamental must not interfere with the recording of the second harmonic at all, the latter must at most be 45 db below the fundamental or expressed in %, approx. 0.6 % of the fundamental. If a second harmonic smaller than 0.6 % is recorded the result obtained is seen on fig. 10 which shows a recording of the presumed second harmonic. The zero level of this recording is increased 20 db relative to the fundamental in fig. 7. For frequencies about 500 c/s the peaks which are seen to be 45 db below the fundamental, are the very fundamental recorded on the slope of the filter curve, and not the second harmonic.

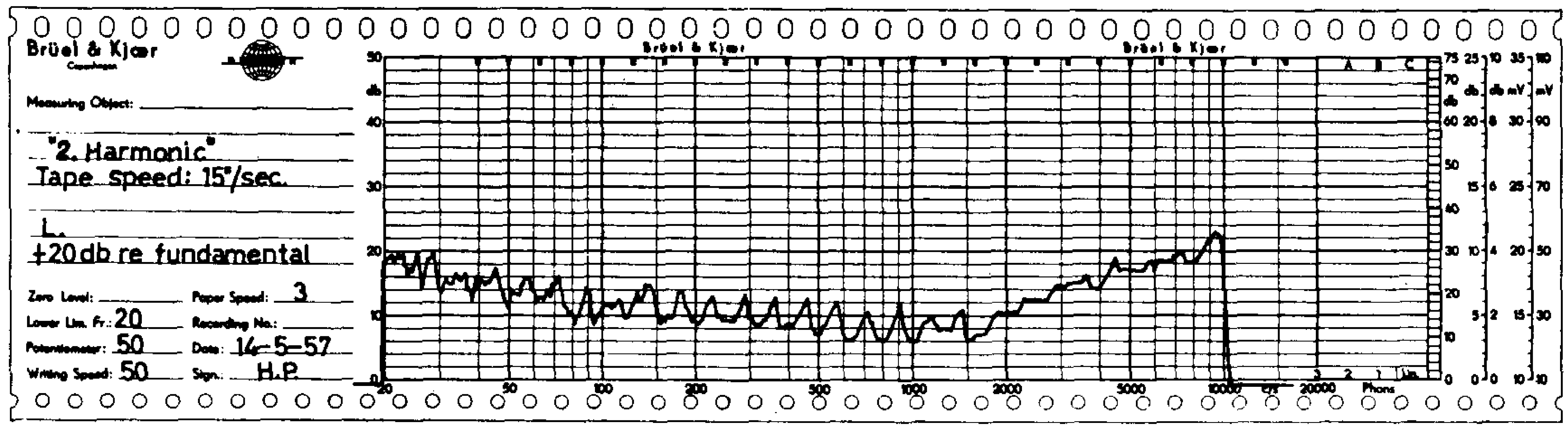



*Fig. 10. Recording obtained with the filter switch of the Spectrometer turned clockwise 3 positions as for recording the second harmonic. The recording below 4.000 c/s is the fundamental attenuated by the filter one octave up.*

When the filter switch is turned clockwise 5 positions recording the third harmonic, the second harmonic lies 3/4 octave below the mid-frequency of the filter in use [dot- and dash-lines]. Analogous with the procedure described above it is seen that the recording of the third harmonic is disturbed by a second harmonic which is more than 32 db up on the third (the third harmonic is then 2.5 % of the second).

As the spacing between the 3. and the 4. harmonic is $4/3 \times 1/2 = 2/3$ octave between the 4. and the 5. 5/8 octave, the 5. and the 6. 3/5 octave and so on, it is obvious that the interferences caused by the preceeding harmonic increases with increase in order of harmonic being measured. In the example given in fig. 7 the 3. harmonic was too vigorous to allow recording of the 4. harmonic.

By means of the set-up shown in fig. 11 the harmonics which are outside the limits of the measuring set-up shown in fig. 5 may be measured. However, this set-up does not enable an automatic recording of the harmonics, but allows only the distortion of single frequencies to be measured. In fig. 11, the output voltage of a tape recorder (a single frequency of convenient duration) is analyzed by means of the Frequency and Distortion Measuring Bridge Type 1602 which mainly consists of a very selective damping network for a.f., and the Frequency Analyzer Type 2105. By means of the Distortion Measuring Bridge the fundamental is attenuated approx. 80 db, and the harmonic components can be measured by means of the Frequency Analyzer.

The results obtained are shown in table 1. As was to be expected due to the magnetic circuit the third harmonic is far the most prevailing. Also here the 5. harmonic was found to be below the noise level, the spectrogram of which is recorded in fig. 12.

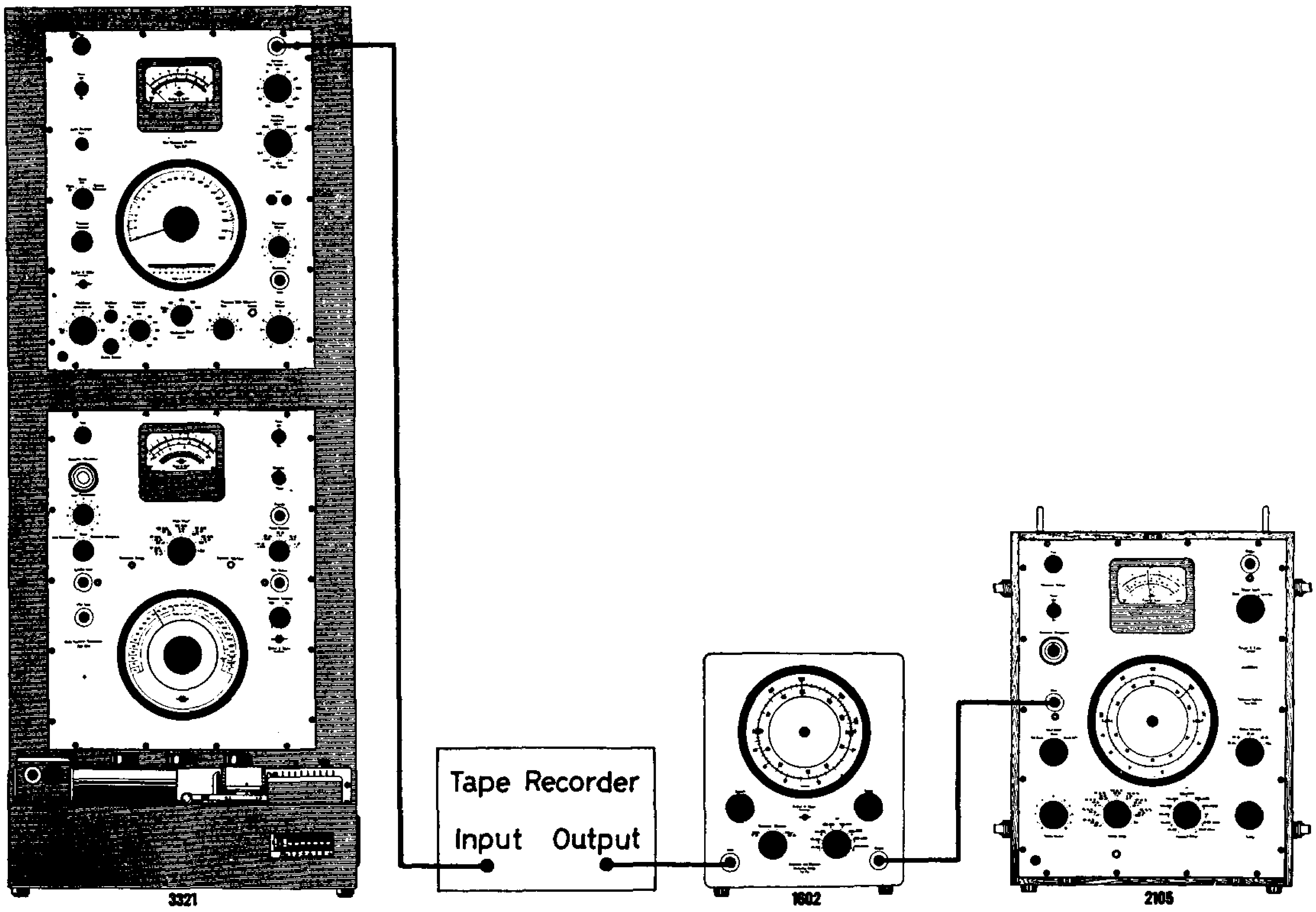



*Fig. 11. Set-up for measuring very small harmonic distortion of single frequencies, using the Distortion Measuring Bridge Type 1602 and the Frequency Analyzer Type 2105.*

| Order of Harmonic | Frequency c/s | Attenuation db | % of fundamental |
|---|---|---|---|
| 1 | 500 | 0 | 100 |
| 2 | 1.000 | 50 | 0.3 |
| 3 | 1.500 | 41 | 0.9 |
| 4 | 2.000 | 58 | 0.12 |
| 5 | 2.500 | > 65 | — |

*Table 1. Distortion of tape recorder L measured by means of the set-up in fig. 11.*

**Wow.**

To record the wow, the set-up shown in fig. 13 may be used. The principle of the measurement is that the frequency-variations are transformed into voltage-variations by means of the slope of a suitable filter of the Spectrometer.

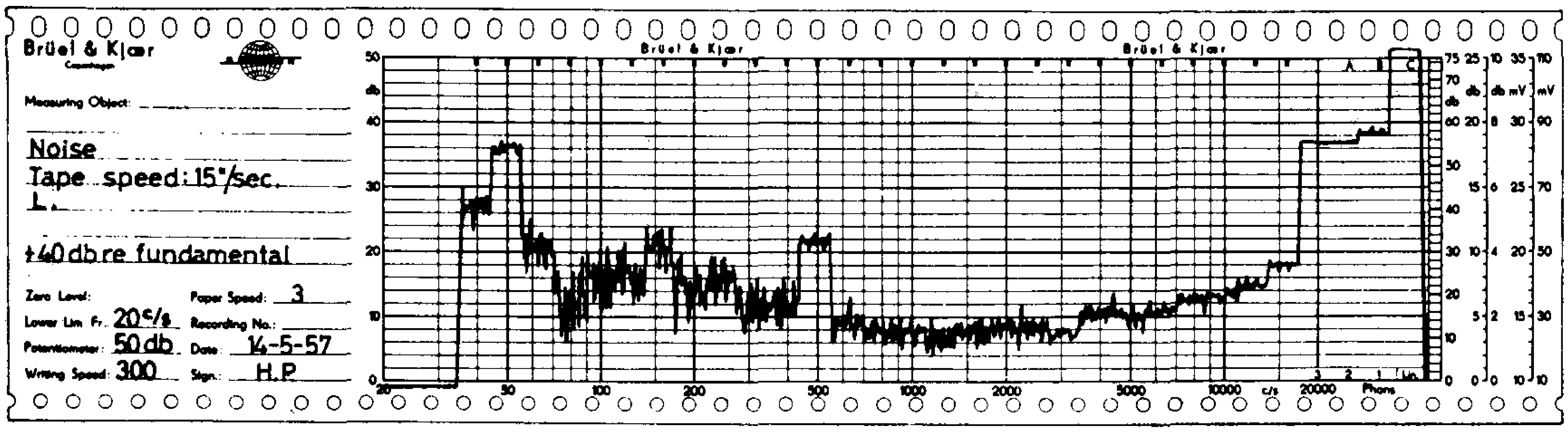



*Fig. 12. Noise from the tape recorder measured with the Spectrometer. Tape-speed 15"/s.*

Let us presume that a certain frequency $f_2$ is recorded on the tape recorder. The reproduced voltage of the tape recorder is then via an amplitude-limiting network fed to the Spectrometer, the filter switch of which is displaced clockwise one position relative to the filter with mid-frequency $f_2$. A frequency-variation of $^1/_3$ octave is then transferred into a voltage variation of approx. $^1/_3 \times 75 \sim 25$ db as the average slope of the filter-curve is about 75 db/octave in this area (fig. 9). However, with the filter-switch in this position the function voltage-variation versus frequency-variation is not quite linear. To improve linearity the operation procedure becomes a little more complicated, but once carried out the adjustment necessary previous to similar measurements is extremely simple. The filter switch is turned to a frequency $f_0$. With the output voltage of the BFO directly fed to the Spectrometer input, the BFO is adjusted to that frequency $f_1$ ($f_1 \sim f_0$) for small variations of which the most linear voltage variation is obtained. By future adjustments the filter switch is set to position $f_0$ and the frequency scale pointer of the BFO to $f_1$.

For calibration and adjustment of the complete set-up the "Frequency Increment" knob of the BFO is used. This knob operates a pointer on an "Incremental Scale" which allows exact frequency selection in the range —50 to +50 c/s for any setting on the main scale.

As the recording paper in use must be without preprinted lines as the position of the lines depends on the slope of the filter curve in use, a calibration of the paper is necessary previous to recording.

The amplitude limiting network is necessary to cut off the probable amplitude modulation which occurs simultaneously with the frequency modulation To check the function of the limiting network a set-up as shown in fig. 14

may be used. The attenuator output of the BFO is loaded by a variable capacitive voltage-divider. Driving the variable capacity by a motor the speed of which can be adjusted to different values, a pure amplitude modulation with variable modulation frequency is obtained. The amplitude limiting network should then cut-off these variations as shown in fig. 15. Here the

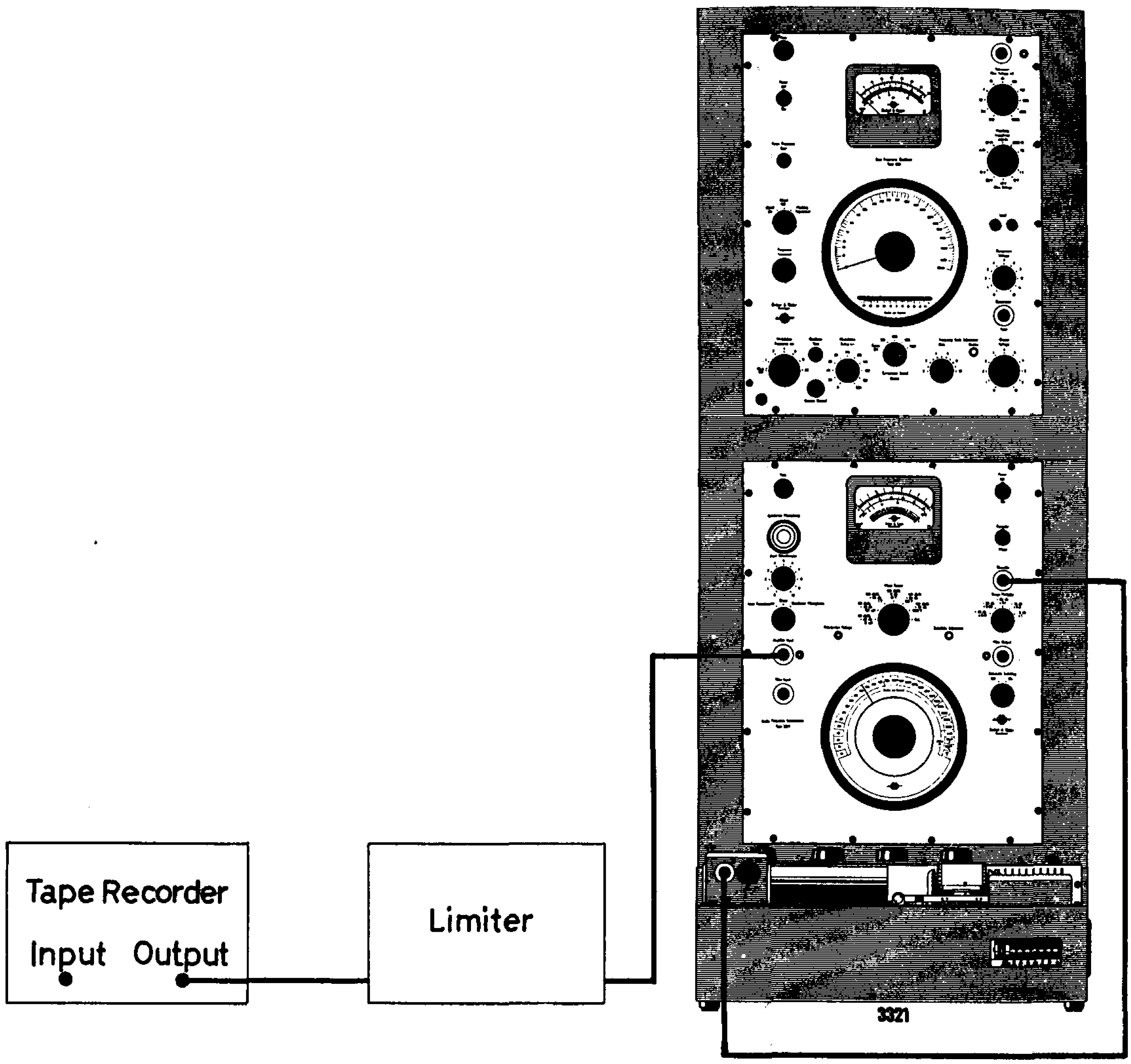



*Fig. 13. Set-up for wow-recording, using a simple amplitude limiting network and 3321.*

amplitude of the modulating frequency is seen both without and with limiting network. The recording is made with the carrier-frequency (BFO-frequency) $f_1 = 5.000$ c/s and a depth of modulation of approx. 1 %. The filter slope used was the 4.000 c/s filter of the Spectrometer and a linear "10—35" potentiometer was used on the Level Recorder.

To find the optimum combination of the "Potentiometer db Range" and the "Writing Speed" setting of the Level Recorder, a pure frequency modulated signal with known depth of modulation is recorded. This signal may be

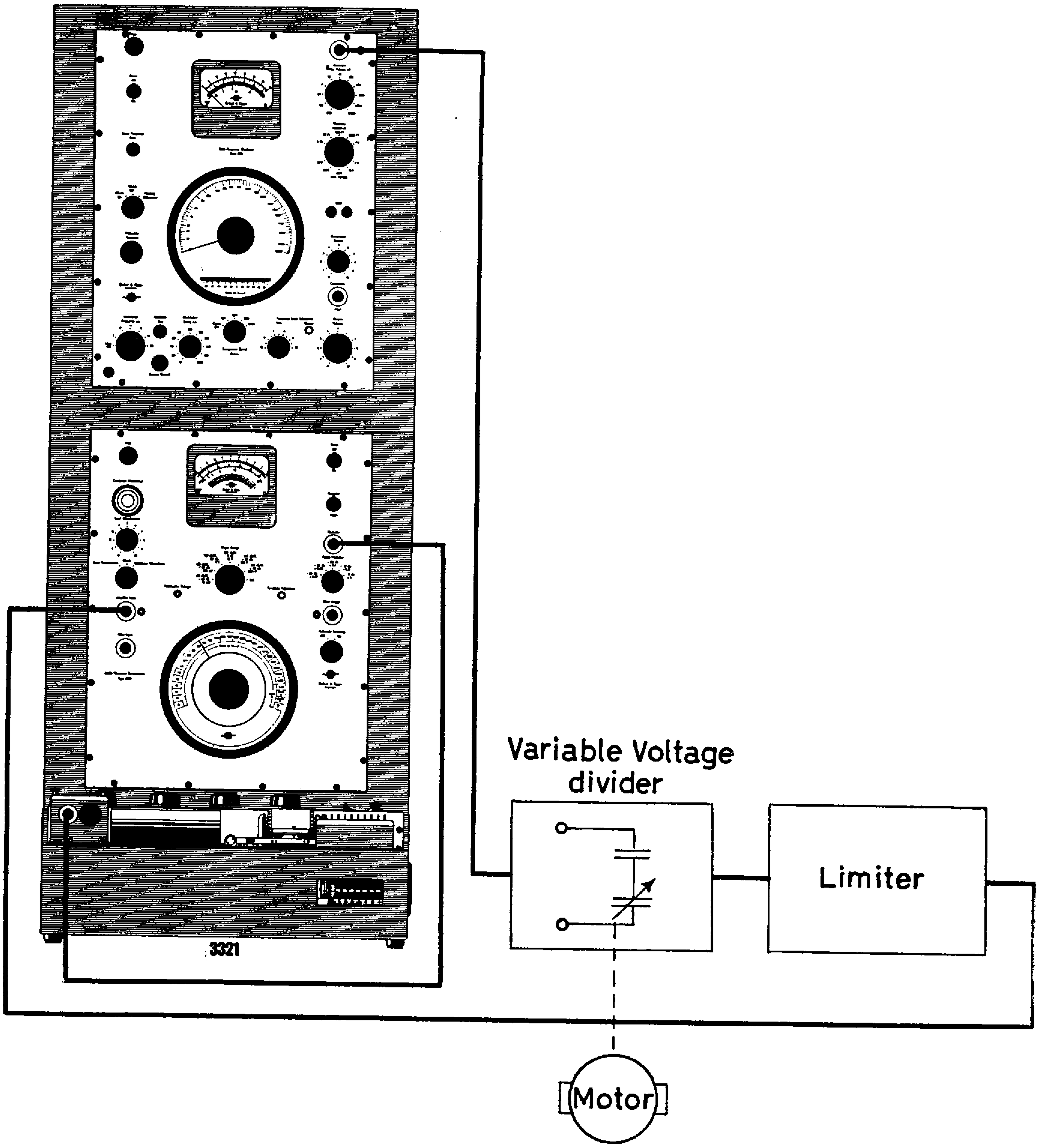



*Fig. 14. Set-up for checking the amplitude limiting network.*

produced by paralleling the variable capacitor of the BFO with an external motordriven capacitor and using the "Attenuator" output terminals of the BFO as signal output. It was found that "15 db" on the "Potentiometer db

Range" and "700 mm/s" on the "Writing Speed" was the most convenient setting of the knobs, for modulation frequencies up to 18 c/s.

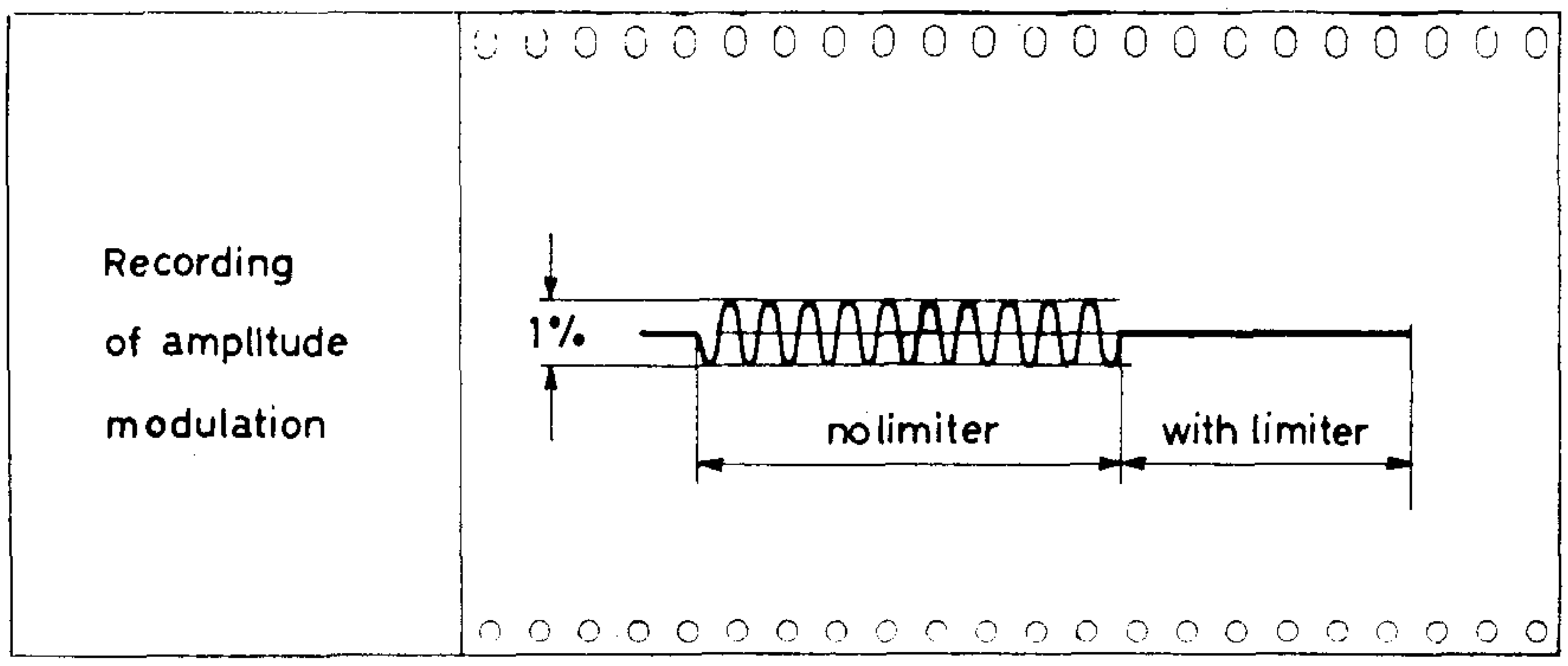
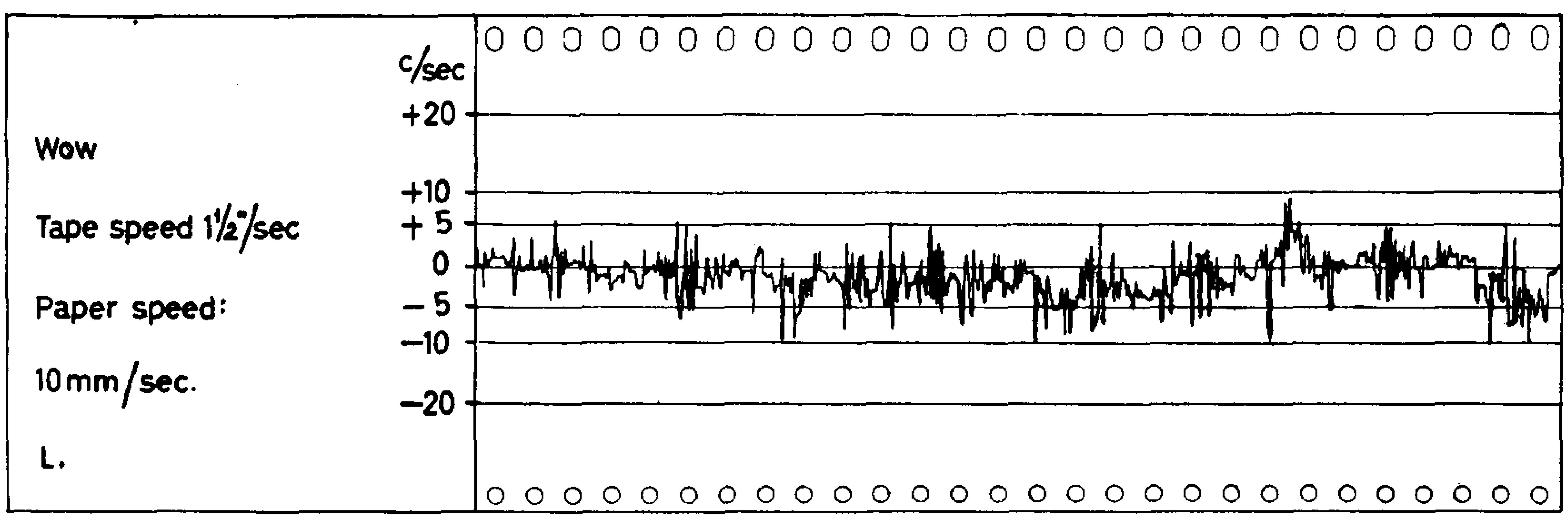



*Fig. 15. Recording of amplitude modulation with and without amplitude limiting network supplied. "10—35" linear potentiometer is used.*



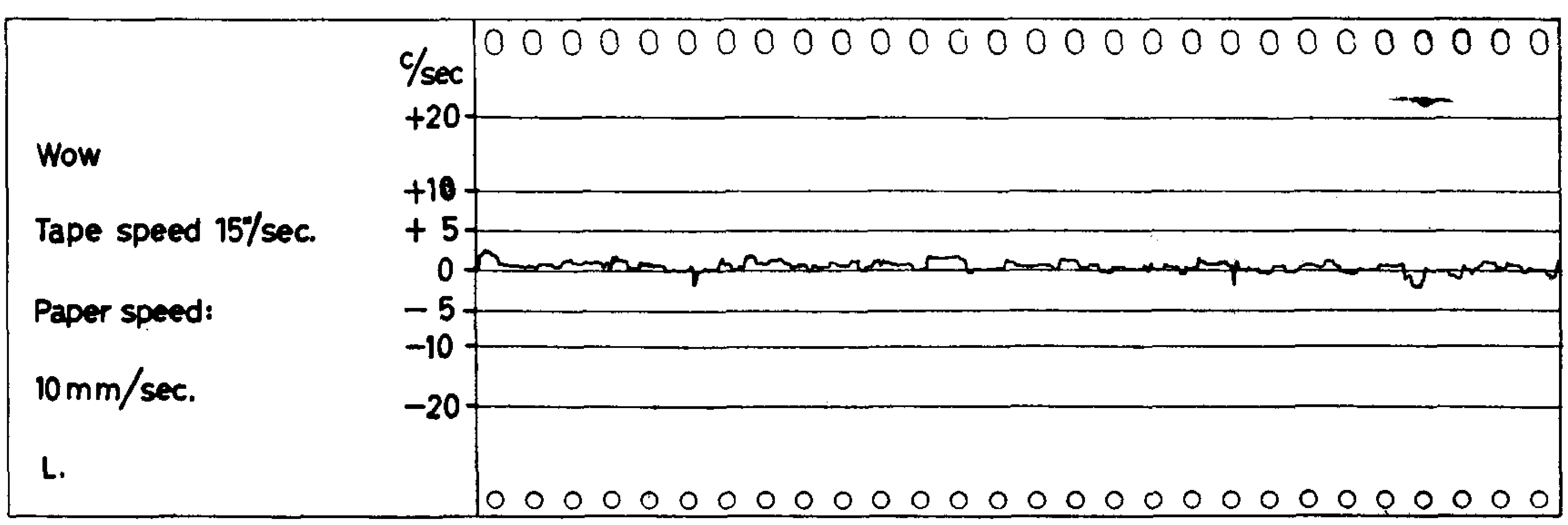




*Fig. 16 a-b. Recording showing the wow as a function of time. The frequency modulation is transferred into "amplitude modulation" by means of the slope of a filter in the Spectrometer. A linear potentiometer "10—35" was used on the Level Recorder. The wow is recorded on the basis of 1.000 c/s.*

Fig. 16 shows the wow of the tape recorder recorded by means of the set-up described above. As the recorded mid-frequency was found to $f_1 = 960$ c/s, the deviations $\pm 5$, $\pm 10$, and $\pm 20$ c/s correspond to 0.52, 1.05, and 2.09 % wow.

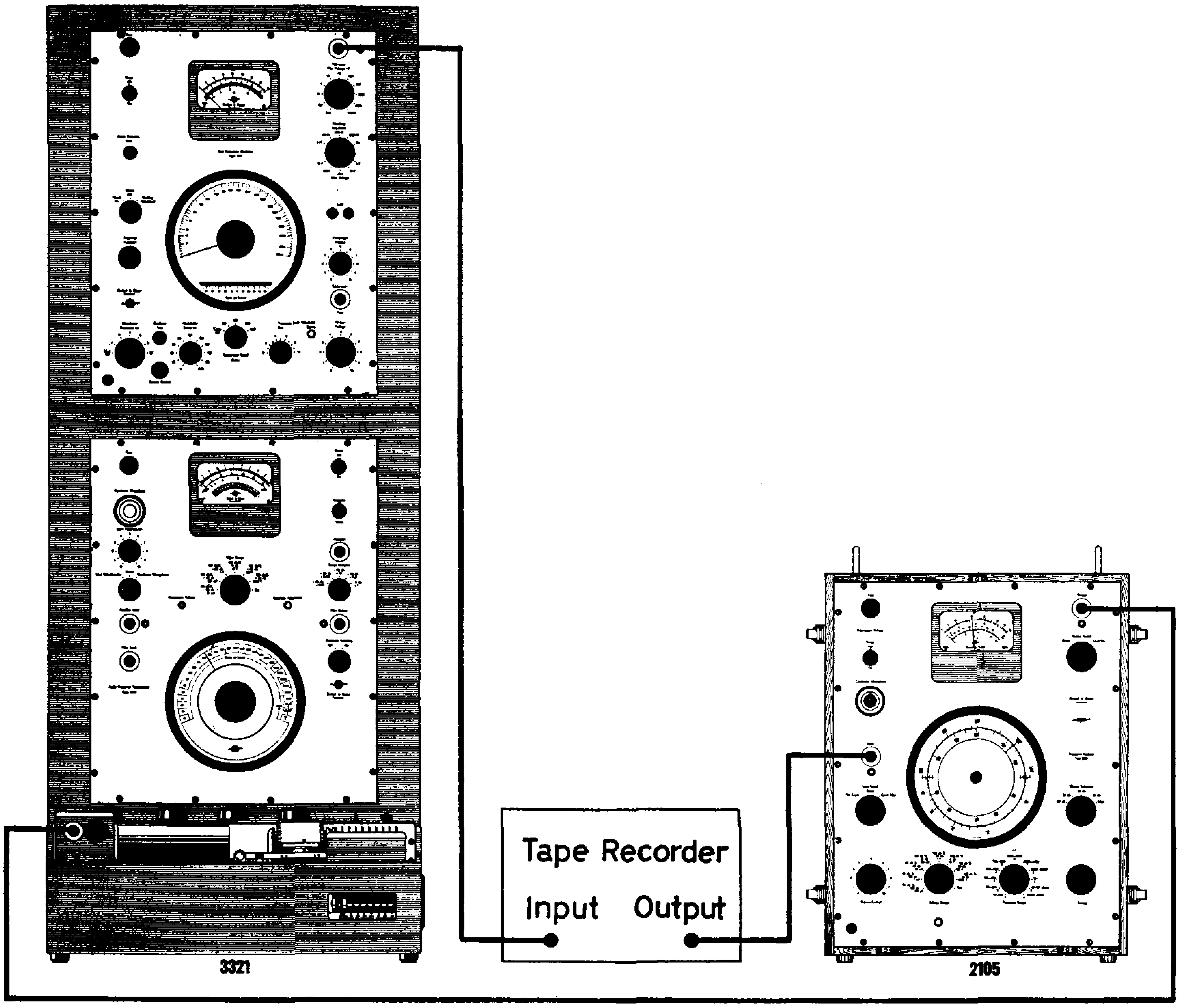



*Fig. 17. Set-up for wow-recording with increased sensitivity for small wow values, using the steepest slope of the filter curve in the Frequency Analyzer.*

Another possibility for wow-recording is to use the set-up shown in fig. 17 where the Spectrometer is replaced by the Frequency Analyzer Type 2105. As the slope of the filter curves of the Analyzer is greater than the slope of the filter curves of the Spectrometer, an increased sensitivity is obtained (fig. 18).

The most convenient adjustment procedure of this set-up is to set the frequency scale pointer of the BFO to a fixed frequency $f_1$, and alter the tuning of the Analyzer until the most suitable conditions are obtained. In fig. 19 a recording of the wow similar to the recording fig. 16b is shown. As the fixed frequency $f_1 = 1.000$ c/s the frequency-deviations are readily expressed in per cent.

If the wow should turn out to be too vigorous, a frequency analysis can be very helpful in pointing out that prevailing frequency (or frequencies) which causes the wow to increase. For frequencies above 20 c/s the wow-

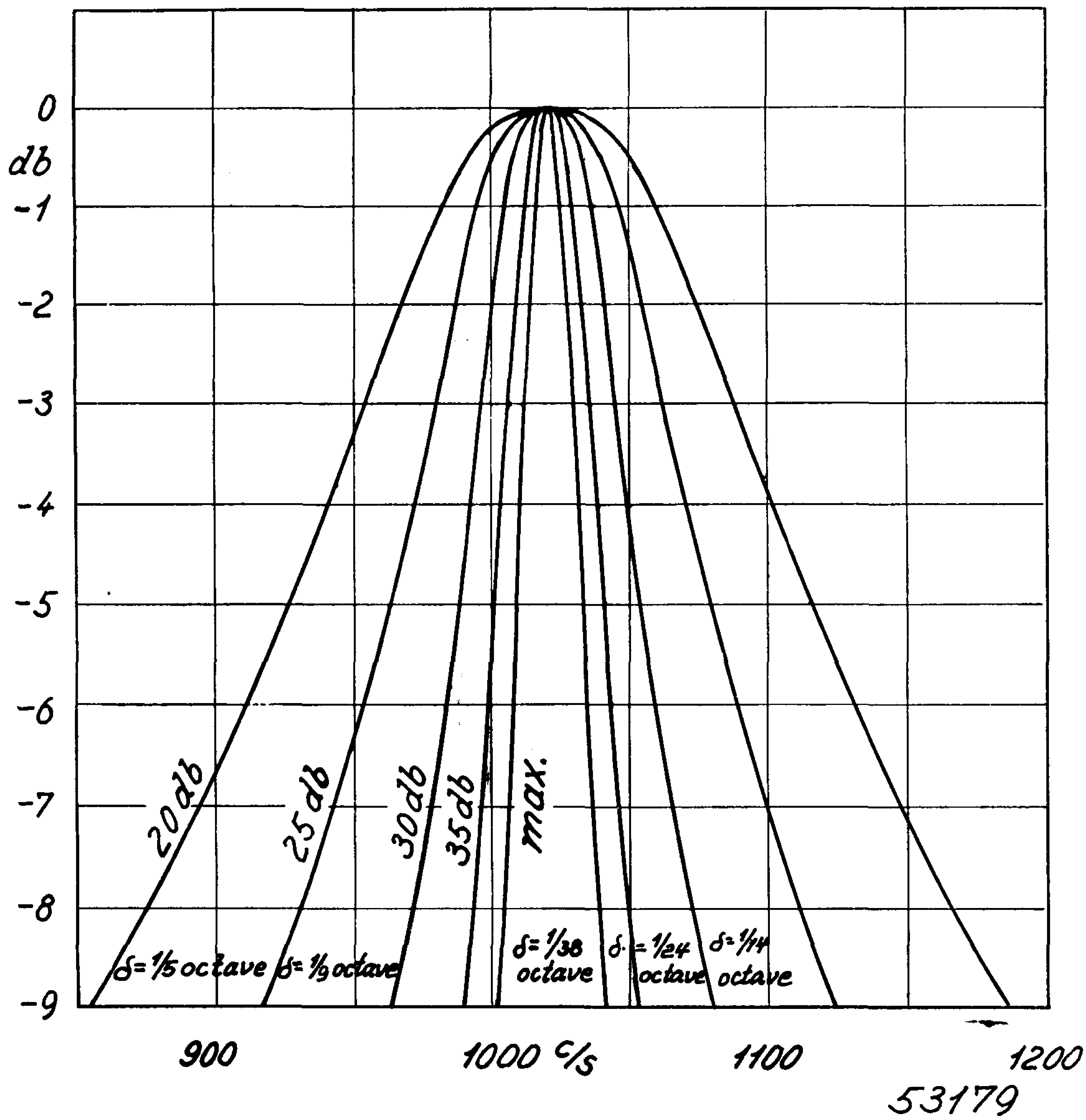



*Fig. 18. The tops of the different selectivity curves of the Frequency Analyzer recorded with extended frequency scale and a 10 db potentiometer.*

recordings already obtained do not give sufficient informations. The set-ups shown in fig. 20a and b enable frequency analysis in the range 16 c/s—20 kc/s to be carried out. The normal Spectrometer Type 2109 then must be supplied with the Filter Chassis ZS 0045 extending the measuring range of the Spectrometer downwards from 40 c/s to 16 c/s.

With the recorded frequency $f_1 = 10.000$ c/s (on tape recorder No. I) and the spectrometer-frequency $f_0 = 12.500$ c/s, the a.m. signal from the Spectro-

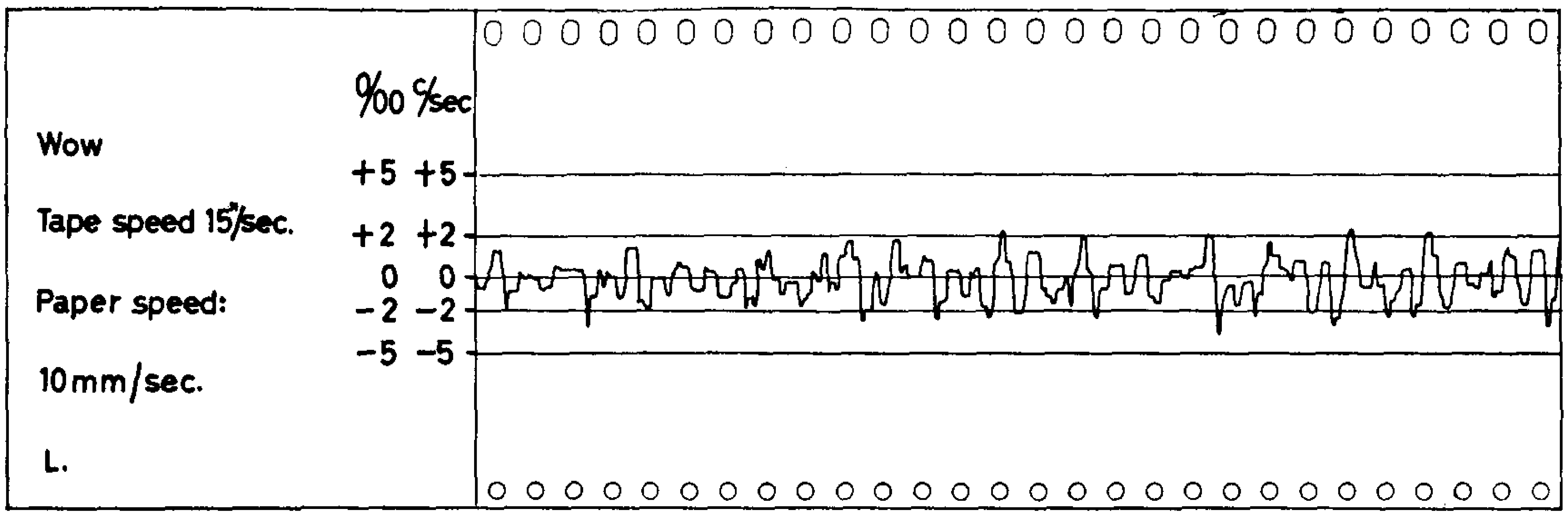



*Fig. 19. Wow recorded by means of the set-up in fig. 17.*

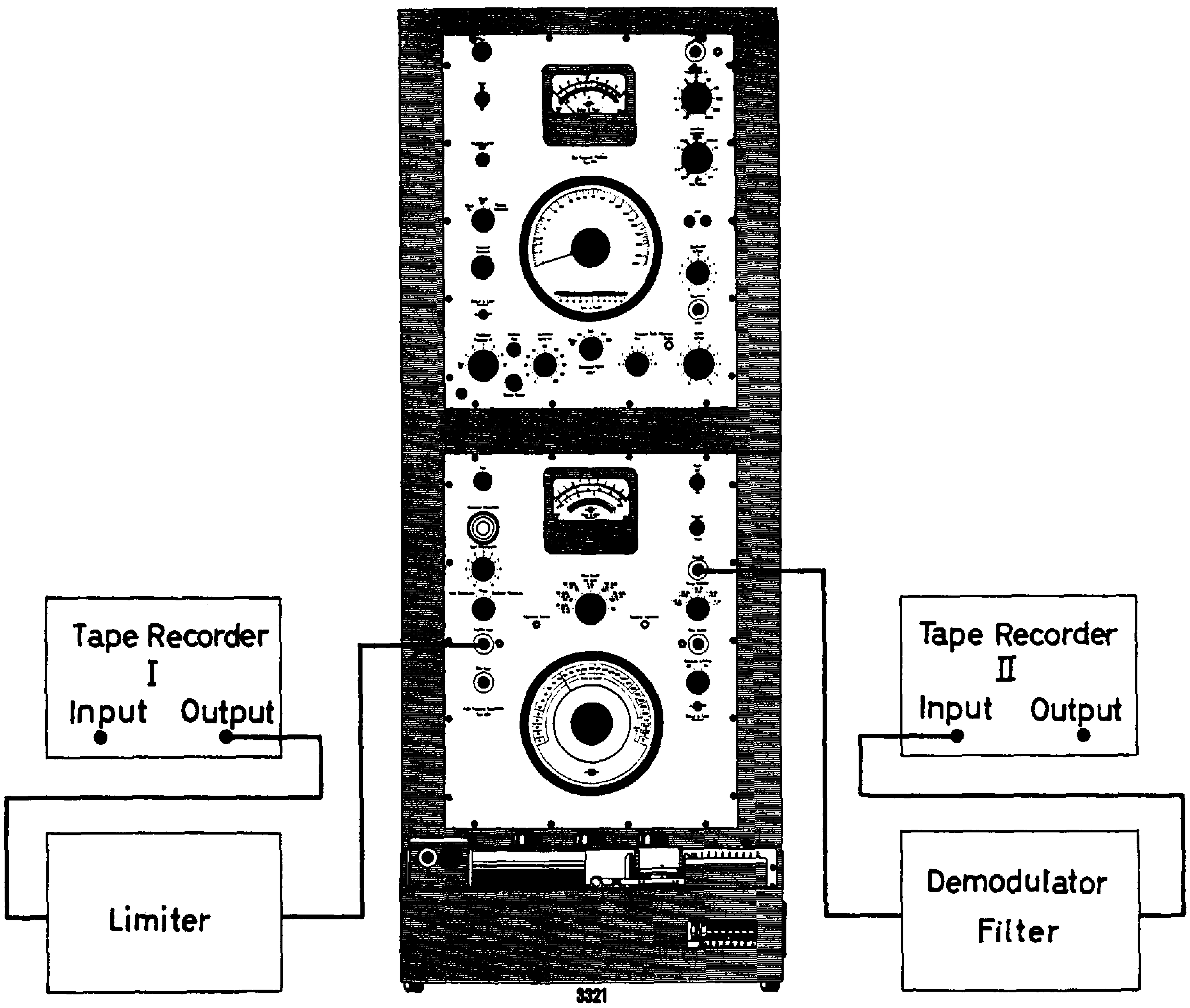



*Fig. 20. Set-up for frequency analysis of wow from a tape recorder.*
*a) Tape recorder No. II records the wow of tape recorder No. I.*

meter is demodulated and filtered through a lowpass filter (cut-off frequency 500 c/s) to avoid the carrier in overdriving tape recorder No. II, the recorded signal of which is analyzed by the spectrometer as shown in fig. 20b.

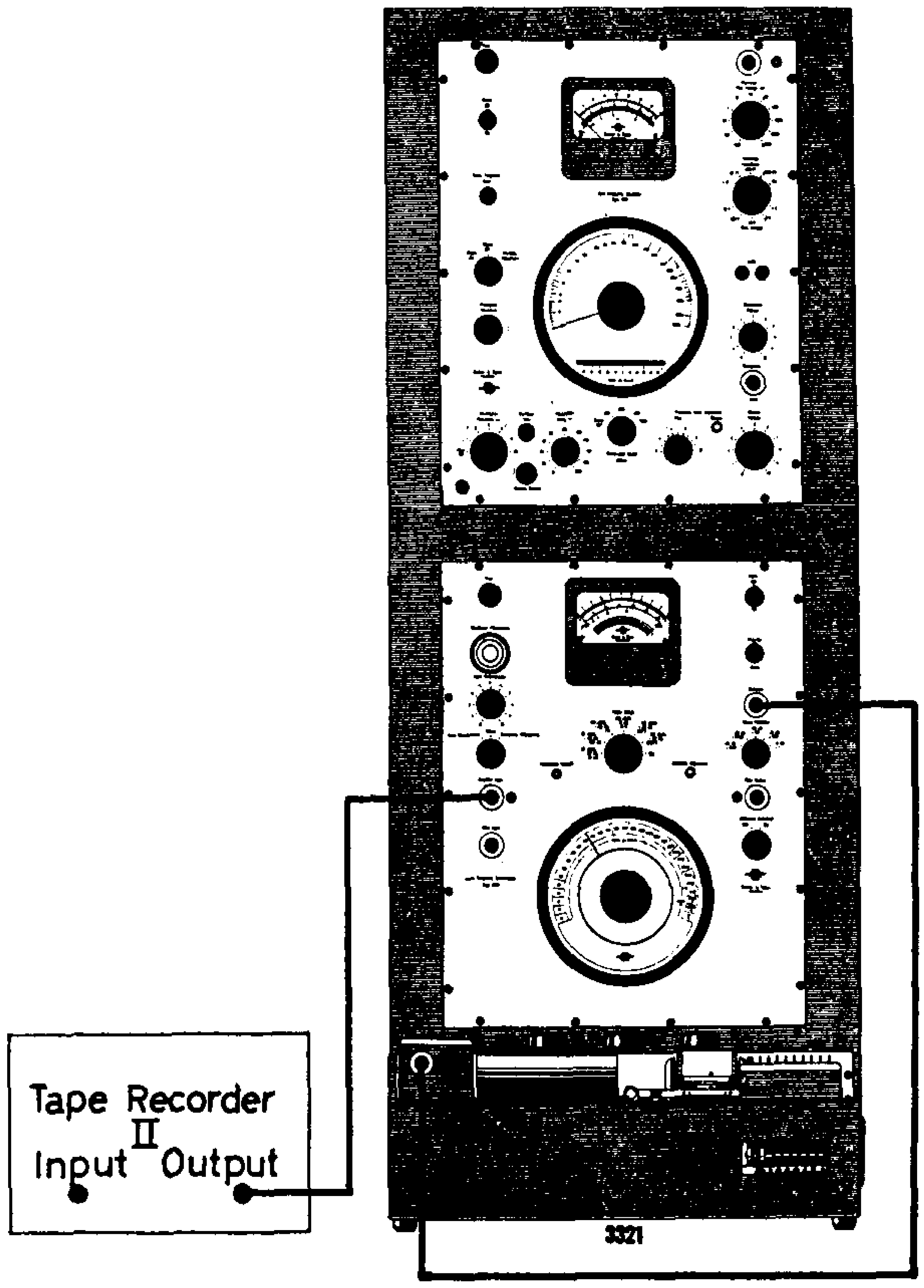



*Fig. 20. b) An analysis of the reproduced signal from tape recorder No. II is made by means of the Spectrometer.*

A spectrogram obtained according to the methode mentioned, is shown in fig. 21. The relative big contents of 16 c/s and 32 c/s are due to an excentricity of the tape driving motor shaft.

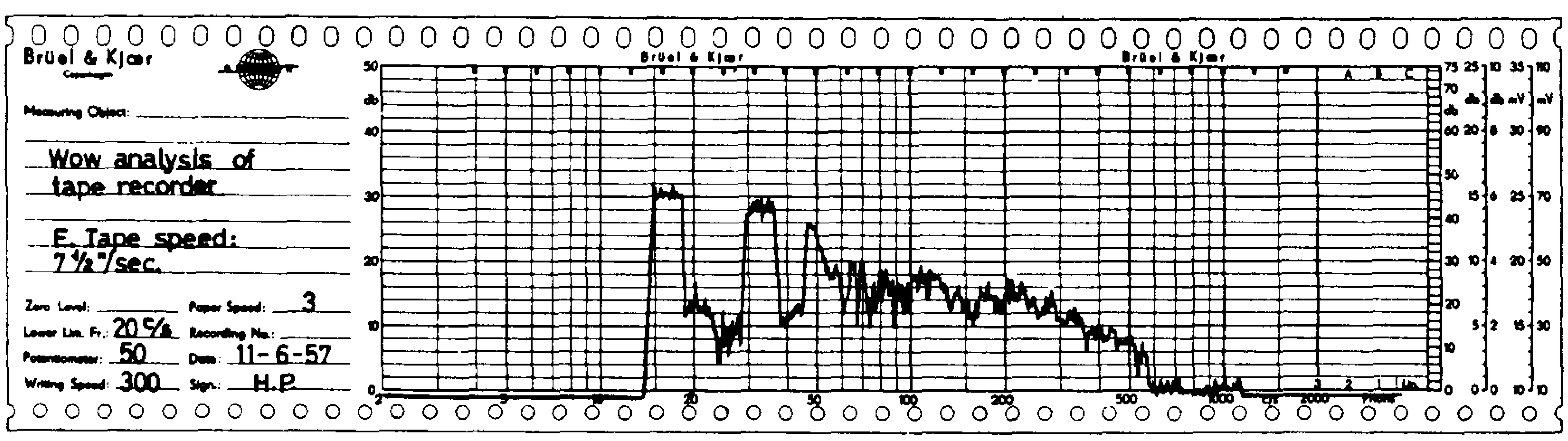



*Fig. 21. Analysis of the wow from a tape recorder. Recorded by the set-up shown in fig. 20 a-b.*

The highest wow-frequency which can be measured with reasonable accuracy is limited by the transmission-time for the filter in question. As this transmission-time for the 12.500 c/s-filter is approx. 250 $\mu$sec ~ 4 kc/s, wow-frequencies below the cut-off frequency of the lowpass filter (500 c/s) are within this limit.

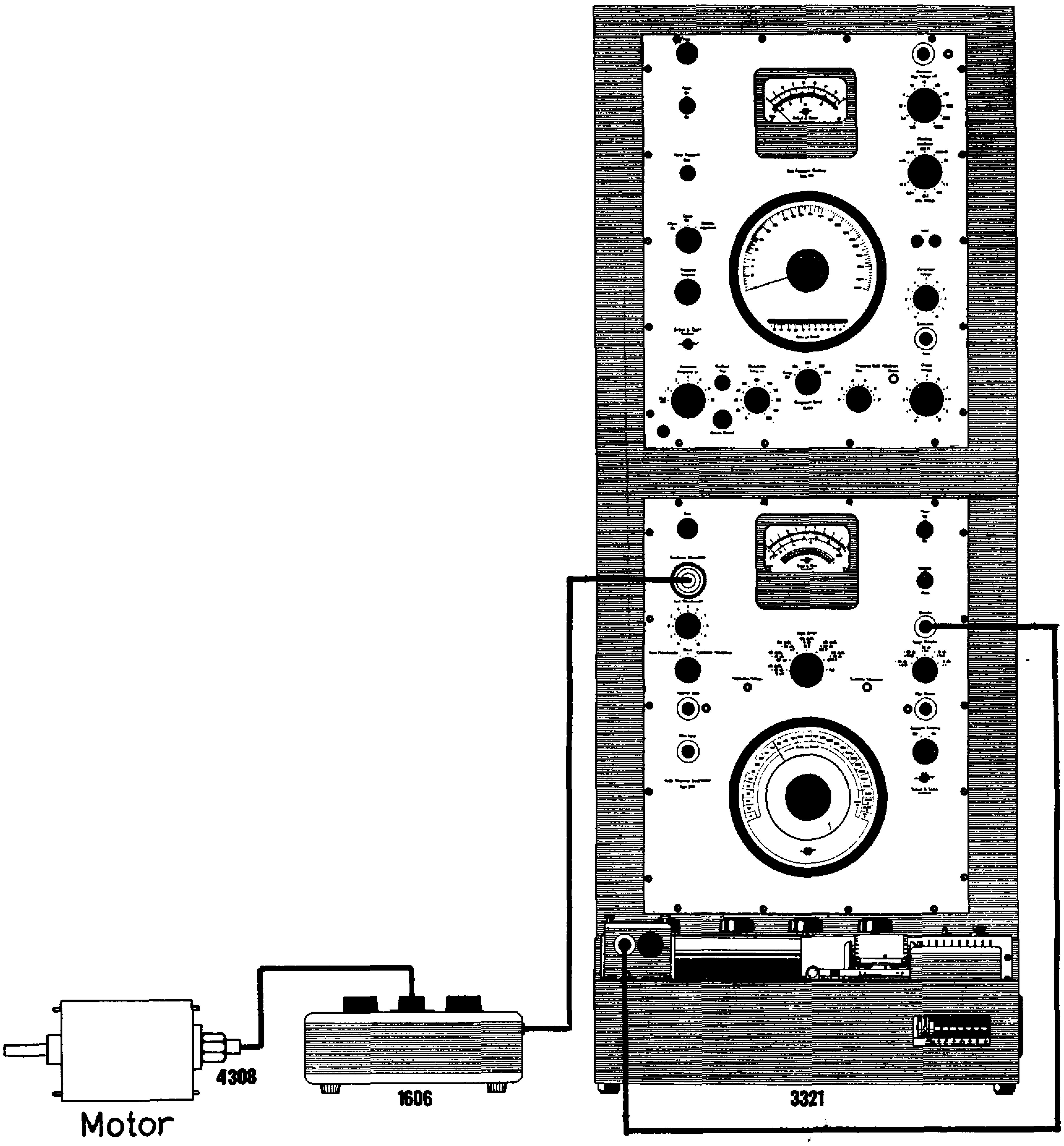



*Fig. 22. Set-up for vibration-analysis of the motors in a tape recorder.*

**Vibration of Motors.**

As described in Technical Review No. 4-1956, and No. 2-1957 analyse of motor vibrations are very useful in production control. With the set-up shown in fig. 22 the vibrations of the motors in a tape recorder may be carried out. The Accelerometer Type 4308 is attached to the motor under test. The electrical signal from the Accelerometer is via the Preamplifier Type 1606 fed to the Spectrometer, and recorded by the Level Recorder. The Accelerometer

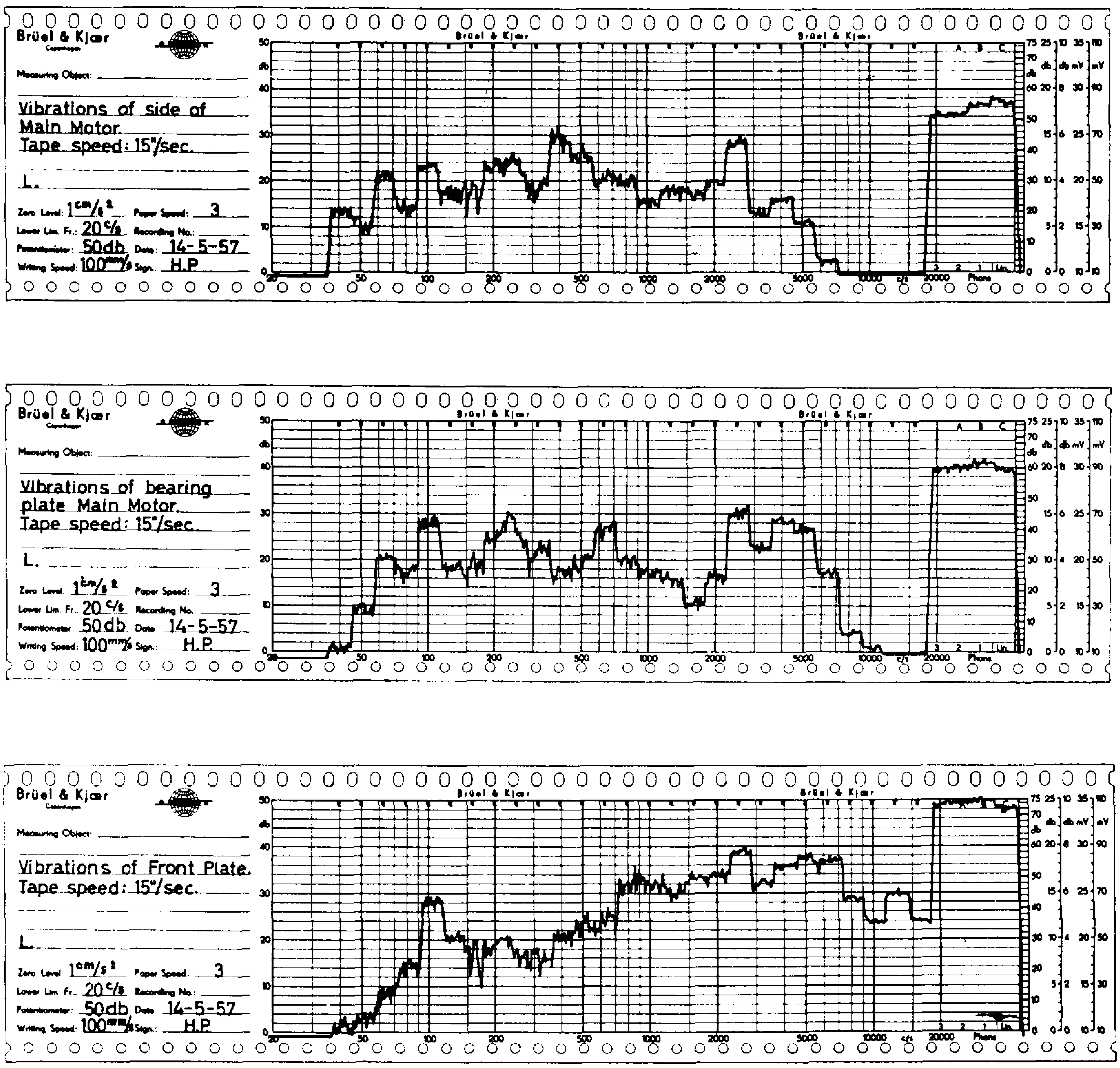



*Fig 23 a-b-c. Vibrations of the main-motor recorded with the Accelerometer attached at different points on the motor.*

may be fixed to the measuring object in different manners as described in the Manual for the Accelerometer. For the case in question the mounting of the Accelerometer was carried out by attaching a small magnet to the Accelerometer. Whenever iron objects are to be tested this mounting offers a very suitable operation procedure for production control.

When attaching the Accelerometer to the object under test it must be kept in mind that the measurements always must be carried out on the same place of the object. The importance of this appears from fig. 23 which shows the recording of vibration-tests of the main motor in a tape recorder. Fig. 23a, 23b and 23c are recorded under equal conditions but for the mounting place of the Accelerometer. It is seen that both the vibration level and the resonance frequencies are different in the three cases.

As mentioned in the summary the A.F. Response and Spectrum Recorder Type 3321 is the main instrument for the investigations. However, the apparatus contained in Type 3321 are available as separate units and in the following combinations: The Spectrometer plus the Level Recorder (Type 2311) and the BFO plus the Level Recorder (Type 3302).

# News from the Factory:

**Use of B & K Instruments on 400 c/s Power Supply Systems.**

All B & K Instruments except those containing an electric motor, can be operated on 400 c/s power supply systems. However, when the instruments are operated on such systems the following remarks should be noted:

| **Instrument:** | **Note:** |
| --- | --- |
| Beat Frequency Oscillator Type 1014 | The frequency adjustment on 400 c/s ("Power Frequency Beat" adjustment) normallv results in a less accurate frequency scale.<br><br>The noise and hum level, which when the instrument is used on 50 or 60 c/s power supply systems is approx. 70 db below max. output level will then be approx. 65 db below max. output. |
| Vibration Pick-up Preamplifier Type 1606. | The small built-in shaker-table, which is normally used to check the calibration of accelerometers can not be used on 400 c/s. |
| Frequency Analyzer Type 2105. | The instrument should be carefully grounded. If not, the noise and hum level will be approx. 2—3 db higher when operated on 400 c/s than when operated on 50 or 60 c/s power supply systems. Reference Adjustment: The built-in reference voltage cannot be used directly for calibration. It is recommended to calibrate the instrument on 50 or 60 c/s, then change to the 400 c/s power supply and note down the "Ref."-voltage value. This value may be used for all later calibrations on 400 c/s instead of the red mark on the meter scale. |

| Instrument: | Note: |
| --- | --- |
| Audio Frequency Spectrometer Type 2109. | The hum voltage induced in the filter coils is somewhat greater when the instrument is used on 400 c/s supply systems than when used on 50 or 60 c/s systems.<br>However, the values stated in the specifications for Type 2109 will still hold.<br><br>When the Condenser Microphone Type 4111 is connected to the instrument the noise level will be approx. twice the value stated for 50 or 60 c/s power supply systems.<br><br>Reference Adjustment: See "Frequency Analyzer Type 2105". |
| High Speed Level Recorder Type 2304. | The built-in motor can not be used on 400 c/s. Reference Adjustment: See "Frequency Analyzer Type 2105". |
| Wide Range Voltmeter Type 2405. | Reference Adjustment: See "Frequency Analyzer Type 2105". |
| Audio Frequency Voltmeter Type 2407. | Reference Adjustment: The normal procedure is accurate and can be used on 400 c/s as well as on 50 or 60 c/s systems. |
| Audio Frequency Voltmeter Type 2408. | Reference Adjustment: See "Frequency Analyzer Type 2105". |
| Microphone Amplifier Type 2601. | The hum voltage is approx. 1 db higher when the instrument is used on 400 c/s than when operated on 50 or 60 c/s power supply systems. |
| Microphone Amplifier Type 2602. | The hum voltage, referred to the input of the instrument is approx. 3 $\mu$V at operation on 400 c/s. (When operated on 50 or 60 c/s the hum voltage is 2 $\mu$V). Use of Condenser Microphone: See "Audio Frequency Spectrometer Type 2109". Reference Adjustment: See "Frequency Analyzer Type 2105". |

| **Instrument.** | **Note:** |
|---|---|
| Inverter Type 4610. | When operated on 400 c/s the hum and noise voltage components may, under certain conditions, show a beat between the internal oscillator frequency (400 c/s) and the power supply frequency. The frequency of the internal oscillator can in these cases be changed slightly by changing the value of the capacitor marked C3 (70 nF) in the circuit diagram. |
| Frequency Response Tracer Type 4707. | The built-in motor can not be used on 400 c/s. |
| Electronic Counter Type 6503. | The timers for preset time counting can not be used during operation on 400 c/s power supply systems. |

# New Instruments

**Scintillation Counter Type 6536.**

The Scintillation Counter Type 6536 is designed for use in connection with the Electronic Counter Type 6503 and consists of a photomultiplier built in a nickel plated brass housing.
The photo-multiplier is shielded by a foil of mu-metal reducing the disturbing effects of external magnetic fields to a minimum.

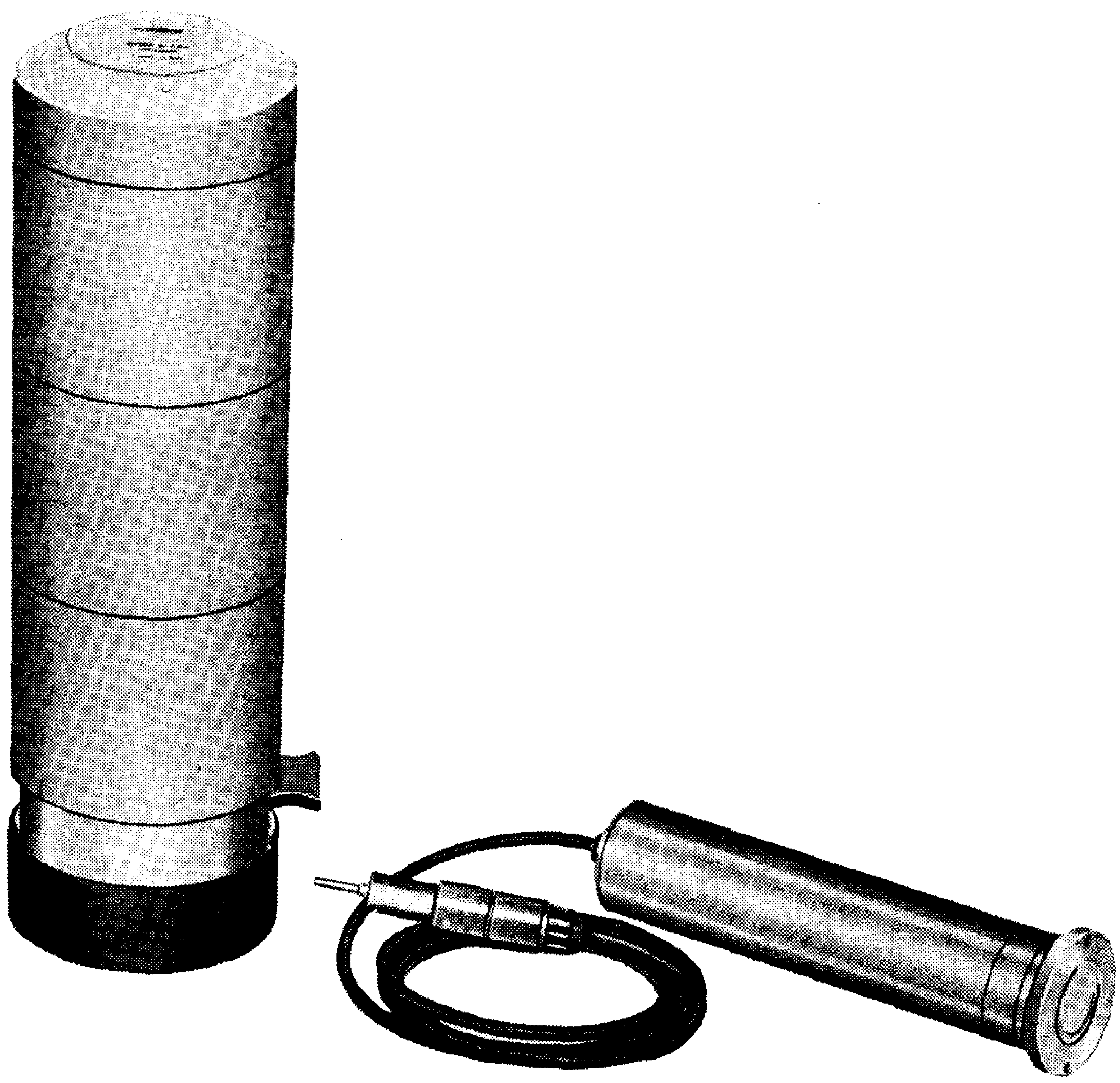
Type 6536 can be connected directly to the Electronic Counter Type 6503 by means of a screened cable (supplied with Type 6536), and no extra amplifiers or high tension accessories are necessary.

Because of the short resolving time of the Scintillation Counter it is capable of measuring much stronger radiation intensities than those which can be measured by an ordinary G.M.-counter. Furthermore, the density of the scintillating crystal makes it well suited for $\gamma$-ray counting.

Type 6536 is normally used in connection with one of the Scintillation Crystals MX 0001 or MX 0002, but also other scintillating units can be employed.

It can be fitted in the Shielded Sample Holder Type 6533 or employed as a hand type monitor. Furthermore, it can be readily applied to already existing measuring arrangements.

When placed in the Shielded Sample Holder Type 6533 the effect of radiation from external sources is reduced to a minimum, and the measuring arrangement is well suited for tracer technique experiments.



**Shielded Sample Holder Type 6533.**

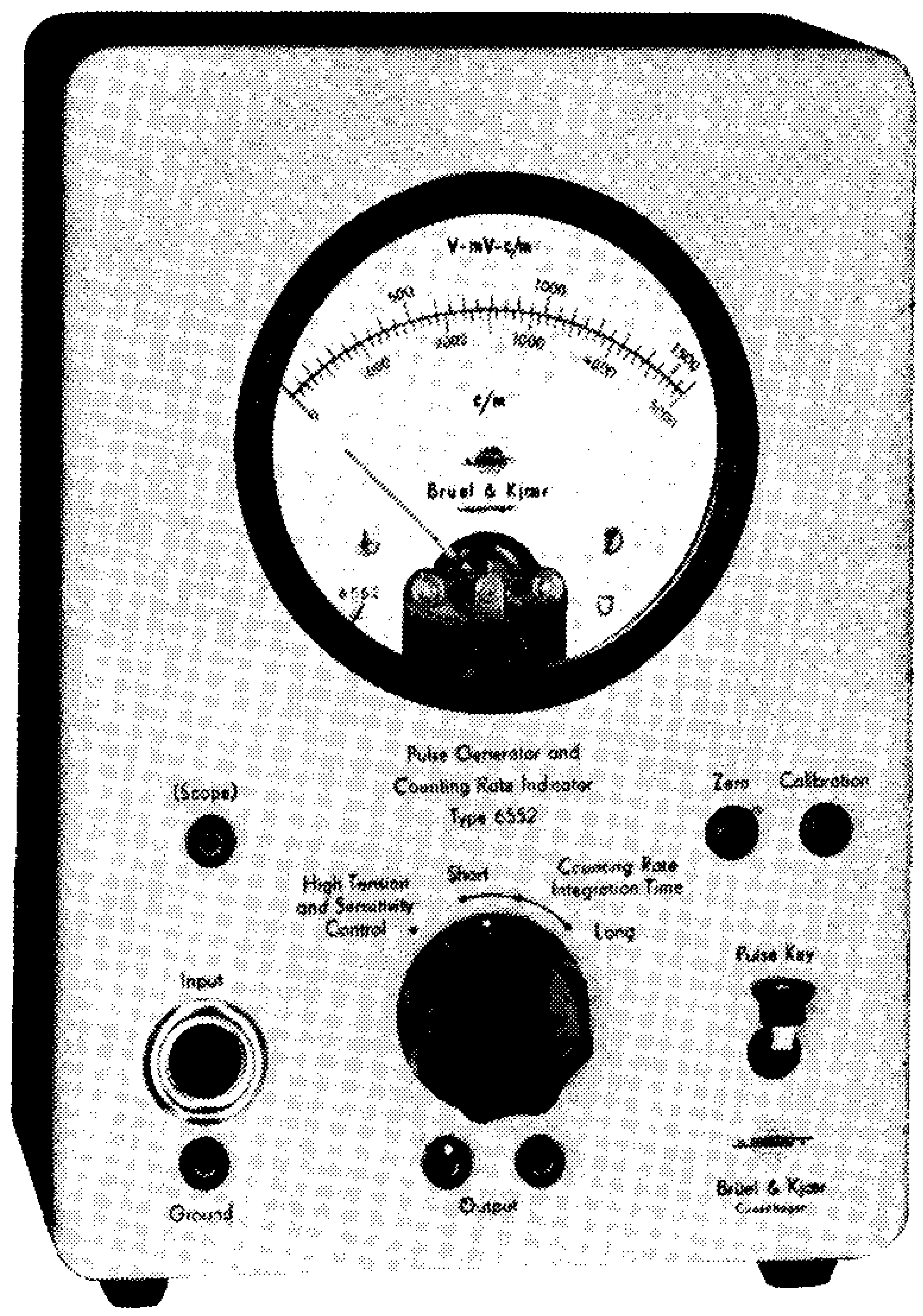
Type 6533 consists of the bottom FB 0010, three barrells FS 0010, the top FA 0010 and the sample holder UA 0010 itself. The lead parts from a shielding with a minimum thickness of 28 mm.

The slide holder has three slots accommodating slides which are located by means of spring loaded steel balls, so that the geometric reproducibility is 0.1 mm. On the slides can be placed dishes, cuvettes, filter paper holders or absorbers.

**Pulse Generator and Counting Rate Indicator Type 6552.**

The Pulse Generator and Counting Rate Indicator Type 6552 is designed for use as a test and accessory instrument for the Electronic Counter Type 6503. By means of this instrument the high tension supply from the Electronic Counter as well as its sensitivity can be checked. The sensitivity is checked with the aid of single pulses produced by a pulsing device in 6552, employing the high tension control of Type 6503 to adjust the height of the pulses.

Furthermore, a check on the scaling of Type 6503 can be made. This check is carried out using either single pulses from the pulse key, or equally spaced pulses of variable pulse frequency supplied from a built-in pulse generator. The desired pulse frequency is set by means of the high tension control of the Electronic Counter.




The connection between Type 6552 and Type 6503 should be made with the aid of one-cored cables (supplied with Type 6552) and no external voltage supply is necessary.

When the Type 6552 is used as Counting Rate Indicator the pulses supplied from the Electronic Counter are integrated by means of an electronic integrating network, the result being indicated on the instrument meter. By means of a switch three different time constants can be chosen for the network, the counting rate range itself being determined by the resolving time adjustment of Type 6503.

When switched for counting rate measurements the voltage across the indicating meter of 6552 is also available on the terminals marked "Output". Connecting these terminals to the input of the Level Recorder Type 2304 via the Inverter Type 4610 level curves of the counting rate as a function of time, or another physical quantity, can be recorded automatically.

The Pulse Generator and Counting Rate Indicator Type 6552 enables an easy check of radioactive radiation and is excellently suited for routine measurements.

Furthermore, the measurement of radiation intensities approx. 30 times greater than those which can be measured when only one of the two channels in the Electronic Counter Type 6503 is employed is possible.

The output voltage available from Type 6552 also enables radioactive processes, for example processes taking place during laboratory experiments, to be controlled, and a continuous check on the radiation level can be made

**Scintillation Crystal MX 0001.**

Thallium-activated NaJ crystal in Al-container. For use with the Scintilla tion Counter Type 6536.

**Well Scintillation Crystal MX 0002.**

Thallium-activated NaJ crystal (Well type crystal) in Al-container. For use with the Scintillation Counter Type 6536.

**Brüel & Kjær**

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