RCA Victor

LABORATORY APPARATUS

In conjunction with the design and manufacture of Radio Receivers, RCA Victor Engineers have felt the need for certain types of Laboratory Apparatus not generally available. This equipment may take the form of entirely new apparatus or it may be refinements to existing equipment.

The following pages describe several pieces of apparatus which are used by the Engineering Organization of the RCA Victor Company and which are available for separate sale. In the manufacture of this equipment, the Engineers responsible for its design have had but one consideration to be met in its design. That consideration is to produce the very highest quality in respect to both electrical and mechanical design.

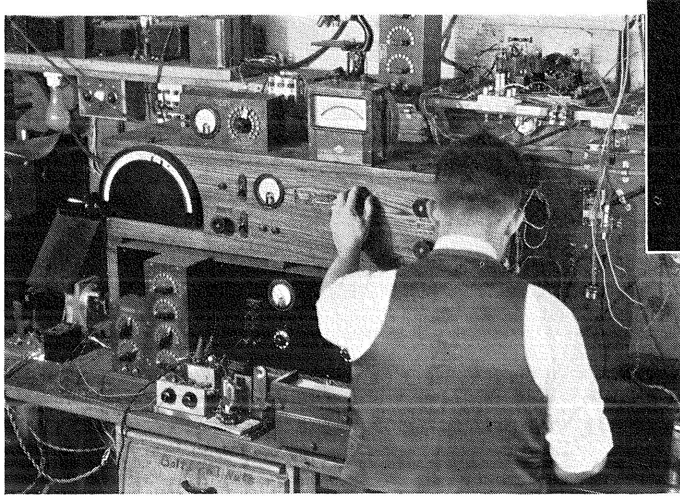
The following items are typical of the equipment manufactured under these considerations. We solicit your inquiries pertaining to them or to any other apparatus of special design and manufacture.

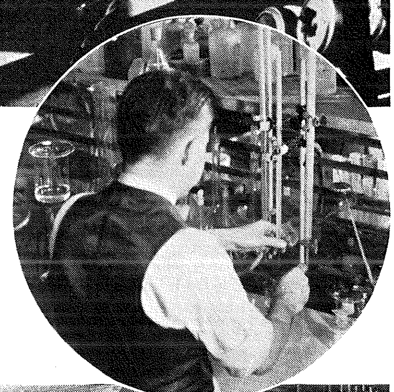
RCA PARTS DIVISION

RCA Victor Company, Inc.

CAMDEN, N. J., U. S. A.

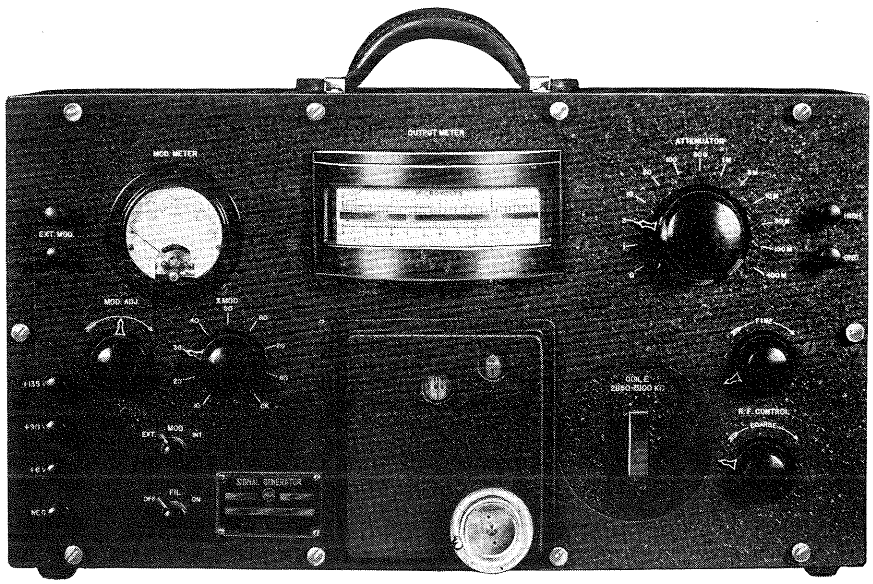
WHERE RCA LABORATORY EQUIPMENT IS DESIGNED AND USED





RCA STANDARD SIGNAL GENERATOR

TYPE TMV-18-D



FEATURES

WIDE FREQUENCY RANGE	Standard coils from 100 kc to 10,000 kc. Extra coils for 25 kc to 25,000 kc.
CONVENIENT OPERATION	Coils Plug in from Panel Front. Simplified Controls.
LARGE SCALE PRECISION METER	Knife Edge Pointer and Mirror.
MINIMUM STRAY FIELD	Double Shielding and Heavy Aluminum Castings.
MINIMUM FREQUENCY MODULATION	Special Compensated Circuit.
IMPROVED PRECISION DIAL	Scale with 3750 Divisions. Capacitor with 270° rotation. Worm Driven Vernier.

ELECTRICAL DESIGN

The standard signal generator Type TMV-18-D is an instrument for obtaining accurate quantitative data for the rating of radio receivers on a basis of performance standards. It permits all the standardized tests for broadcast receivers, and, in addition, permits tests and measurements of superheterodynes, intermediate frequencies and also in the major portion of the present high frequency band.

The voltage range is sufficient to meet all requirements of over-all receiver characteristics and, also, stage-by-stage radio amplifier and detector characteristics and other high frequency measurements.

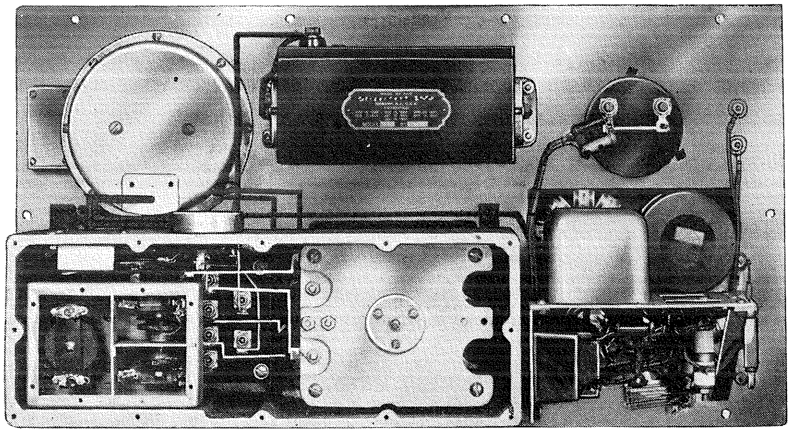
The generator consists essentially of a 400 cycle modulating oscillator, a modulation meter, a radio frequency oscillator, a thermocouple meter for reading the attenuator input voltage, and a resistance network attenuator.

The instrument employs a tuned plate type radio frequency oscillator using an impedance stabilized circuit which gives substantially constant output over the entire frequency range. The output of the oscillator is controlled from the front of the panel. This control is a carefully selected r-f pad network of such design that a constant load is maintained on the oscillator for all values of output. The frequency range of 100 kc to 10,000 kc is covered by means of a variable capacitor and six plug-in coils (additional coils are available as accessory equipment to extend the frequency range down to 25 kc and up to 25,000 kc). The capacitor has a split stator so arranged that the capacitance for tuning the low frequency coils is approximately three times greater than that used for tuning the high frequency. All switching is accomplished automatically by changing coils, eliminating panel switches and dead-end defects in the coils. The capacitor is driven by a single precision dial.

A self contained vacuum tube oscillator furnished a modulating voltage at a frequency of 400 cycles. Terminals are provided so that an external modulating voltage may be used for modulating at frequencies from 30 to 7,000 cycles, if desired. A switch with knob on the front of the panels provides for changing from internal to external modulation. The modulation meter is so designed that variations in the battery voltage do not introduce any error into the readings obtained with this meter.

A thermocouple meter with a long horizontal scale, mirror, and knife-edged pointer is provided for the reading of the r-f input voltage to the attenuator. The measurement of the r-f attenuator input voltage rather than current, eliminates errors due to reactive components of current in shunt with the attenuator and errors due to any small inductances in the attenuator network, which are particularly objectionable at the higher frequencies. The meter design and calibration contribute greatly to the ease and accuracy of reading. The meter scale is marked directly in microvolts from 0.25 to 5.0.

A tapped resistance network is used for attenuating the voltage output of the oscillator to the desired level. The attenuator control is marked in steps with multiplication factors for the output voltmeter. The steps are 0; 1; 3; 10; 30; 100; 300; 1000; 3000; 10,000; 30,000; 100,000 and 400,000. The output is obtained by simply multiplying the output voltmeter reading by the attenuator multiplying factor. The attenuator steps facilitate the taking of band width selectivity measurements are 10, 100, 1000, and 10,000 times the input at resonance. Change of the attenuator dial position does not shift the frequency of the oscillator.



PERFORMANCE

R-F VOLTAGE OUTPUT

The output is continuously variable from 0.25 microvolts to 2 volts at any carrier frequency. The r-f output voltage varies less than 12 percent with change of the frequency over the range of any coil.

MODULATION CHARACTERISTICS

The internal 400 cycle oscillator is capable of modulating the output up to 80 percent in 10 percent steps. The instrument employs a self-calibrating modulation meter accurate to within 10 percent at any carrier frequency. With the modulation meter held at a constant setting, the percentage modulation of the r-f output will not vary more than 5 percent over the range of 30 to 7000 cycles for carrier frequencies above 215 kc. For carrier frequencies from 150 to 215 kc this variation is not over 10 percent and from 90 to 150 kc, not over 10 percent for audio frequencies from 30 to 5000 cycles.

OUTPUT SYSTEM

The resistor attenuator is a specially designed combination series and ladder network and is accurate to within 2.5 percent between 100 kc and 1,650 kc and to within 10 percent between 1,650 and 10,000 kc. The precision thermo-voltmeter used to measure the input to the attenuator is accurate to within 0.5 percent at 20° C. Errors due to temperature variations from this value are approximately 0.25 percent per degree Centigrade.

FREQUENCY MODULATION

The shift of the carrier frequency, for oscillator plate voltage changes equivalent to 50 percent modulation is not greater than 200 cycles total shift for carrier frequencies below 5,100 kc. For higher frequencies up to 10,000 kc the shift will not be greater than 0.03 percent of the carrier frequency plus 500 cycles times the percentage modulation.

HARMONIC CONTENT

The harmonic content of the 400 cycle internal oscillator is less than 5 percent. Tests made in the range of 215 to 750 kc. show a total r-f harmonic content of less than 2.5 percent

FREQUENCY CALIBRATION

The accuracy of the frequency calibration is plus or minus 0.5 percent. The condenser can be set to an accuracy of 0.05 percent. Calibration curves together with calibration data for expanding the curves to any desired degree are furnished with each individual equipment.

LEAKAGE

Grounds, filters and shields are arranged to reduce stray r-f voltages to a minimum. Battery leads, meters and controls are so filtered, shielded and insulated that no appreciable r-f voltage can be picked up by actually touching the control frames and binding posts (except output binding posts) with the antenna lead of a sensitive receiver. The plug-in coils are designed to reduce stray fields to a minimum and in addition are enclosed in individual cans. Potential differences between any external grounded point, meters or controls, are less than 0.1 microvolt. The stray field is not sufficient to affect the accuracy of measurements within the range of the instrument.

MECHANICAL DESIGN

The complete signal generator is contained in a rugged aluminum case and is provided with a neatly engraved panel. The case is approximately 21″ long, 12″ high and 9″ deep. The signal generator, exclusive of batteries, weighs approximately 40 pounds. The finish of the cabinet and panel exterior is baked black crystalline varnish.

The internal shields, including the attenuator case, are heavy aluminum castings. This type of shielding eliminates voltage in the attenuator due to ground currents and thereby insures greater attenuator accuracy, especially at the high frequencies.

The various manual controls operate smoothly. The frequency control dial has a 50 to 1 worm gear reducing mechanism with spring pressed gears having 3750 divisions for a full 270 degree rotation.

All controls are marked with words or phrases descriptive of their functions. A clockwise rotation of the controls increases their effect.

The equipment is furnished with a substantial carrying case of wood to protect the signal generator and its coil systems from mechanical injury during transportation. The case is carefully padded with felt and is provided with spring clips on the inside of the lid to hold the five spare coils while not in use. The overall dimensions are approximately 23⅝ inches long by 11½ inches wide by 18½ inches high.

TUBES SUPPLIED WITH GENERATOR

Modulating Oscillator	One UX-112A
Modulation Meter	One RCA-230
R-F Oscillator	One RCA-56

Batteries Required

One 135 Volt Plate Battery Tapped at 90 Volts

One 6 Volt Filament Battery

RCA PARTS DIVISION

RCA Victor Company, Inc.

Camden, N. J.

RCA UNIVERSAL CURVE RECORDER

Type TMV-36B

In the laboratories of—Radio and Sound Equipment Manufacturers—Technical Schools and Universities—Consulting Engineers and Experimenters—there is very often required some form of Curve Recorder which will enable the engineer to obtain, rapidly, an accurate record of his measurements in the form of a permanent graph or curve.

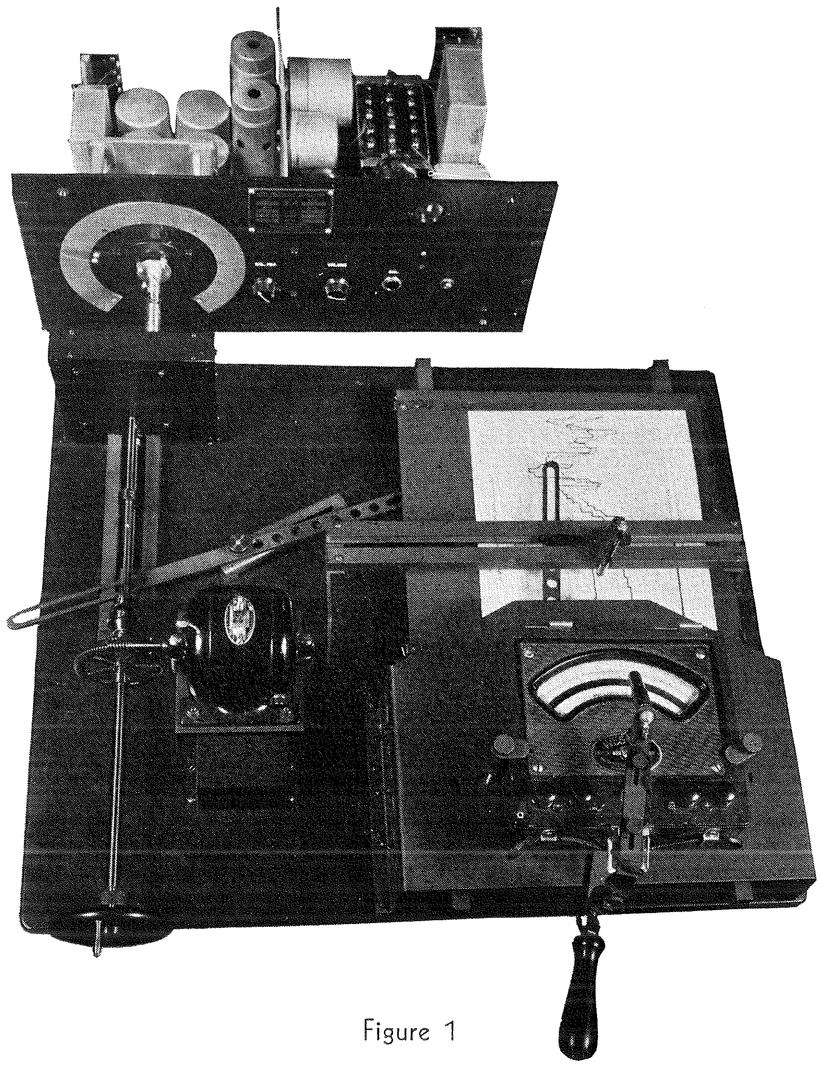


Figure 1

While some engineers still continue to record measurements in tabulated form, or from such tabulations obtain an approximate curve, accurate only at the points taken,—the majority have come to realize the economy and advantages of a Curve Recorder and have therefore adapted this instrument to a variety of equipment in order to solve the many development and manufacturing problems which daily confront them.

For several years the RCA Victor Company has designed and built various types of curve recorders for use in the laboratories and factories. The result of this experience has led to the development and design of a universal instrument which has been used by our engineers for the past two years and is designated the TMV-36B.

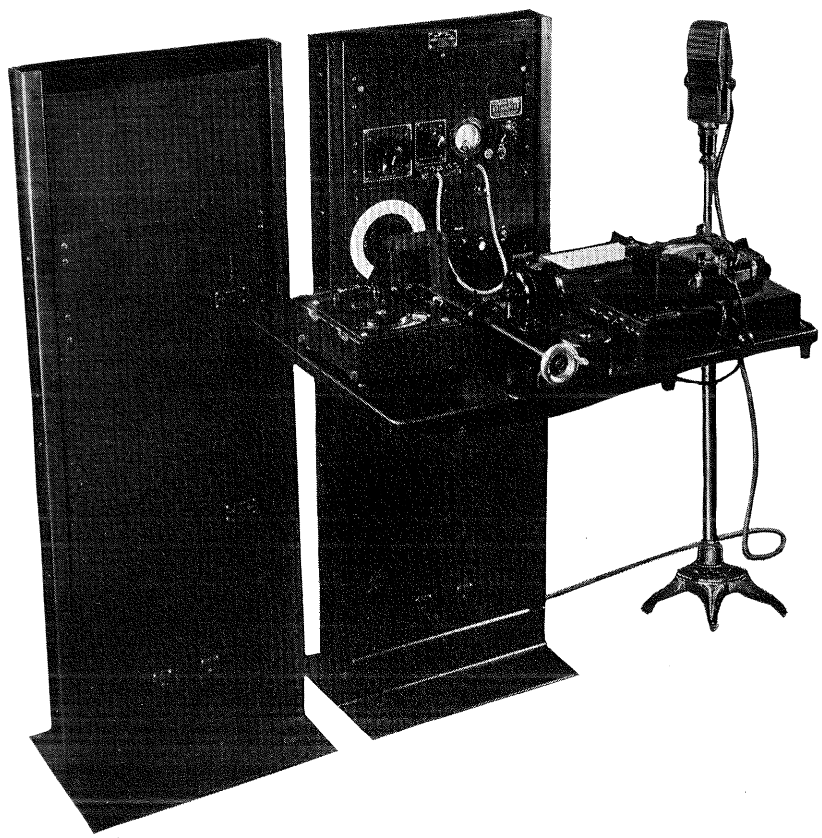


Figure 2—Use of Curve Recorder for Making Complete Sound Pressure Measurements

DESCRIPTION

This instrument, as shown in the photograph, consists essentially of a graph-sheet table, or a platen, supported on three rollers, arranged to slide smoothly and silently along a horizontal track beneath a manually operated pen. Attached to this chart holder is a universal motor-driven mechanism arranged in such a manner that the speed and distance of travel may be continuously and uniformly varied. The chart holder is provided with suitable clamps and pilot lights so that any curve paper with linear, semi-logarithmic or logarithmic scale can be attached and lined up in either of two positions correctly. By changing the position of a lever attached to the table, the maximum table travel may be varied from six to ten inches.

A Universal Gear Box is also provided so that the graph-sheet table may be adjusted easily to travel the entire length of the graph paper for either 180° or 270° rotation of the drive shaft on the external measuring equipment. This feature permits the Curve Recorder to be used with practically any type oscillator, signal generator or laboratory instrument. The Universal Gear Box is provided with three shafts and a flexible coupling unit to afford ratios of 1 to 1, 10 to 1 or 60 to 1.

A metal shelf, located in the front right-hand corner of the base, provides mounting for the response meter employed. The hold-down clamps are adjustable to permit the use of various meters* as desired, of sizes between the smaller Weston Type 322 and the larger General Electric Type DP2. The movable pointer of the meter-follower mechanism is located directly above the meter scale and is hand-operated by means of a lever extending from beneath the shelf. A pilot lamp and a triangular insert are contained in the movable pointer to cast a shadow index marker upon the meter scale, and so avoid parallax errors in following the needle. The movable pointer support lever is of adjustable length to compensate for the radius variations encountered between the scales of different meters. The pen is mounted upon a slider traveling in a ball-bearing track, its travel being continuously adjustable between the limits of 4 and 10 inches for full meter deflection.

The motor is provided with a speed control and a reversing switch for drawing curves at various speeds and for rapid re-setting of the graph-sheet table. As supplied, the motor is designed for A.C. operation, 105-125 volts, 60 cycles. At maximum rated voltage the power consumption is approximately 32 watts. Since the driving motor is of the universal type, however, the Recorder may be operated equally well on a D.C. line of equivalent voltage. When operated from a D.C. line, however, it is necessary to excite the pilot lamps through a suitable series resistor direct from the power source and disconnect the standard filament transformer which is provided.

*Meter not supplied.

Applications of the Curve Recorder to Loudspeaker Measurements

Figure 2 shows the Universal Curve Recorder as used with other standard RCA Victor instruments, for taking the characteristics of loudspeakers. The Curve Recorder is coupled to the TMV-52-E Beat Frequency Oscillator which is fed into the Type AA-4194-B amplifier and both instruments are compensated so that the total overall response of the two units is linear to within plus or minus 0.5 db over the frequency range of 30 cycles to 10,000 cycles. The power applied to the input of the device under test is therefore substantially constant, so that a measurement of the non-linearity of the device under test is possible. The loudspeaker is then placed a given distance from the 44-A velocity microphone* which picks up the sound waves and amplifies them through the 41-B Pre-Amplifier and 40-C High Gain Amplifier, across which is connected the TMV-119-A linear rectifier VT Volt Meter. The overall response from the microphone up to and including the Volt Meter over the frequency range of 30 to 10,000 cycles is linear within plus or minus 2 db, and the gain control may be adjusted in steps of 2 db so as to make possible a sound pressure range from 1 millibar to 400 bars. Once the equipment is set up, loudspeaker curves can be obtained in as short a time as three minutes.

The Curve Recorder may also be used with the TMV-18-D Signal Generator to measure the overall fidelity of a radio receiver by connecting the output of the 4194-B amplifier (See Fig. 4) to the input of a TMV-18-D Signal Generator, which is then modulated over the frequency range of 30 to 10,000 cycles. The output of the TMV-18-D is connected to the input of the receiver under test, and the meter of the Curve Recorder connected to a suitable vacuum tube Volt Meter in parallel to a resistance which is equivalent to the speaker voice coil impedance.

It is further possible to modify this arrangement somewhat so as to measure the overall fidelity from radio frequency input to sound pressure output. In making this measurement, the radio receiver and TMV-18-D Signal Generator are connected between the 4194-B amplifier and the loudspeaker.

This recorder may also be used to plot the variation of resistance with angular rotation of—rheostats, potentiometers, volume controls, etc. When used with the RCA Victor Signal Generator, type TMV-18-D, performance curves of intermediate frequency transformers and amplifiers may be obtained. When used with the RCA Victor Beat Frequency Oscillator, type TMV-52-E, curves of audio frequency filters and networks may be plotted.

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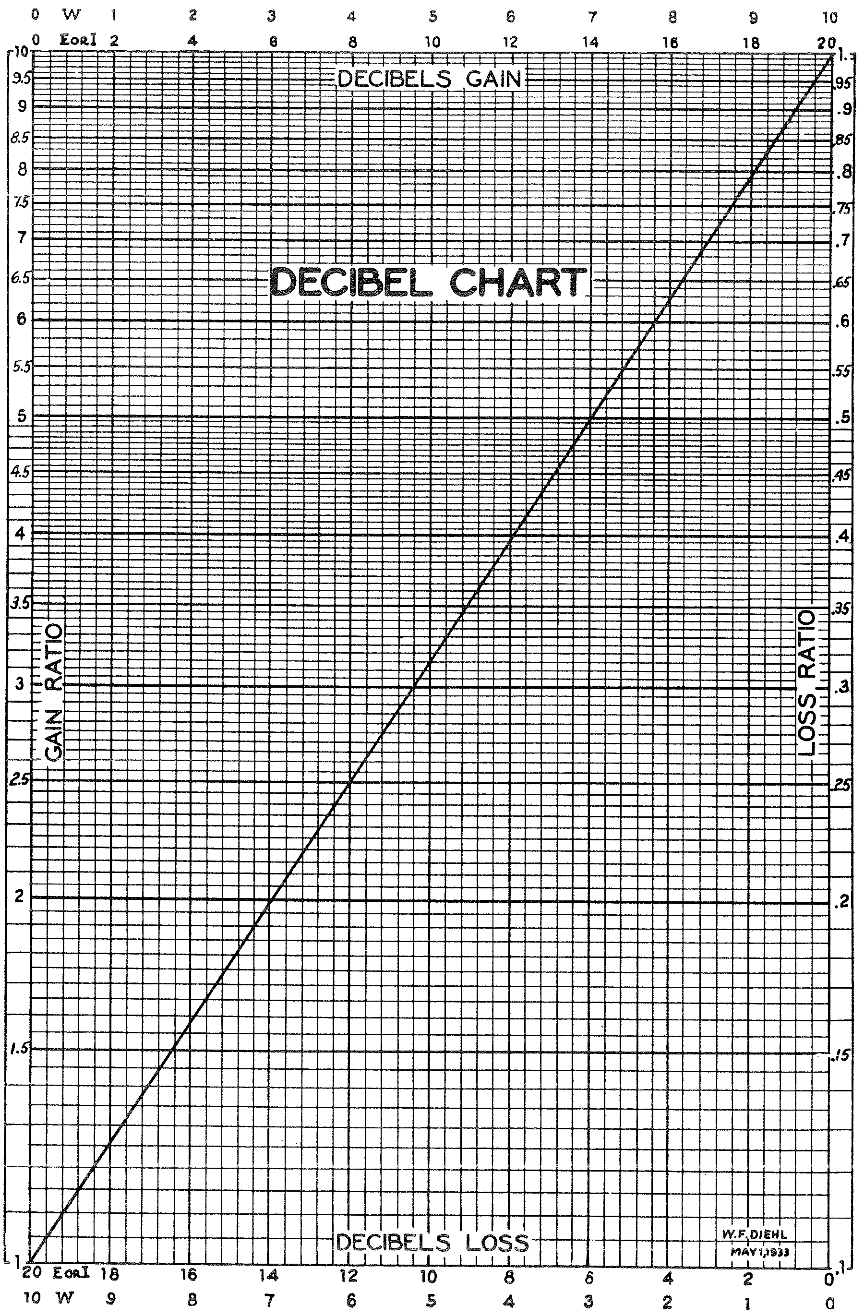
*"Mass Controlled Electrodynamic Microphones, The Ribbon Microphone," by Harry F. Olson, Journal Acoustical Society of America, No. 1, P. 56, Vol. III.

"The Ribbon Microphone," Journal of the Society of Motion Picture Engineers, Vol. XVI, No. 6, 1931, P. 695.

"On the Collection of Sound in Reverberant Rooms with Special Reference to the Application of the Ribbon Microphone," Vol. 21, No. 5, 1933, P. 655, Proceedings I.R.E.

"Use of Pressure Gradient Microphones for Acoustical Measurements," by Irving Wolf and Frank Massa, Journal of the Acoustical Society of America, Jan. 1933, Vol. IV, No. 3.



The Decibel

The decibel (db) 1/10 of the "bel" is a logarithmic unit which may be properly used to express power ratios and power levels only. It is the exact equivalent of the term "Transmission Unit" (TU) which is now obsolete, and is most useful for expressing the relation of the power output to the power input of devices in a communication system, since the overall power gain of the system may be readily obtained by adding algebraically the db gain of the individual devices comprising the entire network or system. When the power output is greater than the power input, the device acts as a repeater or amplifier and there results a transmission gain. When the power output is less than the power input, the device acts as an attenuator and there results a transmission loss.

The number of decibels (N db) by which two amounts of power differ may be expressed as follows:

$N\,db = 10 \log_{10} \frac{P_0}{P_i}$ where P_0 = power output and Pi = power input. If voltage instead of power is used, then

$$N\,db = 20 \log_{10} \frac{E_0}{E_i} + 10 \log_{10} \frac{Z_i}{Z_0} + 10 \log_{10} \frac{\cos_0 \Theta}{\cos_i \Theta}$$

For current instead of voltage

$$N\,db = 20 \log_{10} \frac{I_0}{I_i} + 10 \log_{10} \frac{Z_0}{Z_i} + 10 \log_{10} \frac{\cos_0 \Theta}{\cos_i \Theta}$$

Where I_0, E_0, Z_0, $\cos_0 \Theta$ = the output, current, voltage, impedance and power factor respectively and I_i, E_i, Z_i, $\cos_i \Theta$ = the input current, voltage, impedance, and power factor respectively.

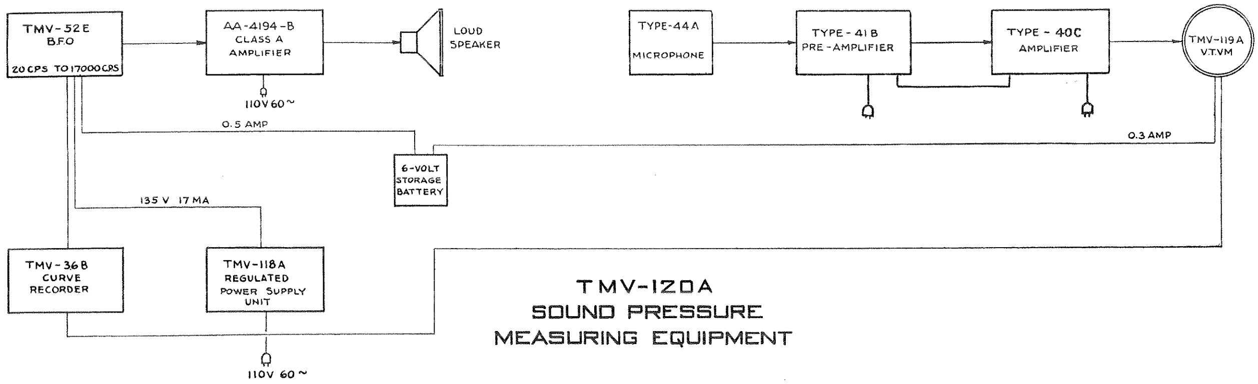
In order to save considerable time in solving the equations the chart shown herewith has been prepared.

Instructions for Using the Decibel Chart

Assume the power output of a device is twice the power input. The power output being greater than the power input, the quantity 2 is located on the left of the chart, on the "Gain Ratio" Scale. Where the horizontal 2 line joins the diagonal line, the gain in dbs is located at the top of the chart opposite the column marked "W." In this example the gain is found to be 3 db. If the ratio were 20 instead of 2, then 10 db would be added, making a total of 13 db. If the power output were less than the input, the ratio would be found on the scale marked "Loss Ratio" and the number of dbs (negative) would be located at the bottom of the chart as indicated on the "DECIBELS LOSS" scale opposite the column marked "W." For example, a loss ratio of 0.50 corresponds to a loss of 3 dbs. A loss ratio of .050 would correspond to a loss of 13 dbs.

When voltage or current is used instead of power, the chart is used in a similar manner with the exception that the scales marked "E or I" are used instead of the scale "W." In this case, when the gain or loss ratio is outside the range of the chart, it is necessary to add 20 db for each power of 10 for power gains, and add minus 20 db for each negative power of 10 for power loss. In using the final complete formula, the number of decibels should first be determined for the voltage or current ratio, then the correction for the impedance mismatch determined from the chart by assuming the impedance ratio to be a power ratio. If a correction is still required for power factor, this can also be obtained from the chart by assuming the power factor ratio to be a power ratio.

NOTE: As the ear is a non-linear device the minimum change in intensity perceptible by the average human ear is not a constant, three (3) db as is generally stated, but varies from one-half (.50) db to eight (8) db depending on the intensity, the frequency and the waveform of the sound. I fthe sound is very loud, eighty (80) db above threshold, then the ear is approximately uniformly sensitive to a change in intensity as small as one-half (.50) db over the entire frequency range of 30 cycles to 10,000 cycles. However, if the sound is of very low intensity, five (5) db above threshold, then the ear is only sensitive to a minimum change of eight (8) db at low frequencies, three (3) db at medium frequencies and eight (8) db at high frequencies.



Complete Sound Pressure Measuring Equipment TMV-120 A

comprises the following instruments

Velocity Microphone	Type 44-A
Pre-Amplifier	Type 41-B
Program Amplifier	Type 40-C
Linear Voltmeter	Type 119-A
Beat Frequency Oscillator	Type TMV-52-E
Universal Curve Recorder	Type TMV-36-B
Regulated SPU	Type TMV-118-A
Class A Amplifier	Type AA-4194-B

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RCA PARTS DIVISION

RCA VICTOR COMPANY, INC.

CAMDEN, N. J.

CHART OF FREQUENCY OR IMPEDANCE
VS.
INDUCTANCE AND CAPACITY

The Chart shown below provides a quick method of determining several unknown factors when one or more are known. The Chart covers a very wide range, namely, from 10 micro-henries to 100 henries inductance, 10 cycles to 50.000 kilocycles, 1 ohm to 10 megohms and 1 micro-microfarad to 10 microfarads. If, for example, one wishes to know the capacitance to use with a 10 henry inductor to have it resonate at 50 cycles, it can be readily seen that it would be a 1 mfd. capacitor. This is determined by finding the intersection of the vertical line representing 10 henries and the oblique line representing 50 cycles. The intersection occurs at the horizontal line representing 1 mfd. The other oblique line at this intersection represents the impedance at this frequency. This is approximately 3000 ohms.