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CONVENIENCE IN NOISE MEASUREMENT
A REALLY PORTABLE SOUND LEVEL METER

● IN THE DESIGN of noise-measuring equipment too much attention cannot be given to those mechanical features which provide a maximum of convenience in operation. Agreement upon a desirable set of electrical characteristics by manufacturers and users of noise-measuring instruments has resulted in the adoption of a set of tentative standards by the American Standards Association,[1] settling for the present any controversial points of over-all electrical performance. When these standard specifications can be met in a small, portable instrument, maximum utility is achieved. The new General Radio TYPE 759-A Sound Level Meter is the result of this approach to the problem of sound level measurement.

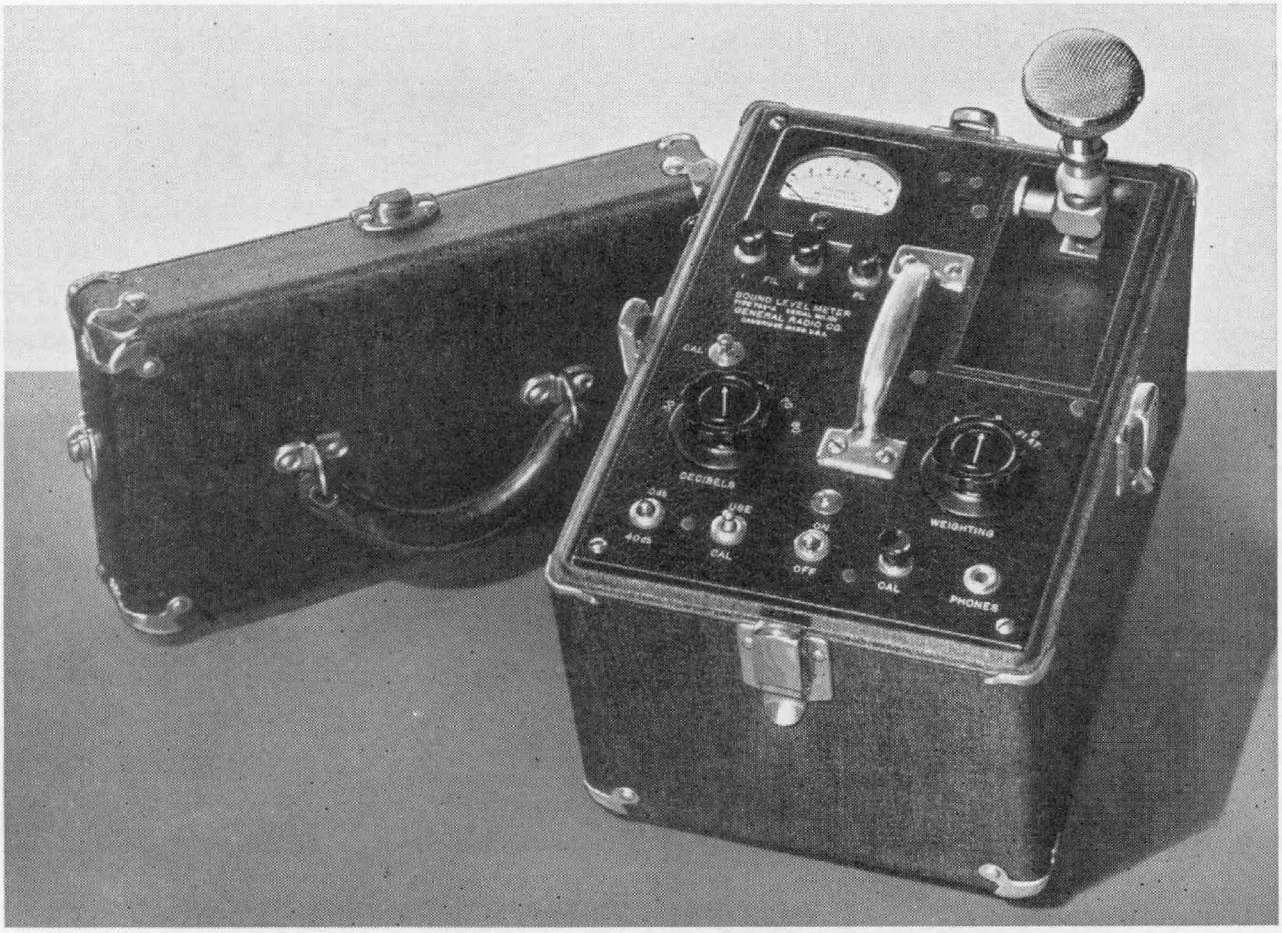
This sound level meter, which is shown on page 2, is a simple, lightweight, and inexpensive instrument. Electrically, it complies with the A.S.A. standards. It is accurate and reliable, with a high degree of calibration permanence. Other features are a nondirectional, wide-range microphone, unusual sensitivity, the provision of three weighting networks, freedom from magnetic pickup, elimination of all battery adjustments, and a simple but accurate calibrating system by means of which the sensitivity may be reset at any time to the factory value. The reference level for the new sound level meter is 10^{-16} watts per square centimeter, which is now quite generally agreed upon as a satisfactory and convenient standard. This value represents the threshold of hearing for a person whose ears are somewhat better than average.

[1] See "American Tentative Standards for Noise Measurement," Bulletin Z24.2-1936 and "American Tentative Standards for Sound Level Meters for Measurement of Noise and Other Sounds," Bulletin Z24.3-1936, published by the American Standards Association.

OTHER ARTICLES IN THIS ISSUE

Regarding frequency weighting networks (which adjust the frequency response of the sound level meter to approximate that of the human ear at various levels), the new meter more than complies with the A.S.A. specifications. In simpler types of noise-measuring instruments, a single network adjusting the over-all response to that of the ear at a 40-db level is generally considered satisfactory, but most of the more elaborate types of sound level meters include also a high level network which the A.S.A. specifies may follow the ear characteristic at a 70-db level or, optionally, may provide an equal response throughout the frequency range. Obviously, limiting the frequency response to a single low level characteristic greatly reduces the usefulness of the instrument at high levels. In actual use, it has been found that there are appreciable differences in high level readings taken with the flat characteristic and similar readings taken with the 70-db characteristic. Accordingly, the General Radio Company has provided on its new sound level meter an adjustable frequency-weighting network which allows a selection of any one of these three characteristics by merely turning the knob.[2] This has several important advantages. In the first place, it allows readings of the TYPE 759-A Sound Level Meter to be compared with those of practically any other new standard meter with a degree of accuracy which would otherwise be impossible, since it is general practice to include only one or two weighting networks on most instruments. Secondly, it is desirable in many cases to use the so-called 70-db

[2] The 40-db and 70-db equal-loudness contours are shown in Figure 2, page 4, of the July-August, 1936, *Experimenter*. The third characteristic provides practically equal response to all frequencies from 30 to 8000 cycles per second.



The TYPE 759-A Sound Level Meter with cover removed

characteristic for moderately high levels, that is, around 70 db, and the flat characteristic for extremely high levels, since this combination provides a better approximation of the action of the average ear.

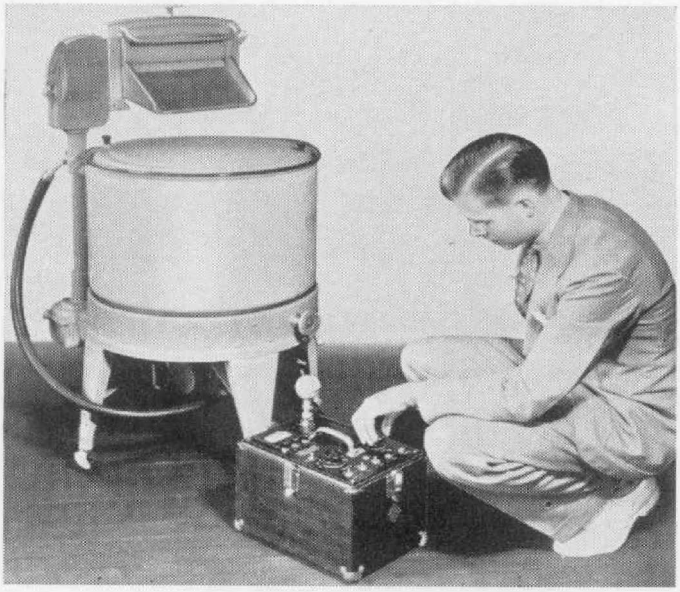
One of the most important improvements in sound measurements is brought about by the availability of practically non-directional microphones. With earlier types of noise meters and, in fact, with some types of sound level meters available at the present time, appreciable errors are introduced into the readings by the fact that the microphone responds unequally to sounds coming from different directions. The TYPE 759-A Sound Level Meter uses a piezo-electric microphone of the "sound-cell" type which is characterized by practically non-directional response, uniform frequency characteristic, and dependability. Ordinary temperature and humidity changes, as well as mechanical vibration, wind, or other factors which appreciably affect other types of microphones do not change the operation of this type of microphone to any noticeable degree. Furthermore, the microphone can be used on any reasonable length of cable without any effect upon the frequency characteristics. A vibration pickup will also be available for use with the sound level meter for comparing vibrations in solids. For special applications, other forms of microphones can be used.

The indicating meter used in the TYPE 759-A Sound Level Meter has also received its share of attention. The new meter has a scale which is practically linear in decibels throughout its range, increasing both the ease and accuracy with which readings may be taken. This desirable result has been obtained by shaping the pole pieces and

Noisy street — 92 db

suppressing the zero point of the meter, so that its response to current is practically logarithmic. Other important features of the meter are the ballistic characteristics, which closely approximate the response of the human ear to transients, and the rectifier characteristic, which adds together various sound components in much the same way as the ear.

Weight requirements have had a direct influence on the electrical elements of the sound level meter. The amplifier is of the resistance-capacitance-coupled type using 2-volt pentodes, thus resulting in a remarkably low total current drain and allowing the use of very small batteries. The use of a high impedance microphone and a properly designed decibel meter eliminates the necessity of coupling transformers in the input and output circuits, and the frequency weighting networks are made up entirely of resistors and condensers. Consequently, no inductances are used in any part of the circuit. In addition to its influence on weight, this feature results in an instrument which is essentially unaffected by alternating magnetic fields, an important consideration when meas-



Home appliance — 62 db

urements are to be made in the vicinity of electrical machinery.

The case of the sound level meter is of "airplane luggage" construction, which is light and at the same time unusually strong. It is completely shielded and covered with a durable waterproof material. The battery compartment is built into the case and all connections to the batteries are made automatically when the cover of this compartment is closed. The panel and microphone compartment consist of a single aluminum alloy casting which is light, tough, and rigid, and which is finished in black crackle lacquer. All other mechanical parts have been designed for light weight and small size.

In portable instruments it is desirable to have as few extra parts as possible. In the TYPE 759-A Sound Level Meter the microphone is mounted directly on a support on top of the instrument, and when not in use the whole microphone assembly folds down into a compartment in the panel. Thus, for average noise measurements, it is merely necessary to lift the microphone out of its compartment and turn on the battery switch. No microphone connections need be made, nor are any tripods, microphone stands, or long cables necessary in most measurements. An extension cable and tripod are available, however, for those few applications where they are deemed necessary.

The sound level meter is distinguished by the unusual simplicity of its controls. The two large knobs on the panel control the decibel switch and weighting networks. Push buttons are provided for checking the battery voltages. A red line on the meter shows when the batteries should be replaced. Because of the use of a ballast tube and a compensated amplifier circuit, the exact battery voltages are not important. This eliminates the need for any filament rheostat or other battery adjustments, which is a great advantage since such adjustments are frequently overlooked or forgotten, with resulting errors in the readings.

The total sound intensity range covered by the sound level meter is

Office — 70 db

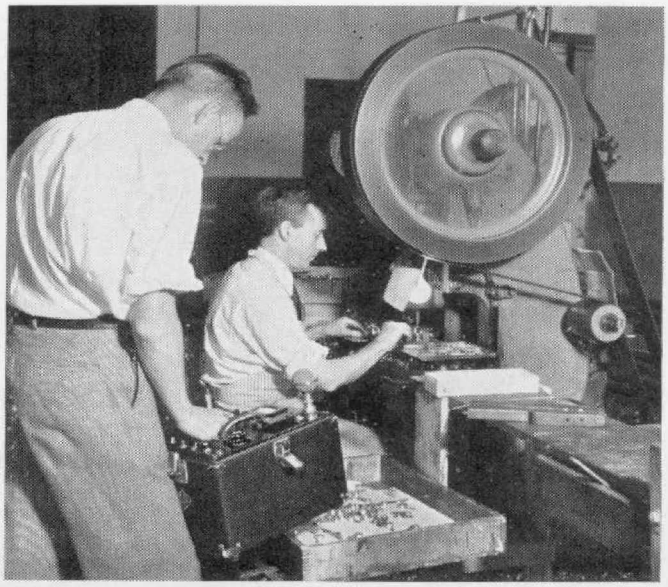
from 24 to 130 decibels above the standard reference level. This 106-db range actually represents a sound power ratio of about 4×10^{10} or a sound pressure ratio of 2×10^{5}. Of course, the lower limit of 24 db will not always

be required for ordinary types of sound measurements, since a minimum of 30 or 35 db has generally been found satisfactory for most commercial work. Nevertheless, it is extremely convenient to have this sensitivity available and with the increasing demands for lower noise levels it is expected that the lower range of the instrument will be used considerably more within the next few years. Similarly, the upper limit of 130 db is above the threshold of feeling, but accurate readings in this range are necessary in order to measure small improvements in high sound levels, since it is frequently through a series of relatively small reductions that the total level is finally brought down to a reasonable value. In addition, many common sounds such as automobile horns, etc., are within the upper range of the instrument. The accompanying photographs show many common applications of sound level meters and indicate average db readings in typical cases.

With normal tubes and batteries, changes in sensitivity of the sound level meter are surprisingly small as the batteries run down. This is due mainly to the compensated amplifier circuit and the use of a ballast tube. The battery circuits in the instrument are suitably isolated so as to minimize degenerative or regenerative effects caused by the increasing resistance of the batteries as they wear out.

This means that for most practical purposes the sensitivity of the instrument may be considered as constant and the calibration checked only at infrequent intervals. It is realized, however, that occasional sets of tubes or batteries will behave somewhat differently from the average, and that for some types of work comparative measurements to a fraction of a db are required. Accordingly, a calibration checking system has been built into the sound level meter which allows the sensitivity to be reset quickly and easily to the original value. In order to check the calibration the instrument is connected to an a-c power line of any commercial voltage or frequency. This supplies an alternating voltage which is used to check the amplifier gain. Convenient push buttons and switches on the panel allow the check to be made quickly, and a screw driver adjustment is provided for resetting it if necessary. In those few locations where

Country road — 28 db



Punch press — 110 db

an a-c power line is not available, an audio-frequency oscillator may be used equally well.

To minimize errors resulting from mechanical vibration, all tubes are suspended on a rubber mounted shelf. The method of suspension is such that the movement of the shelf is quite free for small vibration amplitudes but is sufficiently damped so that no clamping mechanism is necessary. The case itself is provided with soft rubber feet which reduce still further any vibrations which may be transmitted to the tubes as well as cushioning the entire assembly.

The result is a sound level meter which can be carried about easily and used practically anywhere. The total weight, including all batteries, is somewhat under twenty-four pounds, and the assembly is virtually unaffected by ordinary shocks or vibration, or by magnetic fields. In accuracy and simplicity of operation the TYPE 759-A Sound Level Meter represents a distinct advance in the design of noise measuring apparatus. — H. H. SCOTT

The price of the TYPE 759-A Sound Level Meter includes all tubes and one set of batteries. If an extension cable is required for the microphone, the TYPE 759-Pl Cable and tripod should be used. The cable is twenty-five feet long and the tripod is of the folding type which can easily be carried. The price of the cable and tripod is $9.50.

All sound level meters in the initial manufacturing lot have been sold. Additional units will be available December 20, 1936. Complete specifications are listed on page 7 of Catalog J.

Type	*Code Word*	*Price*
759-A	NOMAD	$195.00

TYPE 759-A Sound Level Meter is manufactured under the following U. S. Patents and license agreements:
1. Patents of the American Telephone and Telegraph Company, solely for utilization in research, investigation, measurement, testing, instruction and development work in pure and applied science.
2. Patent No. 1,542,995.

AN OHMMETER FOR THE MEGOHM RANGES

● IN JANUARY, 1925, the General Radio TYPES 287-A and 287-B Ohmmeters were announced to the succinct description, "This instrument consists of a battery and meter in series with a resistance, and a rheostat shunted across the meter to provide a zero adjustment. The dial is calibrated directly in ohms. Clip leads are provided for convenience in connecting the ohmmeter to the device to be measured." The instruments were 0 to 5 milliampere meters connected in series with the unknown external and a known internal resistance and had ranges of 0-2000 or 0-10,000 ohms. Internal 1.5- or 4.5-volt batteries supplied the measuring power. The instruments simply measured the total current flowing when the unknown was connected and were calibrated directly in ohms. These ohmmeters were used for the checking and servicing of radio and electrical devices to such an extent that instruments of similar construction will be found today to be the basis of every radio service and repair kit.

The upper limit of resistance is directly dependent on the sensitivity of the milliammeter used and hence the range is restricted to that possible with the most sensitive indicator commercially available in an inexpensive model. By employing a vacuum-tube amplifier ahead of the indicating meter, however, the range of measurement

Sufficient overlaps are provided on the TYPE 487-A Megohmmeter to permit the use of the open portion of the scale for all values of resistance within the normal range of the instrument

can be extended by a factor of 10^6, the change in range being roughly parallel to that obtained by using a vacuum-tube indicator in the conventional bridge circuit.*

The TYPE 487-A Megohmmeter, illustrated at top of page, is a direct-indicating ohmmeter for the megohm ranges of resistance made possible through the use of a vacuum-tube voltmeter as the indicator. The internal battery has been replaced by the voltage drop across a portion of the output of a power-line rectifier which also supplies the operating voltages for the vacuum-tube voltmeter.

In operation the unknown high resistance is compared in a series connection with an internal standard of 1, 10, 100, or 1000 megohms. As in the conventional ohmmeters, the precision of indication of the megohmmeter is greatest when the internal resistances are nearly equal. The scales of both instruments are similar in spread. The four successive ranges of the megohmmeter differ in readings by factors of 10 to 1, while in each range the comparison of the unknown against the standard can be made accurately within a ratio range of 10 to 1 in either direction from the center-scale value. The generous overlap thus provided makes an open portion of the scale available for all measurements within the normal range of the instrument.

The equivalent ohmmeter battery voltage is fixed at 150 volts, but the actual voltage applied to the specimen varies with the scale reading, being zero at the low-resistance end of the scale and half the total voltage, or 75 volts, at the center-scale reading where the unknown and standard resistances are equal.

There is no danger whatever of shock from the exposed test terminals, for their internal output impedance is never less than one megohm and may be 10, 100, or 1000 times that value.

In the design of the instrument, particular care has been given to the elimination of the objectional features that might be expected to be inherent in the adaptation of the ohmmeter and vacuum-tube voltmeter to the measure-

* R. F. Field, "Bridge + Vacuum Tube = Megohm Meter," General Radio *Experimenter*, Vol. VIII, Nos. 1-2, June–July, 1933.

Editor and notorious photographer

The infirm collapsed

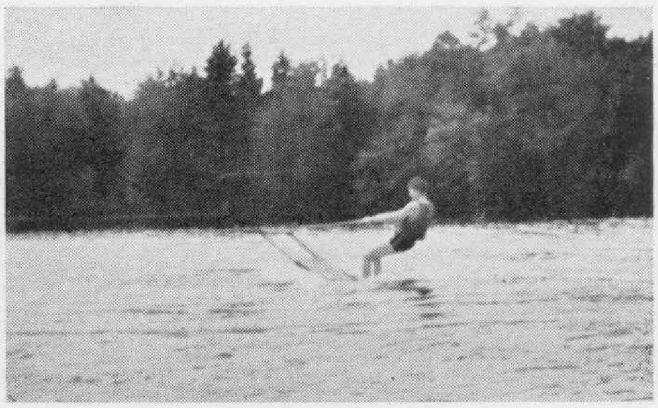
E'NGINEERS RELAX

● **FOR SEVERAL YEARS** Mr. Robert F. Field has been host to the Engineering Department at an annual house party in his Lake Winnipesaukee summer cottage. Here the group breaks up to pursue the various amusements of cards, aquaplaning, mountain climbing, swimming, badminton, according to age and temperament. The affair starts Friday evening and ends Sunday afternoon. About twenty are usually present, and a good time is had by all.

The usual program was varied this year by a kind and courageous luncheon invitation from the Keith Henneys (**Electronics** editor and notorious professional amateur photographer) who have a place about fifty miles away (making them neighbors in New Hampshire). Well stuffed with chicken and things, the more infirm members of the staff collapsed on the grass, while the others wandered about the neighboring mountainside calling to the birds. Having consumed all the food, the party returned to Mr. Field's, and so, after a variety of amusements, to bed.

Sunday was a day of rest for most but some went aquaplaning (and did their resting Monday).

Some went



aquaplaning

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