The GENERAL RADIO EXPERIMENTER

VOL. IX. No. 11 APRIL, 1935

ELECTRICAL COMMUNICATIONS TECHNIQUE AND ITS APPLICATIONS IN ALLIED FIELDS

USING THE NOISE METER WITH A VIBRATION PICKUP

IN industrial noise measurement, particularly when attempting to eliminate objectionable noise in machinery or to reduce sound transmission through walls, it is often useful to make a quantitative measurement of the comparative amplitudes of vibration of the surfaces producing or transmitting the sound. The use of a piezo-electric vibration pickup in conjunction with the TYPE 559-A Noise Meter is a convenient and simple method of measuring these relative amplitudes of vibration.

The piezo-electric vibration pickup transforms the motion of the surface into an alternating voltage of substantially identical waveform. The face of the vibration pickup is covered with a piece of felt, through the center of which a small plunger projects. This plunger bears on the surface against which the pickup is held, and transmits the motion of the surface directly to the piezo-electric crystal. The resultant variations in pressure on the surface of the crystal produce corresponding alternating voltages.

Figure 1 shows the method of coupling the pickup to the noise meter. The transformer is required in order to match the high impedance of the piezo-electric unit to the low impedance of the noise meter input circuit.

When comparing two vibrations of the same frequency, the readings will

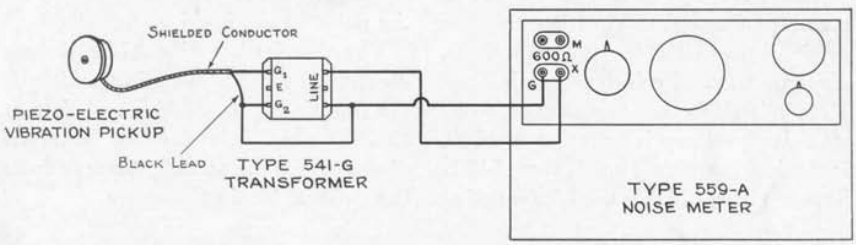


FIGURE 1. Equipment for measuring relative intensity of vibrations of surfaces

indicate directly in decibels the difference between the two vibrations. Relative measurements of this sort are extremely valuable when attempting to reduce the amplitude of a vibration or to trace its source.

Since the noise meter amplifies the various frequencies with a characteristic closely approaching that of the human ear, the readings of the meter, when used with a vibration pickup, are very good indications of the amount of audible noise which will be caused by the vibration being measured. When the equipment is used to compare two vibrations of different frequencies, not only the amplitudes but the frequencies are taken into account, so that the readings are closely related to the annoyance which the vibrations will cause to the average human being.

This equipment is being used by several large manufacturers of acoustic insulating material. Among these is the Seaman Paper Company of Detroit, manufacturers of "Seapak" and other well-known types of insulating materials. This company has used the noise meter both with and without the vibration pickup for extensive tests in the sound-proofing of automobiles, railroad cars, offices, etc. In one case, measurements made with the noise meter were the cause of the Seaman Company obtaining an order for sound-proofing a number of new air-conditioned passenger coaches for a large middle-western railroad.

The science of noise measurements as applied to industrial problems is comparatively new and its entrance into the industrial picture has been accompanied by so much misleading information that the possibilities of equipment of this type have been frequently over-rated. No noise-measuring equipment will tell a manufacturer all that is wrong with his product, but a good noise meter gives definite readings of noise level which show immediately whether constructional changes and adjustments result in an increase or a decrease in noise. This type of instrument is not excessively expensive and is the most satisfactory for industrial use. The use of a vibration pickup extends further the usefulness of the noise meter by allowing comparative measurements of surface vibrations which frequently enable the user to trace a disagreeable sound back to its source.

— H. H. Scott

The Type 559-A Noise Meter is a standard General Radio item and was originally described in the March, 1933, *Experimenter*. The instrument is complete in itself for measurements of over-all noise level and is priced at $190.00, including tubes. The Type 541-G Transformer, which is used for coupling a high-impedance vibration pickup to the noise meter, is priced at $10.00.

The particular vibration pickup mentioned in the foregoing article is the Astatic Type C-104-S and lists at $21.00. This unit can be obtained directly from the manufacturer or from the General Radio Company.

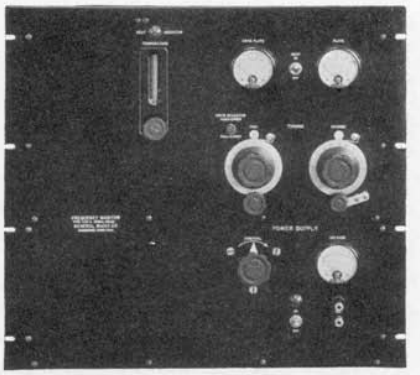
A FREQUENCY MONITOR FOR POLICE AND HIGHER FREQUENCIES

FOR limited service transmitters which operate, for the most part, at frequencies above the standard broadcast band, some positive means of determining the accuracy of the transmitter frequency is necessary. This is particularly true with police broadcast transmitters, where too marked a deviation from the assigned channel may produce sufficient interference to handicap seriously the reception in a nearby municipality operating on an adjacent channel.

Although the tolerances specified by the Federal Communications Commission are not sufficiently narrow to require the 50-cycle type of visual deviation indicator that is used in the normal broadcast band, they do necessitate the use of an accurate type of frequency monitor. Heterodyne frequency meters and tuned-circuit instruments in general, unless of an expensive type, are not satisfactory from either the standpoint of accuracy or that of convenience.

The most acceptable instrument from all angles is the piezo-electric monitor. Its accuracy is in excess of that required at present and it is adequate to take care of more rigid tolerances in the future. It requires a minimum of attention on the part of the operator, whose total effort consists of listening to a beat tone whenever it is desired to check the transmitter frequency.

The TYPE 475-A Frequency Monitor has been designed with the requirements of police transmitters in mind. It consists of a temperature-controlled piezo-electric oscillator, a detector, an audio-frequency amplifier, and a built-in a-c power supply. Monitoring is accomplished by means of the beat frequency, or frequency difference, between the piezo-electric oscillator and the transmitter. Terminals are provided for connecting head telephones or a loudspeaker for listening to the beat tone. The presence of an audible tone in the loudspeaker is an indication that the transmitter has deviated from its assigned frequency by an amount equal, in cycles per second, to the beat frequency.



TYPE 475-A Frequency Monitor

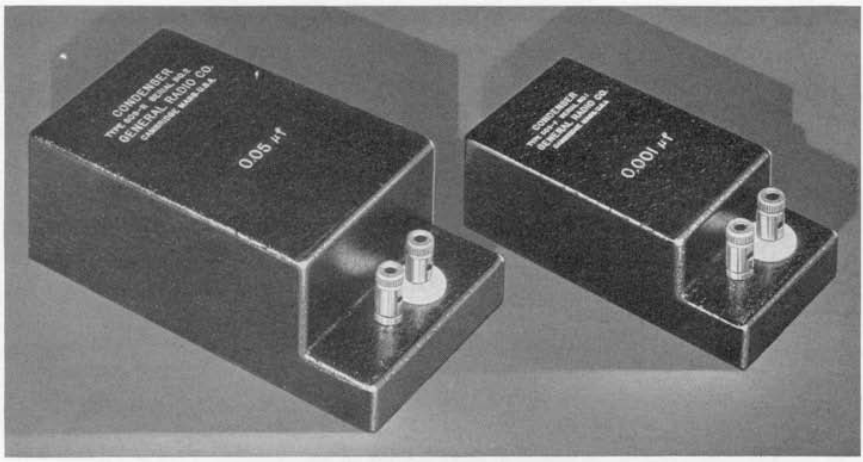
Present-day frequency tolerances on police transmitters are $\pm 0.04\%$. At a frequency of 1600 kc, this is equivalent to ± 640 cycles. At 2450 kc the tolerance is 980 cycles. If the transmitter is adjusted until zero audible beat is reached or until a low tone is heard in the loudspeaker, the operator is assured that the station is operating well within the specified frequency tolerance.

This method of frequency monitoring is accurate, convenient, and comparatively inexpensive. For those police departments which continually receive from the Federal Communications Commission reports of off-frequency operation, the TYPE 475-A Frequency Monitor is the obvious remedy.

The TYPE 475-A Frequency Monitor is priced at $330.00 complete with vacuum tubes. In addition a TYPE 376-J Quartz Plate is required, priced at $85.00, making the price of the complete monitor $415.00, f.o.b. Cambridge. Deliveries can be made from stock. — C. E. WORTHEN

MICA CONDENSERS FOR THE LABORATORY

FOR use in the laboratory, mica condensers, due to the wide range of possible capacitance values in units of small physical size, make excellent secondary standards. The General Radio Company now has available the TYPE 509 Mica Condensers, designed specifically for this purpose. Similar in general construction to the TYPE 505 Condensers,* their larger size permits much higher capacitance values, extending up to 1.0 μf.



TYPE 509 Mica Condensers

TYPE 509 Mica Condensers are carefully assembled and mounted to insure the stability that is necessary in a laboratory standard. After assembly, the condensers are put through an artificial aging process which removes most of the capacitance change which would otherwise occur due to natural aging. That which remains is so small as to be negligible over long periods of time. After aging, the capacitance is adjusted to be within 0.25% of its nominal value. The exact value of capacitance is measured to 0.1% and recorded on the calibration certificate.

The available sizes are so chosen that

*A. E. Thiessen: "Recent Developments in Mica Condensers," General Radio *Experimenter*, Vol. VII, No. 8, January, 1933.

a minimum of duplication is required to obtain all values in any one decade. The maximum safe voltage which can be applied is a function of frequency, as shown in the price list. These limits are imposed by the maximum power dissipation of the unit. At frequencies higher than those stated, the maximum safe voltage varies inversely as the square root of the frequency. All voltages are peak values.

The power factor is less than 0.05% for all sizes. The temperature coefficient of capacitance is less than 0.01% per degree Centigrade.

TYPE 509 Mica Condensers are mounted in two sizes of cast aluminum cases. The dimensions of the larger size are 6 x 3⅜ x 2⅜ inches, over-all; those of the smaller are 4⅞ x 2½ x 1⅞ inches, over-all. The net weights are 3½ and 2½ pounds respectively.

TYPE 509 MICA CONDENSER

Type	*Capacitance*	*Maximum Voltage*	*Maximum Frequency*	*Case*	*Code Word*	*Price*
509-F	0.001 μf	1200 v	440 kc	Small	GOODCONBOY	$12.50
509-G	0.002 μf	700 v	640 kc	"	GOODCONBUG	12.50
509-K	0.005 μf	700 v	260 kc	"	GOODCONCAT	12.50
509-L	0.01 μf	700 v	130 kc	"	GOODCONDOG	12.50
509-M	0.02 μf	700 v	65 kc	"	GOODCONEYE	15.00
509-R	0.05 μf	700 v	60 kc	Large	GOODCONFIG	18.00
509-T	0.1 μf	700 v	30 kc	"	GOODCONROD	22.00
509-U	0.2 μf	700 v	16 kc	"	GOODCONSIN	25.00
509-X	0.5 μf	500 v	12 kc	"	GOODCONSUM	32.00
509-Y	1.0 μf	500 v	6 kc	"	GOODCONTOP	48.00

A NEW REACTANCE CHART

THE June, 1934, issue of the General Radio *Experimenter* announced that a considerable quantity of reactance-computation charts were available for distribution to readers. So many requests were received that our supply was very quickly exhausted.

We have recently prepared a new and improved chart which has a number of advantages over the older one and we shall be glad to forward a copy to everyone who requests it.

230-VOLT TYPE 200-C VARIACS

FIGURE 1. TYPE 200-CUH 230-Volt Variac, unmounted

IN many applications of the Variac adjustable transformers, models for use either on 230-volt circuits or on 115-volt lines for output voltages above 135 volts are required. To meet the many requests for units smaller than the 2-kva TYPE 100 Variac, there have been developed two models similar to the TYPE 200-C for the higher voltage circuits.

These new models are mechanically identical and interchangeable with the TYPE 200-CU or TYPE 200-CM Variacs. They are intended for the following uses: on 230-volt inputs to deliver output voltages continuously adjustable from 0 to 270 volts; on 230-volt input circuits to furnish output voltages from 0 to 230 volts with slightly higher wattage ratings; on 115-volt circuits to deliver output voltages from 0 to 270 volts.

Dials reading directly in output voltage with an accuracy of $\pm 2\%$ for the 270-volt output are furnished with each unit.

The mounted model, TYPE 200-CMH, is regularly supplied with cord and internal connections for these voltage ratings. By means of seven terminals which are provided and which are easily accessible, the other input-output voltage combinations are possible, with either the mounted or the unmounted models.

In the table below, the reference letter corresponds to a similar letter on the "Output Voltage-Continuous Output Current" curves of Figure 2.

Reference Letter	*Input 50-60 Cycles*	*Output 50-60 Cycles*
A	230 volts	0-230 volts
B	230 volts	0-270 volts
C	115 volts	0-270 volts

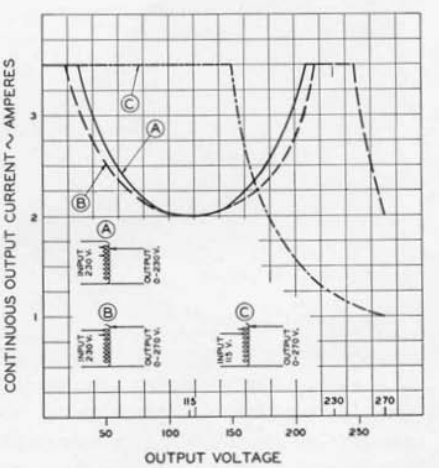


FIGURE 2. Continuous output current vs. output voltage for the three different connections of TYPE 200-CUH and TYPE 200-CMH Variacs

The current ratings shown in the curves are for *continuous* duty. Where the load is applied intermittently over comparatively short periods of time, these ratings may be exceeded materially without harm to the Variac.

TYPE 200-CMH Variac, mounted model, complete with calibrated dial, case cord and plug, switch, and convenience outlet (Code Word, BAIRN).

Net Weight: 10 pounds.

Price $21.50

TYPE 200-CUH Variac, identical with TYPE 200-CMH except intended primarily for behind panel mounting, and not supplied with case or wiring conveniences (Code Word, BAGUE).

Net Weight: 9 pounds.

Price $18.50

For detailed information concerning the construction and use of the Variac transformers, the reader is referred to the following General Radio publications, copies of which will be sent free of charge upon request: Bulletin 936 (Parts Catalog); General Radio *Experimenters:* June-July, 1933; July-August, 1934; January, 1935.

A LARGE CAPACITANCE OIL CELL

THE TYPE 683-C Oil Cell has been designed for the measurement of the power factor and dielectric constant of oil when 1000 cc of the oil are available. This cell follows the design originated by Professor J. C. Balsbaugh[1] of the Massachusetts Institute of Technology. It is similar to the TYPE 683-A Oil Cell[2], but larger in all dimensions.

The general arrangement of its parts is shown in Figure 1, which is a photograph of the cell. The measuring electrodes are concentric polished-nickel cylinders. The inner cylinder is mounted on a central tubing of pyrex glass through nickel discs. The outer cylinder is supported on two pyrex rods fastened to two guard cylinders, which are mounted on the central tubing in the same manner as the inner

[1] J. C. Balsbaugh and A. Herzenberg, "Comprehensive Theory of a Power-Factor Bridge," *Journal of the Franklin Institute*, Vol. 218, No. 1, July, 1934, pp. 49-97.

[2] R. F. Field, "Power-Factor Measurements in Oil Analysis," General Radio *Experimenter*, Vol. IX, No. 4 Sept. 1934, pp. 1-5.

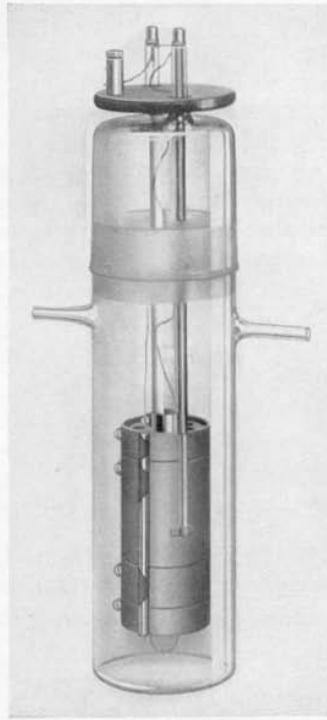


FIGURE 1. TYPE 683-C Oil Cell

cylinder. These mounting discs are punched with holes to allow circulation of the oil being measured and of the cleaning liquid used when the oil is changed.

This type of construction provides a three-terminal condenser in which there is no solid dielectric between the measuring electrodes. The direct capacitance of these electrodes has a practically zero power factor and a unity dielectric constant. An energy loss can occur only in the air between the plates and in the gas occluded on their surfaces. The latter loss is minimized by a heat treatment of the nickel tubing, in which the natural occluded gases are replaced by hydrogen.

The leads from the outer and guard cylinders are nickel wires, that from the former being shielded by nickel tubing connected to the guard. A flexible copper lead from the inner cylinder passes inside the central pyrex tubing, which is large enough to contain a thermometer for measuring the temperature of the oil.

The electrode structure is mounted in a pyrex glass container, having a ground joint and two tubulations. The cell may thus be operated in a vacuum or in an atmosphere other than air. The appearance of the mounted cell is shown in Figure 1. The over-all length is 18 inches and width across tubulations, 8 inches. The outside diameter of the glass container is 4 inches.

The direct capacitance of the measuring electrodes is 90 $\mu\mu$f with a spacing of .075 inch. The volumetric capacity of the container is 1000 cc.

This oil cell may be used only with a bridge having a Wagner ground or a suitable guard circuit. It must be placed in a metal shield which may be the container of the bath for temperature control. The liquid of this bath must be conducting or a close-fitting tin-foil jacket used so that the slight leakage over the outer glass surface may not introduce a loss in the capacitance of the measuring electrodes.

The price of the TYPE 683-C Oil Cell is $250.00, complete as shown in Figure 1. The price of the electrode structure alone, mounted on a 10-inch pyrex tubing and provided with 12-inch leads, is $215.00. —R. F. FIELD

THE GENERAL RADIO COMPANY mails the Experimenter, without charge, each month to engineers, scientists, and others interested in communication-frequency measurement and control problems. Please send requests for subscriptions and address-change notices to the

GENERAL RADIO COMPANY

30 State Street - Cambridge A, Massachusetts