the GENERAL RADIO Experimenter

Since 1915 — Manufacturers of Electronic Apparatus for Science and Industry

VOLUME XXIX No. 3 AUGUST, 1954

A POCKET-SIZE TRANSISTOR OSCILLATOR FOR AUDIO-FREQUENCY TESTING

● **FOR SEVERAL YEARS,** the General Radio Company has carried on an experimental development program in transistor circuits and their applications. The first instrument to result from this program is the TYPE 1307-A Transistor Oscillator, a pocket-size source of test voltage at 400 and 1000 cycles.

Completely self-contained, including batteries and output meter, it can be easily held in the hand, as shown in Figure 1. The small and convenient size of this oscillator, together with its output meter (an unusual feature in so small an oscillator), makes it an extremely useful test device. Because of its small size, it is easy to carry and use in any location, particularly in the field, where transportation is usually a problem and stable power lines are rare. The output meter makes possible quantitative tests, such as supplying a known calibration voltage to the TYPE 1552-A Sound-Level Calibrator for standardizing sound-measuring equipment, as shown in Figure 3. Others include making continuity checks of audio equipment, setting operating levels, checking the sensitivity of oscillographs, and making preliminary calibrations of electronic systems. It is also a convenient power source for bridge measurements at 400 and 1000 cycles.

Circuit

As shown in the schematic diagram of Figure 2, the TYPE 1307-A Transistor Oscillator uses a P-N-P junction transistor in a Hartley oscillator circuit. The inductor of this tuned circuit is an iron-cored coil with an air gap. The coil is divided into two parts to aid in obtaining the proper d-c operating voltages on the transistor, but the large by-pass capacitor connects the two parts in series for the oscillatory currents. The tuning capacitor is connected across the full

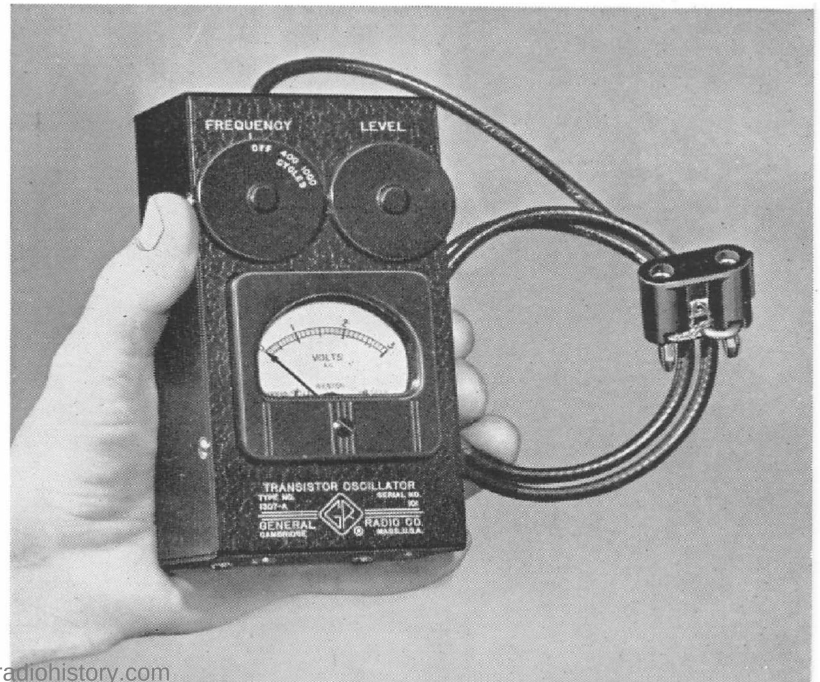


Figure 1. View of the Transistor Oscillator.

Also

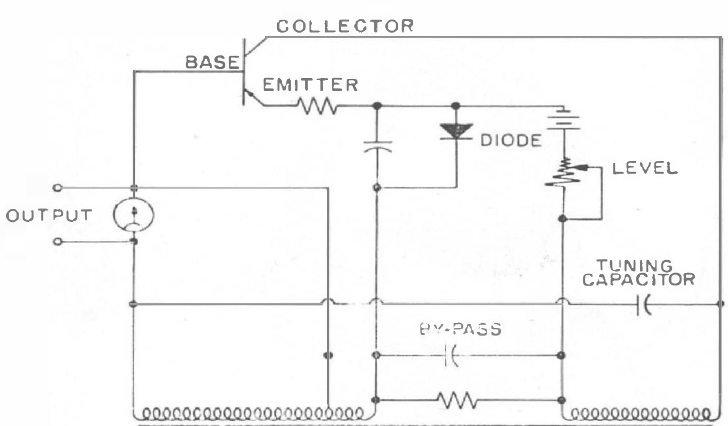
IN THIS ISSUE

Page
SOUND-SURVEY METER AS AN AID TO CHORAL DIRECTORS 4
CATALOGS FOR STUDENT USE 5
GENERAL RADIO SALES ENGINEERS . . 6

coil for 400-cycle operation, and it is switched to be across only part of the coil for 1000 cycles. The control at the left in Figure 1 operates the switch for shifting the frequency.

The circuit of Figure 2 is readily understood in terms of the analogous vacuum-tube-triode circuit. Here, the emitter of the transistor corresponds to the cathode of the vacuum tube; the base, to the grid; and the collector, to the plate. The main part of the tuned circuit for 400-cycle operation is connected between the base and collector (grid and plate), and the emitter (cathode) is connected to the coil at a point between those two elements. The circuit obviously then is equivalent to a Hartley oscillator circuit.

A germanium diode is used as part of the circuit that sets the bias voltage for the base. The operating characteristics of this diode approximate those of the emitter-base junction of the transistor so that oscillations will start for a wider range of temperature, of battery voltage, and of transistors than is readily possible with a linear-resistor in the bias circuit.[1]



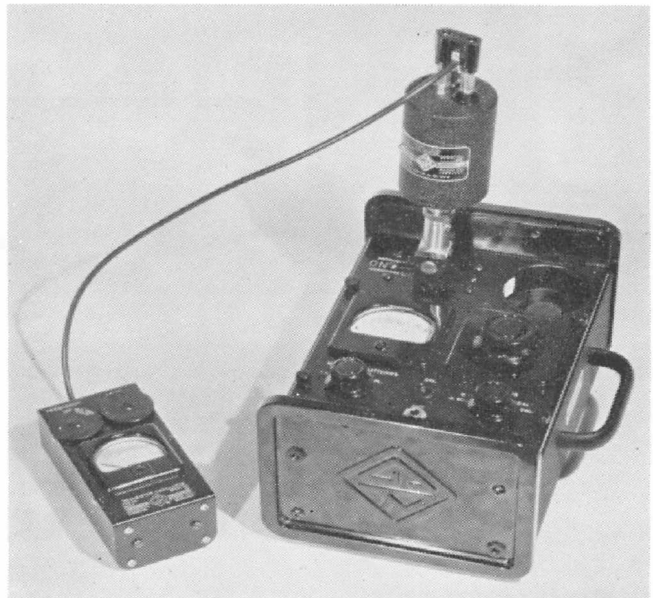


Figure 3. The Transistor Oscillator used as a tone source for the Type 1552-A Sound-Level Calibrator to standardize the Type 1551-A Sound-Level Meter.

A small resistance in the emitter circuit provides degenerative feedback to improve the waveform of the oscillation. As much feedback is used as is consistent with the output requirements and reliability of starting.

Inductor

The inductor used for the tuned circuit was chosen on the basis of a compromise between size and low losses. A large coil with low losses leads to good efficiency and possible low distortion in the output wave. But a relatively small inductor was desired in order to make the whole oscillator small. By the use of high-quality iron, by careful selection of the air gap, and by setting the impedance at the correct level, the distortion in the output wave was held to 5% even with reasonably efficient generation of the signal, using a "postage-stamp" coil.

[1] D. E. Thomas, "Low-Drain Transistor Audio Oscillator," *Proc. I.R.E.*, 40, 11; November, 1952, pp. 1385 - 1395.

Figure 2. Simplified schematic circuit diagram of the Transistor Oscillator.

Output Circuit

The inductor is also used as an output transformer for supplying a 600-ohm load, one of the standard impedance loads for audio-frequencies. For efficient energy transfer, the load is coupled directly to the oscillator. As a result of this direct coupling, a reactive load will shift the frequency of oscillation. Advantage can be taken of this effect, if one desires to shift the oscillator frequency by a small amount from the nominal values of 400 and 1000 cps, although normally an effect of the load on the frequency of oscillation is somewhat of a disadvantage. In actual practice, however, the effect of the load is relatively small, because of the low source impedance of the oscillator output. If the load is resistive, the frequency is essentially independent of the load. Even as low a reactance as 400 ohms at 400 cps (that of a one-microfarad capacitor) shifts the frequency by less than 10%.

The output voltage can be set by an adjustable resistance in series with the battery supply. This circuit arrangement conserves battery life when only low output is needed. The output control is on the right in Figure 1. The maximum output is at least 2 volts across a 600-ohm load.

The rectifier-type voltmeter, 3 volts full scale, indicates the output voltage. As a good compromise between small size and good readability of scale, a 2½" meter was chosen. This meter size was one important factor in determining the ultimate size of the instrument, as can readily be seen from the picture of Figure 1.

CORRECTION

The price of the TYPE 1570-ALM and TYPE 1570-AHM Automatic Voltage Regulator is $465. The price of $470 given in last month's *Experimenter* is in error.

Battery

The transistor oscillator has a much better over-all efficiency than can be obtained with a vacuum-tube oscillator, because of the power required to heat the filament of the vacuum tube. The good efficiency means low battery drain and long battery life. The average life of the three mercury batteries used is over 100 hours.

The battery circuit is opened by setting the FREQUENCY control switch in the OFF position. No warm-up time is required for this oscillator so that the switch can normally be left OFF except when the oscillator is actually being used.

Carrying Case

The over-all size of the TYPE 1307-A Transistor Oscillator is identical with that of the TYPE 1555-A Sound-Survey Meter, and hence the same carrying case can be used, as shown in Figure 4. For field use, the case provides both protection and ease of carrying.

— ARNOLD PETERSON

Figure 4. The Transistor Oscillator fits into the same convenient leather carrying case as the Sound-Survey Meter.

SPECIFICATIONS

Frequency: 400 and 1000 cycles accurate to ±3% at 2 volts output into a 600-ohm resistive load. The frequency decreases slightly with increase in output level. A reactive load will shift the frequency, since the load is coupled directly into the tuned circuit.

Output: Adjustable. Maximum output is at least 2 volts across 600-ohm load.

Distortion: Less than 5% at 400 c and at 2 volts across 600-ohm load. It may be slightly higher at 1000 c.

Voltmeter: 3 volts full scale, calibrated directly in volts at the output terminals.

Output Circuit: The output cable is terminated in a 274-MB double plug. No connection is made to the case.

Batteries: Three mercury A batteries (Mallory RM-1 or equivalent) are supplied.

Transistor: One P-N-P junction transistor (Raytheon Type 721 or equivalent) is supplied.

Case: Aluminum, black finish.

Carrying Case: A leather case with straps is available, Type 1555-P1.

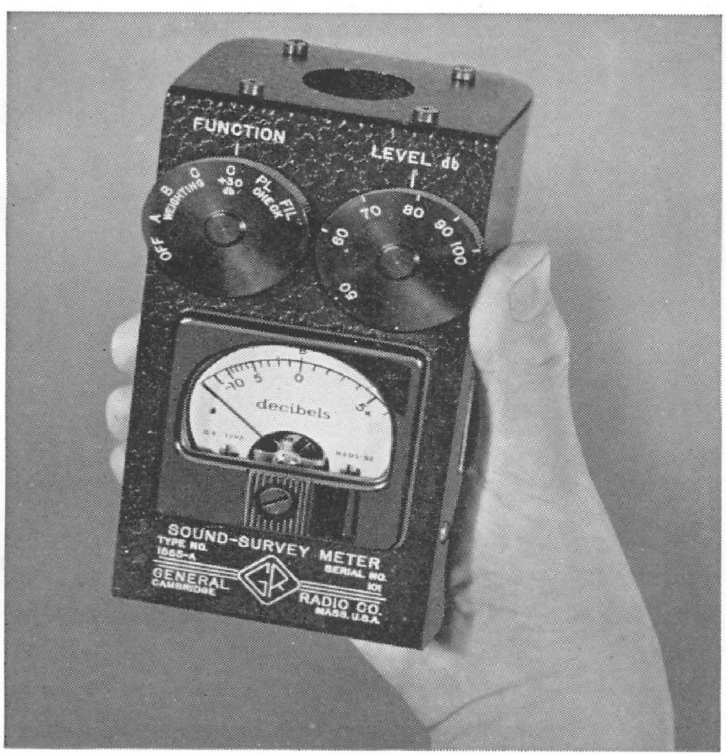
Dimensions: 6 x 3⅛ x 2½ inches over-all, but excluding output cable.

Net Weight: 1 pound, 14 ounces, with batteries.

Type		*Code Word*	*Price*
1307-A	Transistor Oscillator	OMEGA	$88.00
1555-P1	Leather Carrying Case	CASER	10.00

SOUND-SURVEY METER AS AN AID TO CHORAL DIRECTORS

In the April, 1952, issue of the *General Radio Experimenter*, Dr. Arnold Peterson described the Type 1555-A Sound-Survey Meter and suggested many uses for the instrument. In this note still another application of this versatile instrument is pointed out: it is a valuable aid in teaching proper control of volume to choral groups.



As a teaching aid, the meter is best mounted within view of the singers so that they can see the result themselves. The novelty of the situation appeals to students, and they seem more eager to correct a defect when it is implied by an impersonal meter reading than when it is pointed out by a director.

Consider now some specific applications. The untrained ear — and most choral groups have an abundance of them — has little concept of the distinction between mezzoforte and forte. The question is "How loud is loud?" But once a sound-level criterion has been established, the question is answered. The level of an unchanging tone may be easily read on the Sound-Survey Meter by simply zeroing the meter with the level adjustment knob. And by practicing with the meter, a group may be taught to produce closely any indicated volume level. Such an approach — although it may not appeal to a finished musician — is very effective in teaching fundamentals.

Many singers are deficient in volume range. A great help in overcoming this defect is to point out the normal variation in volume range and then to allow the student to utilize the Sound-Survey Meter to record his present ability in that regard, and also to note his improvement from time to time.

But perhaps the Sound-Survey Meter is best appreciated by a choral director when he applies it to the problem of obtaining volume balance among sections in polyphonic music. A factor contributing to the difficulty of obtaining tonal balance is the fact that most singers are not adequately aware of the dependence of loudness on pitch, and tend rather to correlate physiological effort with loudness. Thus in a very loud passage each section tends to exert its physiological maximum, with the result that the first tenors far outbalance the basses, completely destroying the tonal blend. Over the normal frequency and volume range of choral music, the instrument with the function switch in the B position indicates quite well when a loudness balance at different frequencies is achieved. By use of the Sound-Survey Meter, the singers can see for themselves the relative loudness of their "maximum effort" at different pitches. The problem, once understood, is half solved.

In general, the tenor sections have the ability to get louder than the bass sections. Therefore, if volume balance is to be maintained, the tenors must restrain themselves somewhat. Suppose that in a given musical passage the first tenors are too outstanding. Using the Sound-Survey Meter, the director may quickly show them not only that they are too loud, but also exactly how loud they must be in order to blend with the other sections.

Considering its many applications, the Sound-Survey Meter deserves to be part of the standard equipment of choral directors. And indeed it would seem that band and orchestra directors could profitably make similar use of the instrument.

— Brother Romard Barthel
Physics Department
St. Edward's University
Austin, Texas

Editor's Note:

We are glad to be able to publish this article on the value of the Sound-Survey Meter to choral directors. One of the difficulties encountered in writing about sound measurements in the musical field is the difference in meaning attached to such words as "loudness" by the musician and the physicist. Similarly, the word "volume" has no standard definition, but is nevertheless a definite, although somewhat intangible, psychological characteristic of music. As the author points out, by establishing a sound-level criterion, one can, as a practical matter, ignore the definitions.

CATALOGS FOR STUDENT USE

Colleges and engineering schools have often inquired about the availability of our general catalog for student use. While the cost of our catalog precludes regular distribution to students, we often have available, when a new edition is published, a quantity of the previous edition.

At present we have on hand a considerable number of our 1951 Catalog M's, and we shall be glad to furnish them to teachers for classroom or student use as long as the supply lasts. Please request them on your department letterhead stating the quantity desired and the point to which shipment should be made.

WE SELL DIRECT

The General Radio Company maintains no sales agencies in the United States, but distributes its products directly to the user on a net-price basis. The Company maintains factory branch offices in several major cities of the United States which are staffed by skilled, factory-trained engineers.

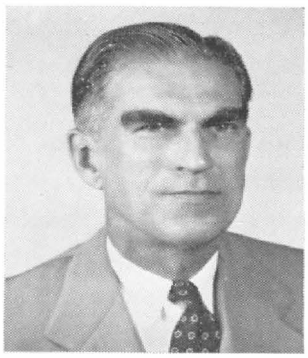
Your inquiries are welcome and may be directed to the main office at Cambridge or to the branch office nearest you. All correspondence receives individual and immediate attention.

For your information, we are listing below the members of our Sales Engineering Staff. When you need technical or commercial information about General Radio products, get in touch with one of these men. They are as near to you as your telephone or the nearest mailbox.

Main Office

275 Massachusetts Avenue — Cambridge 39, Massachusetts

TRowbridge 6-4400



A. E. Thiessen

M. T. Smith

ARTHUR E. THIESSEN, *Vice-President for Sales*
B. E., Johns Hopkins University, 1926.
Bell Telephone Laboratories 1926-28; Engineer, General Radio Company, 1928; Commercial Engineering Manager, 1937; Vice-President, 1944.

MYRON T. SMITH, *Sales Manager*
S. B. and S. M., Massachusetts Institute of Technology, 1931.
Engineer, General Radio Company, 1931; Engineer-in-Charge, New York Office, 1934-1937; Los Angeles Office, 1937-1940; Sales Engineering Manager, 1944; Sales Manager, 1953.

R. B. Richmond

S. W. DeBlois

STEPHEN W. DEBLOIS, *Export Manager*
B.S., Cornell University, 1936.
Lincoln Electric Co., 1936-1937; Armco International, 1938-1941; Signal Corps, U. S. Army, 1941-1945; Engineer, General Radio Company, 1946; Export Manager, 1953.

ROBERT B. RICHMOND, *Engineer*
B. S., Northeastern University, 1948.
U. S. Army Air Corps, 1943-1946; Engineering Department, General Radio Company, 1948.

J. C. Gray

R. E. Bard

JOHN C. GRAY, *Engineer*
Wentworth Institute, 1937-1939; B. S. Northeastern University, 1950.
United Aircraft Company, 1939-1941; M.I.T. Radiation Laboratory, 1941-1945; Engineering Department, General Radio Company, 1950.

ROBERT E. BARD, *Engineer*
B. S., Illinois Institute of Technology, 1942.
Instructor in Electrical Engineering, I. I. T., 1942-1943; U. S. N. R., 1944-1945; American Phenolic Corporation, 1945-1948; Professor of Electrical Engineering, Fournier Institute of Technology, 1948-1952; Engineer, General Radio Company, 1952.

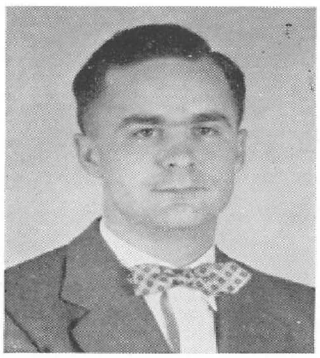

C. W. Harrison

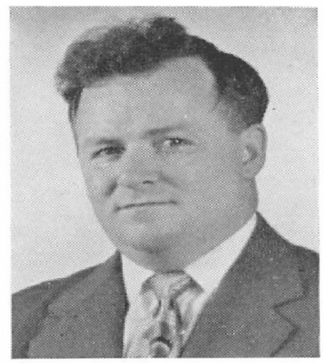

R. K. Peterson

C. William Harrison, *Engineer*
Hobart College, 1943.
B. S., Northwestern University, 1946.
U. S. N. R., 1946; General Electric Company, 1948; U. S. N. R., 1951-1952; Engineer, General Radio Company, 1953.

Ralph K. Peterson, *Engineer*
B. S., Tufts College, 1947.
Standardizing Laboratory, General Radio Company, 1947; Engineer, 1954.

New York Office
90 West Street, New York 6, N. Y.
WOrth 4-2722


W. R. Thurston


G. G. Ross

William R. Thurston, *Engineer-in-Charge*
S. B. and S. M., Massachusetts Institute of Technology, 1943.
Radiation Laboratory, M. I.T., 1945; Engineering Department, General Radio Company, 1943; New York Office, 1950.

George G. Ross, *Engineer, New York Office*
B. S., Northeastern University, 1942.
U. S. Navy, 1943-1945.
Standardizing Laboratory, General Radio Company, 1945; Engineering Department, 1949; New York Office, 1950.

West Coast Office
1000 North Seward Street Los Angeles 38, California
HOllywood 9-6201


F. Ireland


J. G. Hussey

Frederick Ireland, *Engineer-in-charge*
A. B., Harvard College, 1933; Harvard Graduate School, 1934.
Engineer, General Radio Company, 1934; New York Office, 1937; Los Angeles Office, 1940.

James G. Hussey, *Engineer*
B. A. (Physics), University of California, 1949.
U. S. N. R., 1944-1946; Technical Products Company, 1942-1944 and 1947-1948; Engineer, General Radio Company, 1950.

Chicago Office
920 South Michigan Avenue Chicago 5, Illinois
WAbash 2-3820


K. Adams


W. M. Ihde

Kipling Adams, *Engineer-in-charge*
Massachusetts Institute of Technology, 1928-1930.
Standardizing Laboratory, General Radio Company, 1934; Service Department, 1940; Chicago Office, 1946.

William M. Ihde, *Engineer*
S. B. and S. M., Massachusetts Institute of Technology, 1948.
U. S. Army Air Corps, 1944-1945.
Engineering Department, General Radio Company, 1949; Chicago Office, 1951.

W. R. Saylor

Washington, D. C., Office
8055 13th Street Silver Spring, Maryland
JUniper 5-1088

WILLIAM R. SAYLOR, *Engineer-in-charge*
S. B. and S. M., Massachusetts Institute of Technology, 1937.
General Electric Company, 1937-1940; Instructor in E. E., M. I. T., 1940-1943; Engineer, General Radio Company, 1943; Washington, D. C., Office, 1954.

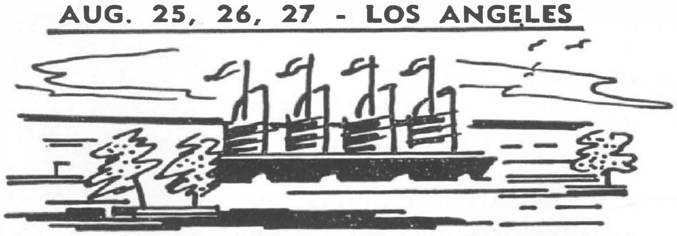
A. S. T. M. HONORS R. F. FIELD

R. F. Field

At the 57th Annual Meeting of the American Society for Testing Materials, Robert F. Field was presented with the Society Award of Merit "for intensive service in Committee D-9 on Electrical Insulating Materials, especially in establishing important test methods, and extending knowledge of these materials."

Mr. Field, who retired from the General Radio Engineering Staff in 1950, first joined the ASTM in 1934 and became a member of Committee D-9 the following year, representing the General Radio Company.

1954 WESCON
AUG. 25, 26, 27 - LOS ANGELES



VISIT US AT PAN PACIFIC AUDITORIUM

GENERAL RADIO COMPANY

BOOTHS 251 *and* 252

GENERAL RADIO COMPANY

275 MASSACHUSETTS AVENUE
CAMBRIDGE 39 MASSACHUSETTS
TELEPHONE: TRowbridge 6-4400

BRANCH ENGINEERING OFFICES

NEW YORK 6, NEW YORK
90 WEST STREET
TEL.—WOrth 4-2722

LOS ANGELES 38, CALIFORNIA
1000 NORTH SEWARD STREET
TEL.—HOllywood 9-6201

CHICAGO 5, ILLINOIS
920 SOUTH MICHIGAN AVENUE
TEL.—WAbash 2-3820

SILVER SPRING, MARYLAND
8055 13th STREET
TEL.—JUniper 5-1088

PRINTED IN U.S.A.