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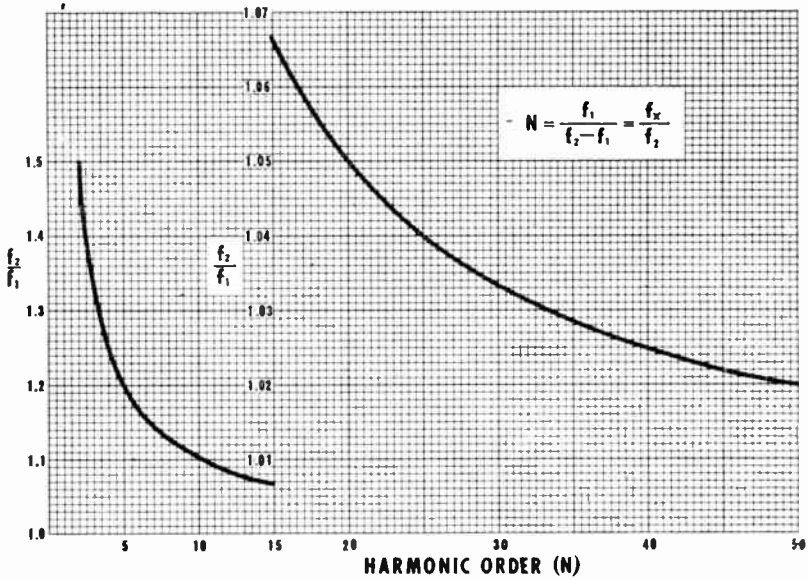
LABORATORY HINTS*

Extending the Range of a Signal Generator

A problem comes up at times in laboratories that are not equipped to measure signals in the ever-increasing higher frequency ranges; that is, measuring a frequency beyond the range of its signal generator. This signal can be applied to a mixing or a detector circuit of some kind, together with an adjustable signal of a lower frequency from a standard oscillator or the signal generator. The oscillator is set so that some undetermined harmonic of the latter is found to beat with the unknown signal. This will happen at more than one setting of the dial, assuming, as is generally the case, that harmonics exist in the oscillator. Carefully determine several of these frequencies that appear in successive order on the dial of the standard where beat notes occur, with emphasis on avoiding missing any one of them in order. Since the unknown frequency is higher than the standard it will be evident that the greater the difference the more numerous the points where these beats are heard.

A trial computation can be made using several successive frequencies determined in this way: f_1, f_2, f_3, f_4, etc., applied to the relation $f_x = \frac{f_1 \quad f_2}{f_2 - f_1}$



Harmonic orders in signal generator range.

* *By courtesy of "Electronic Industries."*

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If no intermediate beat has been missed this computation gives a rough value of the unknown. The precise value will be the value of either f_1 or f_2 multiplied by some integer which gives the value nearest f_x. Inasmuch as extra beat notes are frequently noted, the value should be checked using a third beat note setting, f_3, and then a fourth in the same succession, f_4, then

$$f_x = \frac{f_1 \quad f_2}{f_2 - f_1} = \frac{f_2 \quad f_3}{f_3 - f_2} = \frac{f_4 \quad f_3}{f_4 \quad f_3} \text{ etc.}$$

Any of these relations that do not give the same value of f_x should be disregarded, as false harmonic tones were probably used.

In order to assist in making these computations the accompanying chart can be used to advantage.

Speeding Up Inductance Measurements

When making tests on a Q meter (or other type of instrument based on resonance measurements) inductance and capacitance values bear reciprocal relations with each other at the frequencies listed in the table. For greatest convenience these frequency points can be "spotted" on the oscillator dial direct and the capacitance scale can be provided with an auxiliary scale marked with values equal to the reciprocal of capacitance values.

TABLE I

Frequency	Inductance
50.33 KC	$L = 10^4 \div C$
159.16 KC	$L = 10^3 \div C$
503.30 KC	$L = 10^2 \div C$
1.5916 MC	$L = 10 \div C$
5.033 MC	$L = 1.0 \div C$
15.916 MC	$L = .10 \div C$

(Values are in m.m.f. and millihenries.)

For greatest accuracy the distributed capacitance of the inductance coil must be added to the capacitance value of the tuning capacitor at resonance.

The distributed capacitance of the coil can be quickly measured (if it has an inductance greater than a few microhenries) by connecting in another coil having an inductance of 1 per cent or less of the first, across the tuning capacitor. It will resonate at a frequency 10 times (or more) greater than the value selected for the test coil and used in Table 1. Having resonated the new coil to that frequency, connect the coil whose capacitance is to be determined across the tuning capacitor, and find out how much the setting of the latter has to be altered in retuning. The inductance change due to the two coils in parallel will be quite small and the shift can be considered to be that caused by the distributed capacitance of the coil alone.

When the inductance being checked is small to start with, it may not be possible to find a second coil sufficiently small to carry out this procedure. The usual method† in this case is to determine the capacitance C_1 needed to tune the coil to resonance with frequency A (select the latter so that practically full scale capacitance is needed) and then reduce this capacitance until it is approximately one-quarter of the first value, whereupon a deflection due to the second harmonic of the oscillator setting can usually be noted. Call this value C_2. Then $C_D = \frac{C_1 \quad 4\ C_2}{3}$. Since C_D is usually quite small it is necessary to use extreme care in making these settings. If the second harmonic of the oscillator is not evident, the oscillator must be carefully retuned to the doubled frequency.

† Reference Proc. IRE, Aug., 1921, p. 300.

WANTED: Signal Corps Equipment

You may have Radio-Amateur and Photographic equipment that is urgently needed by the Army Signal Corps. The Army will buy the following from private individuals.

Radio: Standard and commercial built short wave transmitters (such as Hallicrafters HT-1, etc.; Temco and Collins Model 32 and 30) and Standard and commercial built short wave receivers (such as Hallicrafter, National, RCA, RME, Hammarlund or Howard); AC and DC Voltmeters, Ammeters, Milliammeters, Radio Frequency Meters and Volt-ohm-milliammeters; Oscilloscopes, 2-3 inch; Audio sig. gen. 30-15,000 cycles; RF sig. gen. 15-215 megacycles; late model Tube Checkers, and other test equipment,

Photographic: 35 MM Motion Picture Cameras (such as Mitchell (all models), Bell & Howell - Standard Professional, Akeley-Professional (all models) and Eyemo (all models) Bell & Howell Mfg.), etc., and 16 MM Motion Picture Cameras (such as Cine-Kodak Special, Magazine Cine-Kodak, Filmo 70.D or Filmo Auto Master); Tripods; Lenses, all types for 35mm and 16mm equipment; Exposure Meters; and Cameras (such as Speed Graphic 4" x 5", and Speed Graphic 2¼" x 3¼" with or without flash synchronizers) and Leica Model III (F) or 11B (C), or equal; Range Finders; Pack Adaptors and Cut Film Holders.

If you have this type of equipment, you can assist the war effort materially by selling it to the Army. Write to:

EMERGENCY PURCHASE SECTION
PHILADELPHIA SIGNAL CORPS PROCUREMENT DISTRICT
5000 WISSAHICKON AVENUE, PHILADELPHIA, PA.

briefly describing the equipment you have and stating the price at which you can offer each item, FOB Philadelphia. Do not ship any material without specific directions from that office.

Price consideration is based upon your net cost less reasonable depreciation for use, age, and condition of equipment. Inasmuch as all equipment is being purchased FOB Philadelphia, cost of packing and shipping can be shown separately so that an allowance for the costs can be made when material is accepted.

A Free Market-Place for Buyers, Sellers, and Swappers.

These advertisements are listed FREE of charge to C-D readers so if there is anything you would like to buy or sell; if you wish to obtain a position or if you have a position to offer to C-D readers, just send in your ad.

These columns are open only to those who have a legitimate, WANTED, SELL or SWAP proposition to offer. The Cornell-Dubilier Electric Corp. reserves the right to edit advertisements submitted, and to refuse to run any which may be considered unsuitable. We shall endeavor to restrict the ads to legitimate offers but cannot assume any responsibility for the transactions involved.

Please limit your ad to a maximum of 40 words, including name and address. Advertisements will be run as promptly as space limitations permit.

SWAP—Jackson model 640 signal generator, just recalibrated. Want Argus C-3 or C-2, Kodak 35, Fath Derby 35mm or ½ V.P. or other photo equipment. Roy Powell, Box 422, Boynton Beach, Fla.

WANTED—Cash for pocket VOM, such as Triplett 666, 0-1 ma meters, precision resistors, copper oxide rectifier, test equipment. Answer made to all offers. Address D. F. Causey, P. O. Box 44b, University Station, Urbana, Illinois.

FOR SALE — Rider Chanalyst, complete with instruction book and probes, A-1 condition. Highest offer takes it. L. F. Smith, 19 Palmer Street, Passaic, N. J.

FOR SALE—Kolster K-20 and K-43; Kolster-Brandeis No. 15 chassis; Kolster K-5 brand new amplifier with large dynamic speakers; Temple chassis and power pack; G. E. K-32 radio and dynamic speaker, A.C. Utah dynamic speaker; Fada 8 tube chassis. All sets are in playing condition. Louis A. Goldstone, 1279 Sheridan Ave., Bronx 56, New York, N. Y.

FOR SALE—Rider's Manuals, vols. 2, 3, 4 and 5, $20.00. Perfect condition. Will consider trade for late test oscillator or channel analyzer. Make offer. W. J. Closson, 295 8th St., Troy, N. Y.

WANTED—Thordarson high fidelity transformers No. T 15R05 power; T-90A04 audio; T90S13 output; Jensen JHP-52 speaker; some 1% high resistance Morrell resistors, any wattage, state what you have and price; need 1, 2, 5, 10 meg. and .1, .2, .5 meg in particular. Want 1916 QSTs, also Aug. 1917, Feb. 1919, June 1920. Murray J. Douglas, Concord, Calif.

FOR SALE OR TRADE—Large twin cylinder Milwaukee outboard motor, complete, in good shape, with hot shot battery. Sell for $40 or trade for radio tubes, parts or equipment. Tubes such as 35Z5, 35L6, 50L6, 12SA7, 12SQ7, 12Q7, 12A8, 6A8, OZ4, 6X5, 1A5, 1C5, 1A7, 1H5 preferred. McKinley's Radio Service, Zebulon, Ga.

WILL TRADE—For 35 mm camera or? 1 30 watt class A Philco amplifier in portable case complete, mike, speakers and cable; 1 500 watt a.c. generator, puts out 110 v. a.c at 500 watts. for fan belt of car, both $150. 1 communication set, master station and 1 sub., value $25.00 Paint spray complete, value $100.00. No junk. John Arnold, Bluffs, Illinois.

FOR SALE OR TRADE—2 Stanco M-30 mobile transmitters complete with tubes, dynamotor, handset, all cables and Xtals for 30580 kc Bliley MO2. H. B. Reynolds, Oneida, N. Y.

WANTED—Will pay full list price for either a Chanalyst or Supreme Audolyzer. Cripps' Radio Service, Dunsmuir, Calif

WANT—FM converter, will pay cash or swap a new 25X Bark telescope. Also need 500 ma smoothing choke. Will sell 16" transcription table with rugged dual speed motor, a Swiss make. E. E. Matt Radio, 1950 Trowbridge St., Detroit, Mich.

FOR SALE—Supreme 89 deluxe tube and set tester. Can be modernized to test late tubes. As good as new. What is offered? Tone's Radio Service, 126 Fourth Avenue, Paterson, N. J

WANTED—Rider's Chanalyst in good condition, also Rider's Manuals 6 to 13 inclusive if possible. All must be in good condition. Cash will be paid. Rural Radio Service, Clark Lake, Mich.

WANTED—Dry disc rectifier units with or without transformers, or any pack, A eliminator trickle charger, field supply, etc., using dry disc units, Sterling, Hoyt, etc.: small 2½" or less; meters dc ma up to 500 ma. Wheel static eliminator springs similar to J F D Masonite regular or tempered Will buy or swap. See ads in June "Capacitor." Send details. Bob Eubank 1227 Windsor Ave. Richmond 22, Va

FOR SALE OR SWAP—No. 6033A Western Electric hearing aid complete. Includes 388W transmitter, 550 BW ear insertion phone 11A battery box, cables, etc. Uses only three standard D flashlight cells. No tubes or B battery needed. Excellent condition Sold for well over $100 Want National NC-100X or NC-200 without tubes or speaker or complete, or make offer R. N. Eubank, 1227 Windsor Ave., Richmond 22 Va.

FOR SALE — Portable Jackson dynamic output radio analyzer, model 535A $25 F. Combs, 344 Peach Orchard Road, Dayton Ohio.

FOR SALE OR TRADE—1 Webber oscillator, battery operated, 90 kc to 25 mc range, good working condition with battery $15.00. 1 No 171 RCA station allocator, ac-dc or battery operation, less battery, new condition $17.50. 40 new and 20 used tubes. Want Rider's 1 to 5 incl. Glandorf Radio, Williamsburg Iowa.

WANTED—In good condition a McMurdo Silver Model 6 late or early model receiver, with console. Must be reasonable Send details Paul Capito 637 W. 21st St., Erie, Pa

WANTED—A Precision tube tester model 912P, 912CP or 912C, new preferred but will accept one in new condition Quote price and condition. Anthony Vital 317 Linden St Camden, N J

FOR SALE—A.K. "B" eliminator with 607 rectifier tube, 7 short wave 4 prong plug-in coils. Bud 2.5 m h r f chokes, new in original case. 50 radio chassis with half parts still mounted, many later models, 100 used tubes, plenty of hearing aid parts; instrument cases, midget condensers, crystal mike, Astatic crystal ear piece, low impedance magnet ear piece. Edwin T Larason, Box 46 Martinsburg, Ohio

WANTED—Weston 772 multimeter or similar 20,000 ohm per volt multimeter State Price. Maurice Rushworth 531 South Lonawood St., Baltimore 23, Md.

WILL TRADE—SX-25, Super Defiant Hallicrafters communications receiver, almost new, factory seal never broken, for Hickok oscillograph, model RFO-5 or Supreme Model 560A vedolyzer or RCA Rider chanalyst. Robert Wendt, K2 6 Willow Village, Ypsilanti, Mich.

SELL OR SWAP—1942 edition ICS Practical Radio Servicing Course. Complete in every detail. Cost $130.00. Want ½ HP a c. 110 volt electric motor, or a small bench lathe What have you to trade? Clyde W. Wimer, R D. No. 2, Tilwood City Pa

WANTED—Old type Dodge 12 v. motor-generator prefer North East model, or 6 v. or 12 v. dc electric motor ¼ horse or larger, to power wheel chair. Pay cash or have used radio parts and tubes and stamp collection to trade. Dean A Lovell, Waukomis, Okla., P. O Box 21

WANTED -1 7 ' volt ohmmeter meter made by Superior Instrument Co. for their voltohmmeter Model No. 1260. Must be in good condition Any good make condenser checker. Want several small 5 tube superheterodyne radios, must be standard makes. John K. Matsuhiro, 8 6-B Relocation Br., McGehee, Ark.

WANTED — 1931, 1932, 1935-6-7-8, 1940, 1941, 1942 bound vols. RCA service notes. Also GE bound volume. State cash price one or all. The Radio Hospital, 420 N. Hudson, Oklahoma City, No. 3 Okla.

FOR SALE—1 Supreme model 505 tube tester up to date, $40.00 cash Ramm's Radio Laboratory, 218 South Bronough St Tallahassee Fla

WANT—2, 3 or 4 mfd 600 v oil filled condensers, plate relay, slide rule, hornet engine Offer. Radio transmitting parts, meters, photographic accessories, or? Gommo', 46 Northwest 94, Miami, 38, Florida

FOR SALE OR TRADE—Radio transmitting parts meters for fast wide angle lens cover 4x5 127 mm Ektar lens in supermatic or other photographic equipment or Bantam Special. Gommo' 46 Northwest 94 St Miami Shores, 38, Florida.

FOR SALE— 6 RCA ET05022 mobile transmitters (high parts value only, limited parts lists available). 6 Electric Specialty Co SL4 dc generators, 550 v. at .250 amps 12.7 volts at 6 amps at 1500 rpm. 11 RCA dynamotor units 6 vdc input, 250 vdc at .050 amps. 1 0-1 Triplett model 346 thermocouple ammeter. 2 Bliley HF2 crystals 29956 and 29987 kc 11 RCA 841 tubes. City of Racine Police Radio Dept., 1400 Tenth Street, Racine, Wisconsin.

(Continued on page 13)

POWER OUTPUT METERS *

EASY-TO-BUILD AND SIMPLE TO CALIBRATE POWER OUTPUT METER-MEASURES AUDIO FREQUENCY WATTAGE OF RADIONIC EQUIPMENT

Radio, radionic, and amplifier technicians readily concede that an audio-frequency wattmeter which presents little or no load to the power source under test and which indicates power levels directly in watts (even if scale factors need be applied mentally to some of the readings) is an adjunct to the test bench. In trouble shooting and in experimentation alike, this instrument pays large dividends by eliminating much guess work.

P. A. men particularly feel the need for this type of meter when they put amplifiers through their paces. With it, they are freed from burdensome computations of power output and the errors attendant to such figuring. But available instruments have long been in the laboratory class and have been priced accordingly, and the amplifier technician with an average clientele has been forced to get along without direct-reading wattmeters.

A satisfactory audio wattmeter may be constructed of spare parts by any radio or amplifier man. Several well known circuit arrangements are avail-

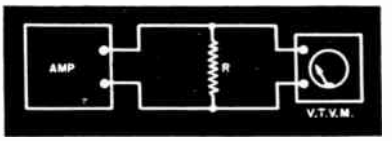


Fig. 1. Showing VTVM connections.

able. The layout chosen will be a matter of availability of the required equipment and access to calibration equipment. We have looked over the various circuits and systems and finally selected a design which lends itself to easy duplication. For calibration, all that is needed is a source of variable a.c. voltage and a reliable voltmeter.

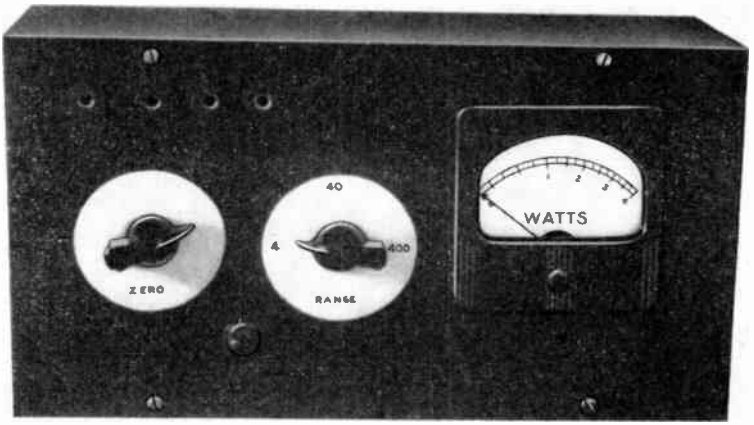
Standard audio wattmeters for radio and amplifier use are either a.c. voltmeters or a.c. ammeters connected to deflect on either the voltage drop across a known load resistor or the current flowing through this resistor. Since these deflections are proportional to the power dissipation in the load, the meter scale may be marked off directly in watts.

Obviously, the power calibration will hold for only one value of load resistance. And since a number of load values are generally encountered in amplifier output circuits, some provisions must be made to convert all impedances to the value associated with the indicating meter or to convert wattage readings in accordance with various impedance values.

In the standard laboratory-type audio wattmeter, the indicating voltmeter is shunted across a fixed resistance in which the power to be read is dissipated. And by means of a tapped input transformer, numerous common impedance values are converted to the value of this resistance. Thus, the meter is always actuated by the voltage drop across the standard load resistor. In the impedance-switching operation, various losses in the transformer, as well as the varying voltage ratio attendant to the changing impedance ratio, are compensated for by auxiliary resistors which are automatically cut in and out by the impedance range switch.

This type of instrument, while of the best design, does not lend itself easily to duplication at this time chiefly because of the special transformer required. None of the common multi-match amplifier-type transformers are suitable for this application, since they do not provide the proper primary and

* *By Guy Dexter in "Radio News."*



Front view of test unit showing panel layout of controls and meter.

secondary taps for wide-range amplifier testing. The special transformer is not immediately available because of the present shortage of materials, and it may not easily be built unless the constructor has had considerable experience in the manufacture of high-quality a.f. transformers. Accordingly, the design we have chosen to present measures the voltage drop across the actual amplifier load or across an auxiliary load resistor and interprets this voltage in terms of watts.

It is essential that the wattmeter function independently of the frequency of the measured power. For this reason, we have employed a simple vacuum-tube voltmeter rather than an oxide-type a.c. voltmeter.

Operating Principle

The operating principle of the simple wattmeter is illustrated by the block diagram in Figure 1. The power source, which is shown here as an a.f. amplifier, is connected in the normal manner to its load device. While the latter is shown simply as a pure resistance (R), it might easily be an impedance instead. In practice, such a load device might be the speaker into which the amplifier operates, or it might be a transmission line.

The v.t. voltmeter, which might be of any convenient type possessing high input impedance, is shunted across the load to indicate the voltage developed across the latter. Its reading is proportional to the power developed in the load by the amplifier and may be used to find the actual power level from the relationship:

$$P = E^2/R = E^2/Z.$$

It is apparent that the meter scale might be graduated directly in watts on the basis of the above relationship. However, it is easily seen that the value of load resistance or impedance must be known, otherwise the calibration would be meaningless. For example: a reading of 10 volts might indicate either 25 watts in 4 ohms, 10 watts in 10 ohms, 20 watts in 5 ohms, 1 watt in 100 ohms, etc., etc. Moreover, the calibration would hold only for the particular value of load with which it was made.

These discrepancies may be offset by making the calibration for some

value of load resistance which will facilitate mental multiplications or divisions of wattage readings when other impedance values are employed.

Figure 2 shows a convenient arrangement of the functional equipment. Here the load resistance has been included in the instrument itself to take the place of the missing amplifier load device. Power measurements are frequently made in this manner in order to permit removal of the speaker which would give rise, during the measurement, to considerable disturbance. The resistor R must have the same ohmic value as the normal load device and must have a wattage rating sufficient to enable it to dissipate safely the maximum amplifier output power. A load resistor so employed should preferably be of the non-inductive power type in order to eliminate the errors introduced by the impedance of inductive, wire-wound power resistors, unless the L/R ratio of the wire-wound unit is extremely low.

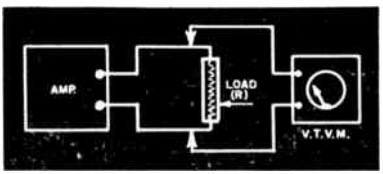


Fig. 2. VTVM used to measure output load.

Most audio power measurements will be made directly across the load device, coupling transformer, or line, and the arrangement of Figure 1 will be applicable. However, it is frequently desirable to have the wattmeter terminate the power source in lieu of the normal load device, so provision has been made in the complete instrument for the insertion by binding post connection of a load resistor of suitable resistance and wattage. Since at least forty load values are commonly encountered in audio-frequency work, no attempt was made to build a high-powered, bulky switched resistance load into the wattmeter. When the operator desires to employ the wattmeter as the amplifier load, he will need only to insert the one resistor connection into the binding posts provided for the purpose. When employing the instrument in the manner indicated in Figure 1, the resistor is removed.

In order to obtain complete isolation of the wattmeter, battery operation of the v.t. voltmeter unit has been adopted. This prevents return paths ordinarily encountered through the power line when both the power source under test and the v.t. voltmeter are operated from the a.c. line. The meter circuit has been made as simple as possible, and low-voltage batteries are employed.

The complete circuit diagram is shown in Figure 3. This schematic reveals the wattmeter to be a specially calibrated electronic voltmeter with high input resistance. The circuit has three voltage (power) ranges: 0-2 volts, corresponding to 0-4 watts; 0-6.32 volts, corresponding to 0-40 watts; and 0-20 volts, corresponding to 0-400 watts. These ranges are afforded by the input voltage divider comprised by resistors R1, R2, and R3, totaling 1 megohm, and the rotary selector switch S1.

The indicating instrument M is a Simpson 0-500 d.c. microammeter. This is the most desirable current range for this instrument, although larger or smaller instruments might be employed with corresponding changes in the power ranges. Thus, a 0-1-milliammeter would afford a full-scale power deflection of approximately 16 watts on the lowest range.

The "B" battery B2 is a midget flat 7½-volt "C" type battery (Eveready 773). The small size of this component (4"x2¾"x1$\frac{13}{16}$") makes it possible to keep the dimensions of the complete instrument small. The filament battery B1 and meter-bucking battery B3 are regular 1½-volt flashlight cells (Eveready No. 950).

The tube employed is a 1Q5-GT with screen and plate connections tied together. The total no-signal plate cur-

rent is quite low at the low value of plate voltage employed, being approximately the full-scale deflection of the microammeter. The meter is therefore not endangered by this current when the zero-adjustment resistor R4 is off adjustment.

No-signal plate current is bucked out of the meter by the rheostat R4 and the 1½-volt cell B3 which make a smooth and efficient zero adjusting combination. Both the filament circuit and the meter-bucking circuit are closed simultaneously by the double-pole, single-throw toggle switch (the two sections of which are shown as S2 and S3) thus both batteries are removed from drain circuits when the instrument is switched off. The negative terminal of the filament battery and the circuit returns are connected to the No. 7 pin of the tube, this being the side of the filament to which the beam element is connected within the tube.

The 0.1-μfd., 200-volt tubular bypass condenser C provides a low-impedance path for any a.c. passed by the interelectrode capacitance of the tube.

The input voltage divider (R1-R2-R3) is made up of three sections—684,000, 216,000, and 100,000 ohms respectively. The two former sections are of odd resistance value and must each be made up of several lower values connected in series. Resistors employed are ½-watt. R_1 may thus be made up by connecting in series one each 600,000 ohms, 70,000 ohms, and 14,000 ohms. Likewise, R_2 is made by connecting in series one each 200,000 ohms, 15,000 ohms, and 1,000 ohms. The accuracy of the two higher-wattage ranges will be dependent entirely upon the accuracy of these resistors. R_1 could be a 1-megohm volume control, R_2 a 250,000-ohm control, and R_3 a 250,000-ohm control. During the calibration process, to be described presently, these controls may be set exactly, as they might also be during recalibration when the tube is subsequently replaced.

The voltage calibration of this v.t. voltmeter circuit is given in Chart I and the corresponding power (watt) values in Chart II.

The binding-post terminals T_1 and T_2 accommodate the test leads or other

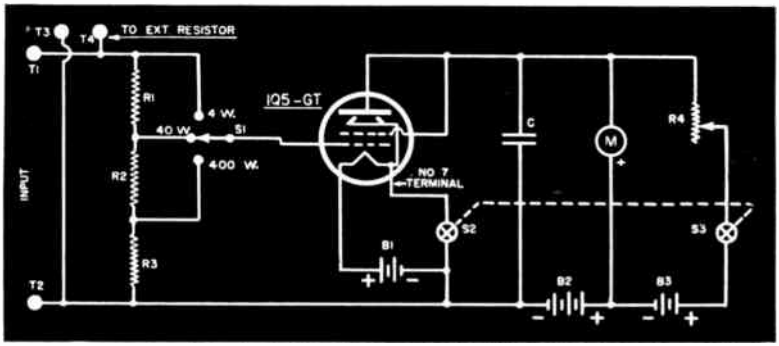


Fig. 3. Schematic diagram of the VTVM output tester.

R_1, R_2, R_3—See text
R_4—100,000-ohm midget rheostat
C—0.1-μfd., 200-volt tubular condenser
S_1—Three-position, single-pole rotary switch
S_2, S_3—D. P. D. T. toggle switch
M—0-500 d.c. microammeter
B_1, B_3—1½-volt flashlight cells
B_2—Midget, flat 7½-volt battery
T_1, T_2, T_3, T_4—Bakelite binding posts
Tube—1Q5-GT

connections made to the power source under test, while the posts T_3 and T_4 are for the external load resistor when this type of unit is employed.

The voltmeter circuit possesses extremely low zero drift. In fact, we have been unable to detect any drift upon the microammeter scale.

The wattage readings given in Chart II are based upon 1 ohm load impedance, this being a convenient value to which other load impedance ratings may be quickly referred when reading the meter. The constructor will find that the voltage calibration given in Chart I will correspond within a fraction of a dial division to the individual calibration he will make.

Chart I

Voltage Calibration (S1 in 2-volt position)

Microamperes	Volts (RMS)
500	2.0
465	1.90
450	1.85
430	1.80
400	1.70
370	1.60
350	1.50
310	1.40
300	1.35
285	1.30
260	1.20
250	1.15
235	1.10
210	1.00
200	.95
180	.90
165	.85
155	.80
150	.78
140	.75
130	.70
115	.65
100	.60
90	.55
80	.50
55	.40
50	.35
40	.30
22	.20
10	.10

Mechanical Construction

The wattmeter, as shown in the photograph, was built of materials that happened to be available. The instrument case is a coated steel chassis, 5½"x10"x3" in size. The front panel is a sheet of thin metal stock originally cut to serve as a base plate for the chassis. The panel is held to the chassis by four self-tapping screws seen along the top and bottom edges. There is ample "breathing space" inside this case, since its overall size is somewhat in excess of that actually required as a minimum. The reader is free to exercise considerable latitude in dimensioning his own unit, since the placement of parts is not at all critical, and the components of the instrument do not occupy a great deal of volume.

The binding post terminals for meter input and for the external load resistor (when the latter is employed) are arranged along the top left edge of the panel. These posts are mounted with shoulder-type fiber washers so that their terminal screws are insulated from the panel through which they pass. The tube socket is mounted on the panel by means of 1½" long 6-32 screws which support the socket away from the panel. Batteries are held to the case (chassis) by means of spring-brass clips which the writer formed from scrap stock. Here again, the reader may exercise his own ingenuity in mounting these components. Leads were soldered directly to the battery terminals, since the low current drain of the instrument makes it possible to operate for long periods of time without changing batteries and any quick-change scheme was deemed unnecessary.

The on-off toggle switch is mounted directly below the two controls, seen along the center line of the front panel in the photograph. The left-hand control is the meter zero adjustment rheostat R4. The right-hand control is the single-pole, three-position rotary wattage range switch S1.

If carbon resistors are used in the R1, R2, and R3 positions, they may

be connected directly between the terminals of S1. If volume control type rheostats are employed, they may be mounted on a narrow subpanel which may be supported from the front panel by means of long screws. All wiring is cabled, since no trouble with circuit interaction, feedback, etc., is experienced at the frequencies at which the instrument is operated.

After the instrument has been completely assembled and wired and the wiring has been checked, the calibration may be carried out in the following manner:

1. Turn on the on-off switch S2. The meter M will immediately be deflected and will read somewhere along its scale. It is not likely that it will be found standing at zero with the current switched on. However, if there is no movement of the pointer, slowly rotate R4, watching the pointer which should be moved up or down the scale depending upon the direction in which R4 is rotated. Allow the instrument to heat up for two minutes before proceeding with the rest of the operations.

2. Bring the meter pointer to zero by adjusting the zero-set control R4 either to the right or left.

3. Provide a variable source of a.c. voltage at any convenient frequency. This will generally be a 60-cycle voltage obtained by means of a potentiometer or variac.

4. Connect the range switch S1 to the 2-volt position, adjust the variable-voltage source to zero and connect the latter to the input binding posts T1 and T2.

5. Connect a reliable a.c. voltmeter (with several ranges) also to the input terminals designated on the diagram as T1 and T2.

6. Adjust the voltage source, bringing the voltage up until the monitoring a.c. voltmeter shows that a voltage of 2 is applied to the input terminals. This voltage will cause a full-scale deflection of the microammeter.

7. Drop the input voltage successively to voltages lower than 2 v., obtaining numerous calibration points along the meter scale. Compare the readings obtained with the sample values given in Chart I. The two should not show a great difference.

Chart II

Wattage Levels Corresponding to Voltage Calibration (Assuming 1-ohm Load)

RMS Volts	RMS Watts
0.1	0.01
0.2	0.04
0.3	0.09
0.4	0.16
0.5	0.25
0.6	0.36
0.7	0.49
0.707	0.50
0.8	0.64
0.86	0.75
0.9	0.81
1.0	1.0
1.1	1.21
1.11	1.25
1.2	1.44
1.22	1.50
1.3	1.69
1.32	1.75
1.4	1.96
1.41	2.00
1.5	2.25
1.58	2.50
1.6	2.56
1.65	2.75
1.7	2.89
1.73	3.00
1.8	3.24
1.87	3.50
1.9	3.61
2.0	4.00

8. After the 2-volt scale calibration is completed, turn range switch S1 to the 6.32-v. position and bring up the input voltage to 6.32.

9. This voltage should produce a full-scale meter deflection. If it does not, the resistors must be adjusted until the deflection is exactly full-scale.

10. Next, set S1 to the 20-volt tap and bring up the input voltage to 20. If full-scale deflection is not obtained in this case, it is likely that only R3 need be adjusted slightly until full-scale deflection is obtained.

11. Remove the indicating meter from the panel and remove the meter carefully from its case. Remove the microampere dial from the meter and make a new dial by tracing around the old one on thin white Bristol board with a sharp pencil. Mark off a new scale on the card and transfer the various voltage positions corresponding to wattage values (see Chart II) to this new scale.

12. When a sufficient number of wattage points have been inked-in and marked, replace the meter in its case and re-install on the front panel.

Application

The wattmeter described in the foregoing is intended for measuring power levels across known values of impedance or resistance. When the power source under test is not equipped with a normal load device, however, a load resistor of the proper ohmage and wattage is connected to the special terminals designated as T3 and T4.

When measuring power across a known load, connect heavy leads from the two ends of the load device (such as a transformer, voice coil, or line) to the input terminals T1 and T2. Energize the power source (such as an amplifier) either by switching it on to produce power output or (as with an amplifier) exciting it with a signal from an oscillator. The wattmeter will be deflected. If the deflection is greater than full-scale, set the range switch S1 to the next highest position. (Standard practice is to start measurements at the highest range and to progress to the lower ones for greater readability, in order to prevent damage to the indicating meter.) Read the power level directly on the scale of the wattmeter.

The direct-reading scale applies only to power levels developed in a 1-ohm load. For all other load values, the meter readings must be divided by a suitable factor. If, for example, the load resistance is 1,000 ohms, mentally divide the meter readings by one-thousand (or multiply by 0.001). If the load impedance is 100, divide by one hundred (or multiply by 0.01). If the load impedance is 30 ohms, divide by thirty (or multiply by 0.3), etc., etc.

THE RADIO TRADING POST

(Continued from page 6)

SERVICEMEN—TUBE DEALERS — Tubes available. Many odd types can be used as alternates for hard to get types. Example—20 types will replace 12Sa7, 12SQ7, 12SK7, 35L6, 35Z5. No set, socket wiring changes. List of nearly 100 alternate types used in our shop and how to use them sent postpaid for 75c. C. E. Ranniger, Gowrie, Iowa.

TRADE—Cinaudagraph 18 in. PM speaker and Radio News hi-fi amplifier for Scott 30 tube Philharmonic, Scott Phantom 19 tube, Phantom DeLuxe 20 tube or Scott 16 tube radio. Cash for difference. Howard Abernathy, Blakesburg, Iowa.

WANTED—Will pay cash for Rider's Manuals, late model tube checker, output meter, set analyzer and new radio tubes. Eugene Gilbert Radio, 1296 Sheridan Ave., Bronx, New York, N. Y.

FOR SALE — Thordarson Model T30W25 broadcast type high fidelity 25 watt 6L6 amplifier, complete with tubes, in new condition. Original price $95.00. First $50.00 takes it. George E. Beggs, Jr., c/o Leeds and Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

FOR SALE OR SWAP—1 WE output trans. for PP 211Es, tubes 1 WE 282B, 5 WE 231D, 3 WE 275A, 2 WE 211E. 4 Centralab PA Delta T pads 50 ohm; 3 RCA magnetic phono heads; 1 6v to 180 30 ma genemotor, 1 6v to 225v 50 ma genemotor, various Weston and Jewell meters, 6v pot units for trumpets. H. H. Harrison, 300 37th St., Sacramento, Calif.

TRADE—5 vol. ICS Reference Library in Industrial Management, in very good condition, for Radio Course, radio books or testing equipment or what? R. A. Lorant, Sr., RFD 1, New Kensington, Pa.

WANTED—RCA Radiola Model 17 condenser block, test equipment VOM and oscillator, will consider any make. State price and make, all mail answered. John J. Puzio, Radio Service, 1250 Franklin St., Taylor, Pa.

WANTED—Tube tester, signal generator, or comb. tube and set tester. For sale or trade, 15 in. jig saw, very good, earphones, tubes new and used, used vol. controls, speakers, chokes. Philco 5 tube and 47 Majestic radios. Royce Saxton's Radio Shop, Rt. 1, Pontiac, Illinois.

WANTED—Rider's manuals 7 to 13, Rider chanalyst, Jr. voltohmist meter, Precision E 200 series 900 tester, state price. Joseph Trahan, 45 Dyer St., Danielson, Conn.

SELL OR SWAP—Univex Mercury camera 35mm, 3.5 lens, 1500 sec. speed and flash gun unit, leather carrying case, exposure indicator, red filter, 5 flash bulbs, like new. $35 or good radio instrument. George Lang, 32 W. Garrison St., Bethlehem, Pa.

FOR SALE—2 used power trans. for 5v, 2½v, 1½v tubes, $1.00 each; 2 used 6v genemotors, good cond., $1.00 each; 4 prs. Kline 6 in. longnose pliers (new) $2.25 each; 3 15 in. heavy duty dynamic speakers, no trans., $10 to $15 each. Any of above shipped FOB on receipt of price. M. A. Porter, 1713 Larrabee St., Chicago, Ill.

WILL SWAP—Five 5.50x17 tires and tubes four almost new, for a good two or 3 in. oscilloscope, or a good short wave commercial receiver, or what have you. Joseph Bucca, 1871 W. 13th St., Brooklyn, N. Y.

WANTED—Hallicrafters S-22R or similar for cash or will trade Hallicrafters S-20 as part payment. M. J. Dodge, New Windsor, Md.

WANTED—1 all wave signal generator, 1 Precision model 920 mutal conductance tube and set tester. State prices. Frank P. Leamer, Jr., Alexandria, Pa.

SELL OR SWAP—Have a good supply of bakelite loctal sockets which take 4-prong UX base tubes. Will swap for any standard bakelite or wafer sockets, or other radio parts. Norbert Rudie, Holdingford, Minn.

TRADE—For late tube tester and oscillator. Speakers ac-dc dynamic and magnetic, dry disc rectifiers, headphones, elec. phono motor and pickup, transformers, radio generators, many used parts. All letters answered. D. Ingersoll, 1741 Lysander, Detroit, Mich.

FOR SALE OR TRADE—1 Confidence tube tester with modernization panel; 1 Triplett Lab. complete (175 kc osc.); 1 Briggs-Stratton 1 hp motor, model FH.; 1 Remington repeating rifle, model 12A, with special Marble front sight (like new). Will trade rifle for multitester or condenser tester. Clifford D. Lessig, Frenchtown, New Jersey.

WANTED — Illuminated window sign, either RADIO or RADIO SERVICE. Will pay cash or what do you want in trade. Also want new or used tubes in good condition. Byron Radio Shop, Byron, Illinois.

SELL OR TRADE—140 pairs Chicago roller skates, perfect condition. Have complete outfit ready to roll. Excellent opportunity for right party. Want radio equipment and parts. Need Chanalyst or Voltomist, also good microphone. W. S. Frank, Route 3, Box 2, Chippewa Falls, Wis.

WANTED—Stancor power pack model 131 or 132 for cash, also signal generator. Robey's Radio Service, Waldorf, Md.

WANTED—General Electric house radio, Model A-82, A-87 or E-126, state price and condition. P. J. Rumbol, 46 N. High St., Greenville, Penna.

FOR SALE—Presto Recorder, new, complete with cutter, overhead feed-screw mechanism, playback amplifier and pickup. $475.00. H. S. Walker, 5433 Victoria Ave., Montreal, Que.

SELL OR SWAP—Weston 547 analyzer, RCA code course with code machine, Wilcox Gay phono record player, National SW-3 complete, 4 sets B.S. coils. WANTED—All wave osc. output meter. William Quigley, 102 Ave. S, Brooklyn, N. Y.

SELL OR SWAP—Emerson electric fan, 12 inch, oscillating, 110 volt direct current. Want small radios, tubes, or what have you to offer? Byron Radio Shop, Byron, Illinois.

WANTED—Rider's manuals, No. 6 to 13. State lowest price and condition, also radio tubes 6, 12, 25, 50, 70 volt tubes. Charles I. Amplo, 2228 Newbold Ave., Bronx, New York.

WANTED—Used 16mm sound projector, with or without amplifier and speakers. Have good used tubes, 35Z5, 35L6, 12SK7 80, 6K7, 6F6, 42, etc., all set tested, to trade or will pay cash. I have odd type new tubes, 2A5, 2A7, 25A7, 12A5, 37, 38, 2A4, 6B7 to sell or swap, what have you? Boulevard Radio Shop, 3120 Taylor Blvd., Louisville, Ky.

WANTED—AC-DC B.C. and short-wave table-model radios; also test oscillator or signal generator, radio parts, used Rider Manuals. Adolph C. Roncalio, 253 West 45th St., Seattle, Washington.

WANTED—Rider's manuals 1, 2, 3, 4, must be in good condition. State price. Sullivan's Radio Service, 930 West 1st St., Duluth, Minnesota.

FOR SALE OR TRADE—Radio and electrical course. Will sell for $20. Must pay own shipping charges. Sullivan's Radio Service, 930 West 1st St., Duluth, Minn.

WANTED—AC-dc multitester similar to Model 446A of Radio City Products Co. make in A-1 condition (no junk). State make, condition and lowest cash price. Fred Prince, Box 305, Normandy, Tenn.

WILL TRADE—Remington portable typewriter new, never used. Will trade for good signal generator, or set tester or cathode ray oscilloscope. What am I offered in the way of test equipment. Henry J. Hudnall, Putney, W. Va.

FOR SALE — RME-69 communication receiver, condition new, in original carton, including Lamb noise silencer, i.f. crystal filter, air tuned r.f., with 8 in. P.M. speaker in metal cabinet to match RME-69, $189.50 complete. L. J. Schnedorf, 610 Monroe Ave., River Forest, Illinois.

WANTED—Weight wind clock works for grandfather clock. Wyckoff Radio Shop, Lincolnton, N. C.

SELL—Airport traffic control frequency crystal, 278 kc Bliley BC3A in holder, never used, cost $20, make offer. W9ARN, Bartonville, Ill.

WANTED—Superior dynarometer or any ac operated VOM, also need condenser analyzer such as Jackson, also power supply, converter from 110 ac to 32 volt dc. Dearth Radio Service, Augusta, Ohio.

FOR SALE OR TRADE—Six R&M 16" osc. fans dc 110 v., nearly new. What am I offered. Will swap, what have you? Upper Darby Radio, 4525 York Road, Philadelphia, Pa.

WANTED—Cash or trade, RME DM30XA or DM36A, Abbott TR 4 or Mrt 3, National One Ten, Browning Converter, S29 Sky Traveller.

FOR SALE—2 Bliley Xtals new sealed in type B5, frequency 7212 and 7224. Also 150 and 75 mtr xtals and holders. V. Howerdel, 102 Hancock Ave., Jersey City, N. J.

WANTED—A Model 95 Aerovox LC checker, a Precision signal generator or other make of a good VTM condenser tester for cash. Roger E. Kean, Union St., P. O. Box 317, Mantua, N. J.

WANTED—Precision E-200 signal generator, must be in A-1 condition. Will pay cash. Describe condition, serial number, date of purchase and price desired in first letter. J. Lipiner, 1032 Rutland Road, Brooklyn, New York.

SWAP—For a 2¼ x 3¼ speed Graflex and equipment or Leica, etc., for my Howard 435A receiver, A-1 condition and brand new 1943 Motor Repair Library, armature winding clearly detailed. Also Winchester 24-12 gauge shot gun, like new. Kates, Woodridge, N. Y.

FOR SALE OR SWAP—Majestic chassis power packs and speakers, Model 90S, 90B, 130. Superhet 160 and No. 70 GE K32 complete. Temple chassis and power pack, RCA Victor R32 complete. Brunswick 9 tube superhet and speaker. Kolster K43 and speaker, Kolster Brandes chassis, Kolster K5 power amplifiers, brand new. Ac-dc 5 tube superhet chassis. Make offer. Need DC milliamp meters 0-75. Goldstone Radio, 1279 Sheridan Ave., Bronx, 56, New York.

WANTED—Signal generator Hickok, 188x, 188, 177x, oscillograph RFO 4 or 5, electronic multitester RCP 662 or other. The Radio Man, 1724 Central Ave., Middletown, Ohio.

WANTED — Latest tube tester, Hickok, Weston, Supreme, or Precision, also signal generator of same make in A-1 shape. Have For SALE 7 and 8 Gernsback (comb.) $3; very good 15 in. jig saw $8; Superior tube tester 1240, $8; new and used tubes, new and used parts, 4 t. Majestic radio, $6. Royce Saxton's Radio Shop, R. 1, Pontiac, Illinois.

FOR SALE—One Readrite Model 432-A tube tester, like new, $15. New self-vulcanizing tire reliners, 600x16, 5.50x 17, $2.95 or will trade for radios. Auto and Appliance Supply, Main at Newton Sts., Granby, Mo.

FOR SALE—Give Offer—All these radios are clean and in playing condition. 1 Majestic 70 chassis power pack and speaker; 3 Majestic 90 chassis power packs and speakers; 2 Majestic 90B and speakers; 1 Majestic 130 and speaker; 1 Majestic 160 super and speaker; 2 Majestic 300 chassis only; 2 Brunswick 9 tube supers and speakers, model No. 17; 1 AC-DC 5 tube super, no speaker; 1 Temple chassis and power pack; 1 Kolster Brandeis chassis, model No. B15. L. A. Goldstone, 1279 Sheridan Ave., Bronx, 56, New York.

WANTED — Solar capacitor exameter, Sprague tel-o-mike, Solar capacitor bridge model CB, CC, QBK, QBC, Cornell-Dubilier BF-50 or BN, Aerovox LC checker. Any of these for cash or trade. State condition and lowest price wanted. Anthony Pusateri, 1101 Fleming St., Coraopolis, Pa.

WANTED — Superior channel analyzer. State condition and price. Ronald M. Neiman, Pottstown Radio Clinic, 433½ Chestnut Street, Pottstown, Pa. Phone 2740.

WANTED—Used oscillator in real good condition. State make, model, serial number and price. George Cannova, 41-15 Union St., Flushing, N. Y.

FOR SALE—Best offer. Several radios in good playing condition, such as Brunswick, Temple, Fada, Kolster, etc. Write for list. L. A. Goldstone, 1279 Sheridan Ave., Bronx, 56, New York.

WANTED FOR CASH—Philco signal generator model 070. Complete set Riders manuals or what have you. Jack's Radio Shop, Mart, Texas.

FOR SALE—Best offer. One 2 amp. and 2 3 amp. Weston model 507 RF ammeters just returned from Weston factory. Also 300 mil. Weston 506, new. Clark Radio, Granville, Ohio.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