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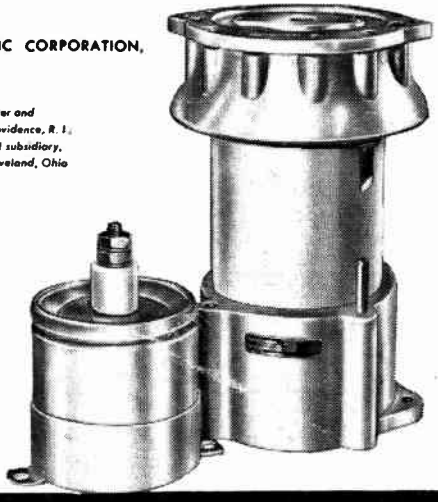

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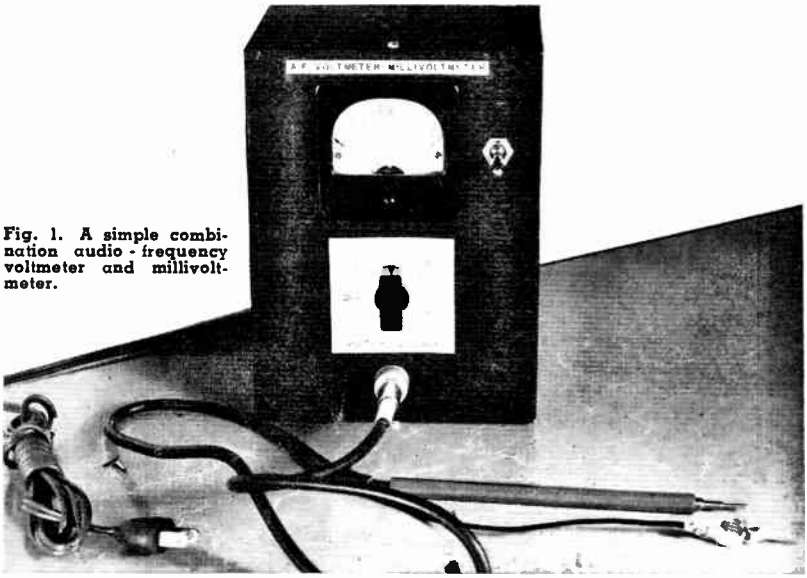

Fig. 1. A simple combination audio - frequency voltmeter and millivoltmeter.

The measurement of audio-frequency gain, distortion, impedance, input signal level, noise level, hum level, etc., often necessitate the checking of potentials of 0.1 volt and less. Such measurements cannot be made accurately, when at all, with the conventional a. c. voltmeter. A millivoltmeter is required. Since high input impedance is desirable for minimum circuit loading, the instrument should be of the vacuum tube type. An audio-frequency millivoltmeter is invaluable for a wide variety of experimental applications aside from amplifier and audio component testing. The high price of commercial a. f. electronic millivoltmeters justifies the private building of this type of instrument by the radio technician.

The design of the instrument described in this article represents an earnest attempt to obtain the best practicable frequency response, widest voltage range, and stability at lowest cost and with greatest simplicity of construction and operation. This meter can be duplicated without difficulty by any radio technician who has built an audio amplifier.

Voltages are indicated directly on the scale of a 0-1 d. c. milliammeter. The five ranges provided are 0-10 millivolts (0.01 v.), 0-100 m. v. (0.1 v.), 0-1, 0-10, and 0-100 volts r. m. s. The last three voltage ranges are added to enable measurement of signal voltages at any point in an amplifier. Response of the meter is linear throughout, so no

special meter scale nor reference chart is necessary. On the 10-millivolt range, the lowest accurately-readable voltage is 0.2 millivolt (one scale division which is 1/50 of full-scale). Between the limits of 0.2 m. v. and 100 volts maximum voltage reading, the instrument covers a voltage range of 500,000 to 1.

The instrument circuit proper uses only one tube—a 12AX7 twin triode. The two triode sections are connected as high-gain resistance-capacitance-coupled amplifier stages in cascade. The indicating milliammeter is actuated by the amplified output signal rectified by four 1N34 germanium diodes in a full-wave bridge circuit. The crystal diodes eliminate frequency error in the rectifier circuit. Since the meter circuit is operated at a 10-volt r. m. s. level, excellent linearity is obtained. One 5W4-GT tube and two miniature 0A2 voltage regulators are employed in the power supply circuit.

Although the instrument is of the vacuum tube type, no zero adjustment is required. This simplifies operation and provides speed in use. Elaborate calibration equipment is not needed to put the instrument into operation.

A simple resistance-capacitance-coupled amplifier circuit is employed. This avoids the complexity of the video-type circuit found in commercial audio millivoltmeters and provides the extremely high gain necessary for low millivolt measurements with a minimum of tubes. While the frequency range is not equal to that of the video amplifier, it is good enough for all practical audio work.

Operating Principle

The instrument essentially is a high gain amplifier-rectifier type of voltmeter. The input signal is applied through a shielded pickup lead and coupling capacitor C_1 to the grid of the first triode section of the 12AX7 tube. The signal voltage divider (comprised by resistors R_1 to R_8, inclusive) and range switch S_1 limit the signal applied to the grid to some value between zero and 10 millivolts. The total resistance of the voltage divider is 1 megohm. The input impedance of the instrument accordingly is equivalent to 0.1 microfarad (the capacitance of C_1) in series with 1 megohm, at the signal frequency. There is some temptation to use higher values of input resistance, but resistance in excess of 1 megohm make the instrument more susceptible to hum pickup and body capacitance effects.

The first triode section is coupled to the second through capacitor C_4 and potentiometer R_{11}. The latter acts as a gain control and is located inside the instrument case where it will be safe from accidental movement. Once this control is set during the initial calibration process, it will need no readjustment except to compensate occasionally for tube aging. Maximum theoretical voltage gain of the dual triode amplifier is more than 2000. By setting R_{11} down, only about half the possible gain is utilized, however, and ample leeway is provided for compensation adjustments. Resistor R_6 and capacitor C_3 form a decoupling filter for stabilizing operation of the high-gain amplifier.

The amplifier output is coupled to the meter circuit through the 0.5-mfd. capacitor, C_6, and rheostat R_{12}. The rheostat serves as an adjustable multiplier resistor which is set during the initial calibration to give meter M a basic range of 0-10 volts a. c.

The tapped heater of the 12AX7 tube is connected for 6.3-volt operation by paralleling socket terminals 4 and 5, and making connections to terminals 4 and 9. One side of the 6.3-volt circuit is grounded to the chassis for hum elimination.

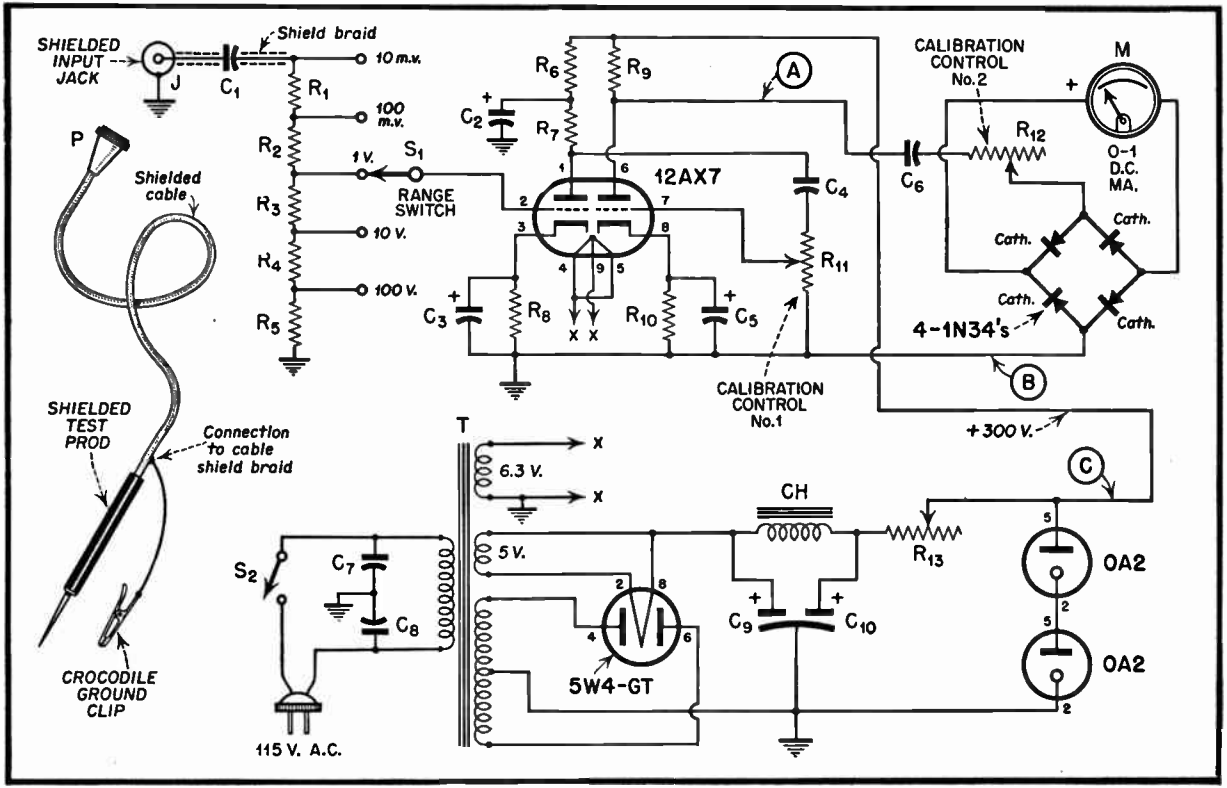

Fig. 2. Complete circuit of the meter.

Construction Hints

All of the rules which apply to efficient construction of high-gain amplifiers must be observed in building this instrument. The salient points to be observed are discussed in the following paragraphs.

1. Return all ground connections to *one* lug solidly bolted to the chassis. The use of a single ground point is easy in this case because of the single-tube setup.

2. Use a shielded *non-microphonic* (cushioned) socket for the 12AX7 tube.

3. Use a shielded jack at J, and place shield braid around the leads between jack J and capacitor C_1, and from C_1 to the input resistor string. Ground this shield braid to the single ground lug on the chassis.

4. In order to minimize leakage, switch S_1 must be ceramic insulated.

5. Twist the tube heater leads (and all other a. c. power leads) tightly into a pair, and clamp them securely to the chassis. Keep these leads well away from the grid terminals of the 12AX7 tube socket.

6. Ground the metal back plate of potentiometer R_{11} to the common ground lug on the chassis.

7. Use only a shielded test lead for delivering the input signal voltage to the instrument. This lead must be terminated by a shielded plug, as shown in Figure 2.

8. Keep all leads as short as possible and run them as directly between points as practicable. It will be advisable to use point-to-point wiring, rather than the subpanel-and-laced wiring scheme, in this instrument, in order to prevent feedback. Use insulated *solid* hookup wire.

9. Bolt all components, such as tube sockets, transformer, and filter choke, securely to the chassis. Inspect the transformer and choke for loose laminations before mounting.

10. Enclose the instrument completely within a metal case.

Resistors R_1 to R_8 in the input voltage divider must be chosen to have the exact values given in Figure 2. Note that resistors R_1, R_2, and R_4 must be made up by connecting two specified resistors in series, in each case. The resistors used in this voltage divider provide potentiometer action. For this reason, their values must bear a definite relationship to each other. The resistors therefore can deviate from the values given in Figure 2, provided *all* other resistors in the string deviate by the same percentage and in the same direction.

The voltage regulation feature must not be omitted from the power supply, since changes in the 12AX7 plate voltage will be reflected in corresponding changes in amplifier gain and meter accuracy. The filter choke, CH, also is recommended for best operation. There is a present tendency to use filter resistors instead of chokes to save space in small-sized test instruments. The resistor was tested in this circuit, but the incomplete filtration of the R-C filter gave rise to considerable hunting in the milliammeter when the signal-voltage frequency approached a harmonic or sub-harmonic of the power-line frequency. It will not be wise to use a transformerless (voltage tripler) power supply, since that type of supply will introduce a shock hazard, as well as coupling hum into the circuit under test.

The builder must be careful to observe correct polarity of the crystal diodes and milliammeter. If the diodes are connected improperly, they may become damaged. Reversed meter connections will give a downward deflection on application of signal.

The instrument, as shown in Figure 1, is built into a steel box, 9" high, 6½" wide, and 6¼" deep. The 12AX7 tube

and its associated components, including potentiometer R_{11}, are mounted on a small metal bracket-chassis held in place by the shank of selector switch S_1 and two screws. The four crystal diodes and rheostat R_{12} are mounted on a small bakelite panel held by the two terminal screws of the milliammeter. Resistors R_1 to R_8 are mounted directly on the range switch, S_1, by soldering their pigtails to the switch terminals. The power supply components are mounted solidly on one side and the removable back of the instrument case. This is a very tight, compact assembly which need not be followed by an individual builder if small overall size is not a must. In fact, it will do no harm to spread out the layout somewhat, provided the amplifier components are grouped close to the 12AX7 socket.

The shafts of potentiometer R_{11} and rheostat R_{12} are sawed short and provided with slots for screwdriver adjustment, since these controls need no adjustment from the front panel.

Initial Adjustment and Calibration

Be sure to check all wiring carefully and verify its correctness before undertaking initial adjustment and calibration.

The first part of the circuit to be adjusted is the voltage regulator in the power supply. To make this adjustment, go through the following procedure in the order of steps shown:

1. Referring to the circuit diagram, Figure 2, unsolder temporarily the d. c. output lead at Point C from terminal 5 of the top 0A2 tube.

2. Insert a 0-100 or 0-50 d. c. milliammeter in series with the slider of R_{13} and terminal 5 of the top 0A2 tube. Connect the negative terminal of the meter to terminal 5.

3. Set the slider near the high-resistance end of R_{13} and tighten it enough to make contact while being able to slide along the resistor.

4. Switch-on the a. c. power.

5. Using an insulated screwdriver or insulated pliers, move the slider along R_{13} until the milliammeter shows a reading of exactly 30 milliamperes. At this point, tighten the slider in place and switch-off the power.

6. Remove the milliammeter from the circuit and restore the connection between the slider of R_{13} and terminal 5 of the top 0A2 tube.

7. Restore the connection of the 300-volt high-voltage lead (Point C) to terminal 5 of the top 0A2 tube.

The voltage regulator adjustment now is completed. The d. c. voltage, measured with a high-resistance voltmeter connected between ground and terminal 5 of the top 0A2 tube, should be 300 volts.

The amplifier next should be checked for hum, noise, and osciliation. To do this, follow the steps given below in the order in which they are listed:

1. Set range switch S_1 to its 100-volt position. Keep the instrument out of the vicinity of any known a. c. fields.

2. Do not plug the test lead into input jack J.

3. Set potentiometer R_{11} to approximately half-scale.

4. Set rheostat R_{12} to approximately quarter-scale.

5. Switch-on the a. c. power and allow about 5 minutes for the tubes to come up to normal operating temperature and stabilize.

6. Switch S_1 successively to its 10 v., 1 v., 100 m. v., and 10 m. v. points, watching meter M for any steady deflection. Deflection on any of these ranges will indicate the presence of some steady signal (such as hum, noise,

or oscillation) in the amplifier. If such deflection does occur, a pair of headphones must be connected in place of meter M to identify its nature. If the extraneous signal is hum, temporarily short-circuit jack J to ground. If the hum disappears when J is grounded, it was picked up by the "hot" terminal of the jack and very likely was due to some strong a. c. field in the neighborhood of the instrument. If the hum does not disappear, it is getting into the circuit directly from the instrument's own power supply, and may be caused by failure to ground one of the 12AX7 heater terminals, faulty tube shielding, too long a lead from terminal 2 of the 12AX7 socket to switch S_1, failure to shield this lead, or mounting the power supply components too close to the 12AX7 circuit.

If the extraneous signal is noise, it will be identified as a continuous hiss, roar, cracking, or frying. The inherent noise level of the amplifier circuit is not high and should give no trouble. So if noise is detected in sufficient strength to deflect the meter, it probably arises from defective resistors, capacitors, or tubes.

If a whistle, squeal, sharp buzz, motorboating, or crying is heard in the headphones, oscillation is present in the amplifier circuit. Elimination of this trouble often calls for rearrangement of the layout and wiring of the amplifier to remove the feedback.

7. If no steady meter deflection is obtained without input signal (or if the trouble described in the foregoing paragraphs has been cleared up), calibration may be made.

8. Calibration is simplified to a single-voltage test at one point on the meter scale, since the meter scale and response is linear. First, set switch S_1 to its 100-volt position, set potentiometer R_{11} at about half-scale, and set rheostat R_{12} at its highest-resistance point.

9. Plug-in the shielded test leads and connect them to an accurately-known source of exactly 10 volts r. m. s. A 60-cycle source will do, although somewhat better accuracy may be obtained with a 1000-cycle source.

10. Set range switch S_1 to its 10-volt position.

11. Adjust rheostat R_{12} until milliammeter M reads exactly full-scale for the 10-volt signal input.

12. Some technicians may prefer to isolate the meter circuit by disconnecting it completely from the amplifier and to apply the 10-volt calibrating signal directly to points A and B. However, little advantage is to be gained from this added operation.

13. Possibility of overloading in the second amplifier stage can be checked by running the input signal voltage up in steps of 1 volt from zero to 10 volts. The corresponding readings of the milliammeter, M, should be exactly 0.1 milliampere apart and should fall on the heavy black divisions on the meter scale. If the second triode is overloading, the higher readings will be crowded close together. This condition can be corrected by reducing the setting of potentiometer R_{11} until the proper deflections are obtained in all portions of the meter scale.

14. If desired, the frequency response of the instrument may be checked by feeding a constant-voltage input signal (for example, 1 volt) into the instrument, varying the frequency of the input signal continuously from 20 cycles to 15 or 20 kc., and noting the change in reading of meter M. A correction curve can be drawn on the basis of this check.

Use of the Instrument

The meter will find application wherever measurements of a. f. voltage must be made between 0.2 millivolt and 100 volts r. m. s. The possible applications are much too numerous to be listed in full in this space. However, a few of the principal measurements which may be made with the instrument are listed below:

Input signal voltage of a. f. amplifier
Microphone output
Phono-pickup output
Voltage across impedance-determining resistances
Gain per stage
Overall gain
Volume level
Distortion
Fidelity
Intermodulation
Null detection in a. c. bridges
Hum level
Noise level
Audio oscillator output
Negative or positive feedback voltage
Stray-coupled audio voltage
Ripple
Talking-picture photocell output
Modulation percentage
A. F. signal tracing
Wave filter operation
Heterodyne filter adjustment in hi-fidelity t. r. f. receivers
Audio power output
Pushpull amplifier balance
Phase inverter balance
Turns ratio
Oscilloscope sensitivity
Capacitance
Inductance

List of Components

C_2—0.1 mfd. 400 v. tubular—C-D Type DT 4P1

C_3—8 mfd. 450 d. c. w. v. tubular electrolytic—C-D Type BR 845

C_4—20 mfd. 25 d. c. w. v. tubular electrolytic—C-D Type BR 202A

C_5—0.05 mfd. 400 v. tubular—C-D Type DT 4S5

C_6—20 mfd. 25 d. c. w. v. tubular electrolytic—C-D Type BR 202A

C_7—0.5 mfd. 400 v. tubular—C-D Type DT 4P5

C_8, C_9—0-1 mfd. 400 v. tubular—C-D Type DT 4P1

C_{10}, C_{11}—8 mfd. 450 d. c. w. v. tubular electrolytic—C-D Type BR 845

CH—10 henry 30 ma. midget filter choke—Utah 4661

J—Microphone-type chassis jack—Amphenol 80-C

M—3-inch 0-1 d. c. milliammeter—Triplett 327-T

P—Microphone-type cable plug—Amphenol 80-M

R_1—900,000 ohms (0.4 and 0.5 megohm ½ watt resistors in series)

R_2—90,000 ohms (40,000 and 50,000 ohm ½ watt resistors in series)

R_3—9000 ohms ½ watt

R_4—900 ohms (400 and 500 ohm ½ watt resistors in series)

R_5—100 ohms ½ watt

R_6—50,000 ohms 1 watt

R_7—100,000 ohms 1 watt

R_8—1500 ohms 1 watt

R_9—100,000 ohms 1 watt

R_{10}—1500 ohms 1 watt

R_{11}—¼ megohm potentiometer—I. R. C. Type CS

R_{12}—10,000-ohm wirewound potentiometer—I. R. C. Type W-10,000

R_{13}—2500-ohm 10-watt wirewound resistor with slider—I. R. C. Type ADA

S_1—Ceramic-insulated, single-pole, single-gang rotary selector switch (stopped down to 5 positions)—Centralab 2501

S_2—Single-pole, single-throw toggle switch

T—Power Transformer: 300-0-300 v., 50 ma.; 5 v., 2 A.; 6.3 v., 2 A.—U. T. C. R-54

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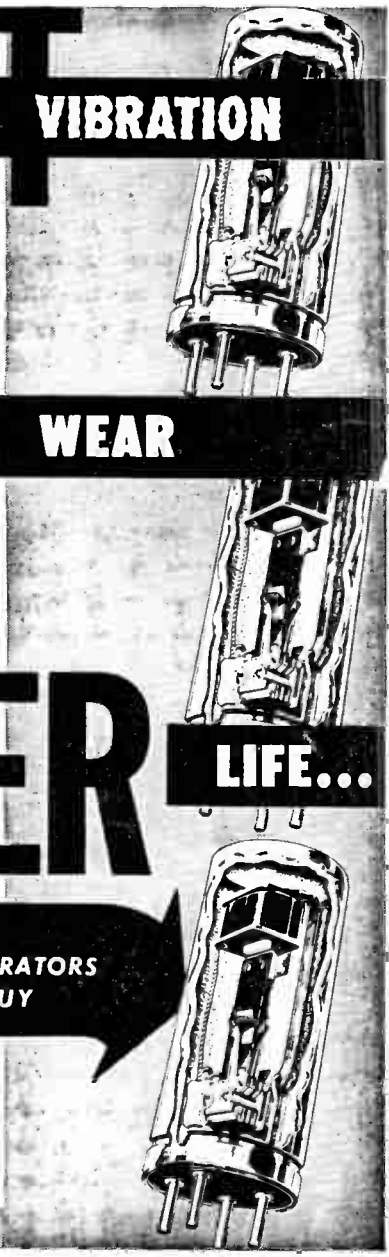

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TRADE—Weston Master II exposure meter, Philco Model 7050 tube tester. Want oscilloscope or what have you? L. Putnam, Woodward, Ia.

WANTED—Riders Manuals from vol. 11 thru 20 inclusive. State price and condition. Harry Sherman, 673 Moody St., Waltham 54, Mass.

WANTED—Some No. 15 tubes for Zenith radio. E. Prescott, R. 4, Anoka, Minn.

FOR SALE—Hickok AM-FM signal gen., crystal controlled model 277X. Used very little, best offer over $50. F. G. Sealy, Box 317, Broderick, Calif.

SELL OR SWAP—3-way portable Zenith radio; 1/4" electric drill. Want VOM tester or 8mm movie camera. Best offer. John Lagana, 2001 Morris Ave, Bronx 53, New York.

TRADE—BC-375 transmitter, 4 tuning units, antenna loading coil, 4 spare (211) tubes, with complete conversion diagrams, all in good condition. Would like to have small TV set or kit, or wire recorder. T. A. Childers, North Kenova, Ohio.

SELL OR TRADE—BC603 FM receiver with dia. and voltage doubler 120V a.c. power supply. Very good condition, set to receive 10 meters. Want $25 or good tube tester. M. J. Kolo, 9315 Brockton St., Detroit 11, Mich.

WANTED—Teletype machines, any type. Series governed motors preferred. Machines to be used in ham bands. Certification will be provided. Melvin W. Johns, 750 Huron Rd., Cleveland, Ohio.

FOR SALE OR TRADE—Federal photo enlarger and 1 set Machine Shop Practice books. Want sig. gen. or VTVM. Billy Jones, RFD 2, Louisville, Tennessee.

FOR SALE OR TRADE—Precision ES-500 oscilloscope; Precision E-400 sweep sig. gen., perfect condition. $175 for pair or equivalent trade. Ray Viglione, 276 Washington St., Perth Amboy, N. J.

FOR SALE—Excellent REK-O-CUT professional 16" recorder, amplifier, dynamic micro phone, $200 f.o.b. Athens, or will trade for expensive stencil duplicator. Also have C&P 8x12 press, motor, very cheap, make offer. Allmon, 375 Holman, Athens, Georgia.

SWAP—Bendix 12 channel aeroplane or marine transmitter and receiver. Swap for ham or photo gear. L. Meister, 1526 Schley St., Hillside, N. J.

FOR SALE—G.I. R-90L 2-speed disc recorder, $22.50; Webster 80 wire recorder, $65; Garrard RC-65 intermix changer, $20; Supreme 589-A tester, $22.50. All in excellent working cond., f.o.b. Rockford. M. Phillips, 311 Penfield Pl., Rockford, Illinois.

WANTED—16" vertical transcriptions. Advise make, titles, etc. Will pay cash or trade. Have high fidelity audio equip., including speakers, changers, magnetic pickups, recording equip., etc. D. G. Pace, 564 Audubon Ave., N. Y. C. 33, N. Y.

SELL OR TRADE—Majestic motor, pickup, recording head; Supreme No. 85 tube-tester; 1900-IRC-B7a-1-W insulated resistors. Want typewriter, 3x5 printing press, 10-15 watt amp., or make offer. Will accept certain type tubes. I. Stubblebine, 140 S. 4th St., Reading, Pa.

SELL OR TRADE—Have instructograph with 14 tapes; 8mm movie camera, telephoto lens; transmitting tubes and parts. My list for yours. W. M. McDonald, Box 351, Harrisville, R. I.

WANTED—N.R.I. Model 45 professional multi-meter and model 88 sig. gen. in good condition. J. L. Grotjan, 1020 N. Boston Ave., Tulsa, Okla.

FOR SALE OR TRADE—1500V, 300 ma power supply; 10, 11, 6 meter Lafayette converter; Wilcox F-3 receiver. No reasonable trade or cash offer refused. Ralph Colton, 504 W. 110 St., N. Y. C.

SELL OR TRADE—Pair of ice skates, size 9; tripod with tripod head, all good condition. Want wire recorder converter or radio test equipment. William Thompson, 1208 - 77 St., Brooklyn 28, N. Y.

WANTED—Good communications receiver or phono records of Russ Columbo. Fred Simonian, 931 Washington St., Lynn, Mass.

WANTED—Simpson 260 or Triplett 625NA or 630 VOM in A-1 condition. Have radio tubes and misc. parts. List sent on request. Butler C. Clave, R 2, Petoskey, Mich.

FOR SALE—14 UX199 RCA radio tubes. Best offer. Also 2 General Industries 9" single speed motors. FOB N. Y. Irving Kline, 619 West 175 St., New York 33, N. Y.

FOR SALE—Heathkit push-pull 5" scope, 2 months old, perfect; model 599 Supreme tube and set tester with latest roll chart and adapters. $35 each. D. L. Roberts, 609 E. Mo. Kirksville, Missouri.

FOR SALE—Audak X-18 transcription pickup, magnetic 500 ohms, $8; Revere T-100 tape recorder, $115; 78 rpm record player, plays thru radio, $5. All good cond., f.o.b. Rockford. V. R. Hein, 418 Gregory St., Rockford, Ill.

WANTED—Meissner sig. shifter or other V.F.O. State price and condition in first letter. Albert Miller, 1075 Bryant Ave., Bronx 59, N. Y.

FOR SALE—Precision volt-ohmmeter, model 832, $10; RCP voltmeter, model 462, $15. Good condition. Lee Radio and TV Co., 4336 Degnan Blvd., L. A. 8, Calif.

TRADE—Key Machine, photo enlarger, Motorola Auto Radio, 3-way port. radio, electric drill, tubes. Want late model tube tester or test equipment. Furnish description first letter. Sam Berenblum, Greenwich, Conn.

FOR SALE—Hallicrafters S-53 receiver, good condition, $55; Garod 3-way portable, model 5D4, complete with batteries, $19; Chicago volt - ohm - milliammeter, leather case, $11. Dick Bruce, 1171 Union St., Manchester, N. H.

FOR SALE—Supreme Manuals (used) vols. 1926-38, '39, '40, '41, '42. Original price $10.50. Will send postpaid upon receipt of check or M.O. for $5.25. Brown's Radio Service, Bank Bldg., Coloma, Mich.

WANTED—Converter: input 115V a.c. 60 cycles; output 12V d.c. at 10A and 32V d.c. at 8A. Will consider separate or individual units for input and output ratings. Adolph S. Voldish, 123 Glassboro Rd., Woodbury Heights, N. J.

FOR SALE OR TRADE—Will wire electronic circuits, kits, etc., to specifications for cash or Sams or Riders Manuals. E. G. Schwartz, 126 Wilson St., Havre de Grace, Md.

FOR SALE—Jensen 8" base reflex cabinet, $10, with Jensen 8" PM speaker, $15. T. Popel, 1213 Elm Ave., Brooklyn 30, N. Y.

FOR SALE—Fada FM tuner, model 795, needs alignment; Webster-Chicago portable amplifier, model 66-1A. Will sell separate. Make cash offer. Henry Kolk, Washingtonville, N. Y.

FOR SALE—7 to 9. mc transmitter, converted with meter and power supply, ready to go on the air, $20. Sid Biederman, 160 E. Third Et., Mount Vernon, N. Y.

WANTED—Complete set of TV test and alignment equipment, VTVM, a 7" or 10" TV set, and a 7" or 10" TV CR tube. Have cash. Quote price and model first letter. G. Bradford, 705 St. Marks Avenue, Brooklyn 16, N. Y. C.

FOR SALE—PL-55 Plugs, 36 cents, PL-68 Plugs, 45 cents ea. H. Lewis, 548 Brompton, Chicago 13, Ill.

FOR SALE—Hallicrafters S-53 receiver, $45; Corona portable typewriter, $15; Garod maroon colored 3-way portable, only $25 with batts. Need money for college. Dick Bruce, 1171 Union St., Manchester, N. H.

WANTED—One tape-recorder head. Will trade for parts or cash. Clifford A. Meyer, 1015 - 3rd Ave. S. W., Pipestone, Minn.

FOR SALE—Knight 20 watt hi. fid. amp., and Meissner 8C FM tuner. R. C. Barley, 144 W. 2nd Ave., Roselle, N. J.

FOR SALE—Two tone window neon sign, red and blue, Radio Service. Letters are 5" and 3" high. Will swap above for good test equipment. Arnold L. Halpern, 450 Brighton Ave., Long Branch, N. J.

FOR SALE—Precision sig. gen., E-200, and Hickok tube tester, model 530, excellent condition. Best offer takes both. Dan Harris, 1776 Weeks Ave., New York 57, N. Y.

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WANTED—10 or 12 inch TV set; Oak Ridge signal generators model 103 or 104. Also a good signal tracer. John Arnold, P.O. 84, Bluffs, Ill.

SWAP—Have loctal and special purpose tubes, BC-645 units, assorted xmtr. and receiver parts. Want miniature and octal tubes, 6 volt mobile receiver covering 200-500 kc., or what have you? O. C. Vidden, Fertile, Minnesota.

WANTED—Used S.W. receiver (a.c.), with phones, 5-80M (Heathkit might do). Also Sprayberry communications course, with kits. Payments by dollar check. S. J. Smith, Via 4 Fontane 161, Rome, Italy.

WANTED—SSR-1-G receiver, 2.4 - 16.3 mc. State condition and price. L. V. Broderson, 122 43rd. St., Sacramento 16, Calif.

TRADE—Excellent BC-342 receiver for ART 13 transmitter (not converted). Want to buy 08-10-139 instruction book for radio transmitter BC-375E. J. P. Hyde, Box 242, Manassas, Va.

FOR SALE OR TRADE—Good Triplett tube tester model 3413, used 3 times; Feiler TS-3 stethoscope in good shape. Best offer takes both (shipped express collect). What have you? J. S. Thompson, 414 Crawford St., Dalton, Ga.

TRADE—National Radio Institute complete Radio Television Communications course, 3 used kits included, about 60 books. Also Deforest Training School radio course, 20 books. Trade for Eico, Heath or other late model 5" scopes. George B. Carter 1650½ Artisan Ave., Huntington 3, W. Va.

SWAP—For TV projection components. 500 watt 2 meter transmitter AM or FM completely powered by Thordarson. Also receivers, meters, tubes, KW power supply, condensers, 872 rectifiers, etc., what have you? Normand Carignan, 3 Curtis St., Providence 9, R. I.

FOR SALE—Hickok model 191X crystal controlled microvolt generator, used very little, excellent condition, $100 f.o.b. J. R. Waldowski, 3511 54th Ave., Cicero 50, Ill.

TRADE—Remington Noiseless 8 typewriter, used about 10 hours, complete with folder and carrying case, value $98. Want good standard make tube checker or VTVM of equal value. State type and make. Eddie Gigliotti, Box 282, RD 3, Bangor, Pa.

TRADE—Minute "16" camera; Feiler TS-2 tracer; Eico scope; NR1 sig. gen.; VTVM; other items. Want tape recorder, BC-342, S40, or similar receiver, or what? W. Troppman, 525 Methow, Wenatchee, Wash.

WANTED—Operating and Instruction book for Dynorometer model 1260 Superior Instruments Co. Frank A. Driver, 307 Orange Rd., Montclair, N. J.

WANTED—Instructograph complete including instruction book, a.c. model. Also Candler System Junior Scientific Code Course complete. Norman J. McHale, 77 Turner Ave., Buffalo 20, N. Y.

SWAP—Simpson sig. gen., model 315, 75 kc. to 30 mc.; a laboratory instrument in A-1 condition. Want repeating deer rifle 25-20 or larger. Must be in good condition and not worn out. Jesse Ramey, 1309 Leeson Ave., Cadillac, Mich.

WANTED—Type 25B8 radio tube. Oscar Crafton, P.O. Box 268 Belleville, Ill.

TRADE OR SELL—U. S. Signal Corp Radio Course on AM-FM and transmitting. Best offer. G. H. Swiska, 109 E. School St., Woonsocket, R. I.

WANTED—Radio test instruments. Buy or swap. Inquire by mail only. J. Gregory, 73 E. 121 St., apt. 3, N. Y. C., N. Y.

FOR SALE—Heathkit oscilloscope, model 0-4, used very little, $25. J. Cunningham, 25-34 - 44th St., L. I. C. 3, N. Y.

FOR SALE OR TRADE—Two 522's; one BC-224. Need J-3-Cub landing gear and 65 Lycoming propeller. Charles Zito, Box 270, Middletown, Pa.

FOR SALE OR SWAP—National SW 3 with power supply and coils for 10 20 meters, excellent cond., less speaker $20, or what have you? Want 35mm slide projector with slides, state make and cond. R. Hartman, 2401 Fourth Ave. South, St. Petersburg 7, Fla.

WANTED—RCA wire recording head, recording wire, tubes, Red Book. Trade 150 watt, 110V d.c. to a.c. converter; battery portable; 8" fan;; tubes, etc. Clinton Harden, 5 Jackson St., Room 18, Lawrence, Mass.

FOR SALE—5" Dumont 274A oscilloscope and Precision model 10-20 tube and set tester. Used only a few times. Best offer. George W. Bellis, 874 Lincoln Ave., Maywood, N. J.

FOR SALE OR TRADE—SX-25 and spkr. in good condition, $80. Or trade for 10" or 12" TV set in good condition. Allan S. Joffe, 1622 Chestnut St., Philadelphia 3, Pa.

SWAP—4 auto radios - '35 Ford, '37 Chev., '40 Nash, 1 underdash type; gas engine; 40 meter xmitter; battery charger; code OSC; tork time switch; BC-454; 10,000V neon xformer; wireless tuner. Need portable typewriter, bench saw, or? Stan, 2748 Meade St., Detroit 12, Mich.

FOR SALE OR SWAP—Westinghouse Rotary Converter. Want sig. gen. Louis Geller, 411 W. 114th St., New York 25, N. Y.

FOR SALE—RCA Rider Chanalyst, excellent, with leads and manual, $100; Waterman 2 "in" scope and Electronics Design VTVOM with leads and manuals, $30 each. R. Beeson, 647 Chestnut, Dubuque, Iowa.

FOR SALE—20,000 ohms-per-volt Electronic multitester, 4½" meter with leads and papers. $28 postpaid. Walter Siuta, 4011 Lawndale St., Detroit 10, Mich.

WANTED—G I Mill typewriter and Meissner signal shifter, both in good cond. State price and condition. C. Pandelaky, 108 Bay Terrace Ave., Staten Island, N. Y.

TRADE—BC-348-Q, converted to a.c. Want television set in working order or a press type camera — Graphic or similar. Elvin L. Holley, Box 336, Vaughn, N. M.

FOR SALE—Hickok model 203 electronic volt-ohm-capacity meter; perfect cond., $75. Michael Landis, 29 West 12th St., New York 11, N. Y.

SALE OR TRADE—Cinemaster 11 8mm movie camera. Want two stage TV booster and tenna-rotar. Vick Radio Service, P.O. Box 216 Kershaw, S. C.

FOR SALE OR TRADE—Webster model 50 automatic record changer, $15; 15 watt PA amplifier, grey chassis with top cover, will drive a 15" spkr. or field coil type, $20. Or will trade both items for a good tube tester. C. Wegrzynowski, 51 North Central, Buffalo 12, N. Y.

SELL OR TRADE—3 sets Weston Sensitrol relay and photocell, $50 a set or trade for high fidelity audio equipment. F. W. Preeshl, New Richmond, Wisc.

FOR SALE—Hickok 288X sig. gen. AM-FM sweep, used 2 months. Cost $186, will sell for $140. H. D. Bishop, 316 Ivy St. N.E., Atlanta, Ga.

FOR SALE—RCA model 2-T-60 12½" TV set, used 3 months; 16mm sound projector, with mike, 2 spkrs., screen, used about dozen times. Make offer. Ernest Herzog, 1239 Otis Pl., Bethlehem, Pa.

WANTED—Good sweep generator. Give all details in first letter. Also need transcription player, must be a bargain. H. W. Smith, 503 Walsh St., Austin, Texas.

WANTED—Riders Manuals, vols. 12 back through 1. No incomplete volumes considered. Sundell's Radio Service, 116 N. Cayuga St., Ithaca, N. Y.

WANTED—The book "The Inventions, Researches and Writings of Nikola Tesla" by Thomas Commerford Martin. (Published in 1894 by The Electrical Engineer.) Leland I. Anderson, 127 Seymour Avenue S. E., Minneapolis 14, Minn.

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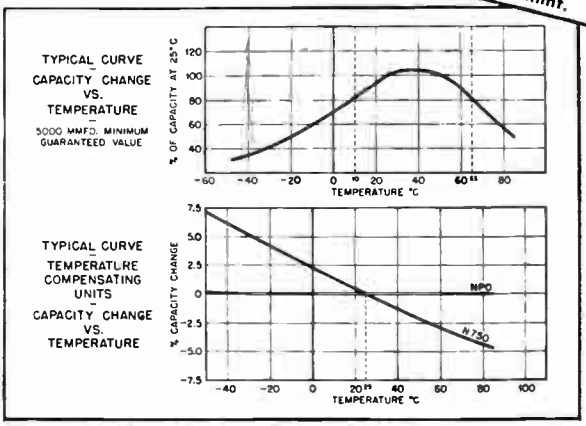

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