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A. C. BRIDGES

Bridges of various sorts are employed widely for the accurate measurement of resistance, capacitance, and inductance and also of other quantities such as power factor, dissipation factor, and Q which are associated with impedances. An unknown quantity may be determined by means of a bridge circuit in terms of an accurately-known standard quantity. Thus, the bridge method of measurement is a comparison method.

Figure 1 shows the basic arrangement of a 4-arm bridge circuit. The input voltage is applied to points 3

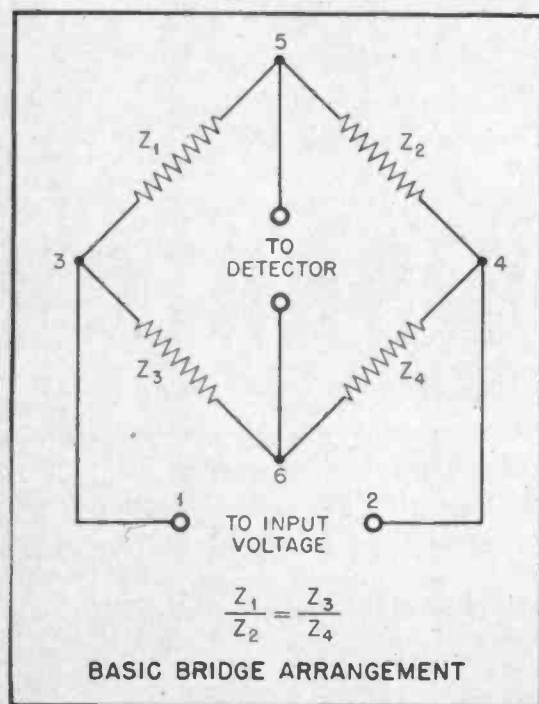


Fig. 1.

and 4 of the network, and a suitable current or voltage indicating instrument (sensitive voltmeter or galvanometer), termed the **detector**, is connected between points 5 and 6. If one or more of the impedance legs are adjusted so that $Z_1/Z_2 = Z_3/Z_4$,

no current will flow through the detector because points 5 and 6, under these conditions, will be at the same potential. This is the condition referred to as **null**. At null, as evidenced by zero deflection of the detector, the

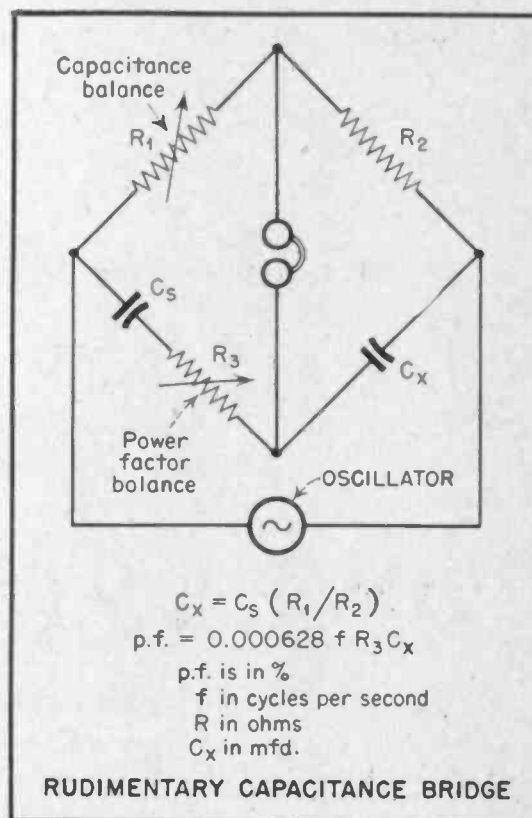


Fig. 2.

unknown value of any one of the impedances may be determined in terms of the other three known values from the foregoing equation. Thus, $Z_2 = (Z_1 Z_4)/Z_3$.

A bridge intended only for resistance measurements will contain four pure resistance arms (the symbols R_1 , R_2 , R_3 , and R_4 will replace the Z -designations in Figure 1); the input voltage will be pure d.c., supplied by a battery; and the detector will be a

d.c. galvanometer. Inductance and capacitance measurements, however, require that one or more legs of the bridge be suitable reactances or impedances. The input signal then must be an alternating voltage of appro-

bridge is needed for reasons of convenience or economy, it is more satisfactory to confine resistance measurements to the d.c. bridge.

Capacitance is measured with the rudimentary 4-arm, Schering, and Wien bridges. Inductance is checked with the Maxwell, Owen, Hay, and resonance bridges. Among other miscellaneous applications, distortion may be checked by means of the Wien and resonance bridge circuits, and frequency in the audio spectrum may be checked with the Wien bridge.

Two adjustments usually must be made with practical a.c. bridges. The first is the reactive balance and is the one giving the information from which we determine the unknown capacitance or inductance value. The second is the resistance balance which shows the

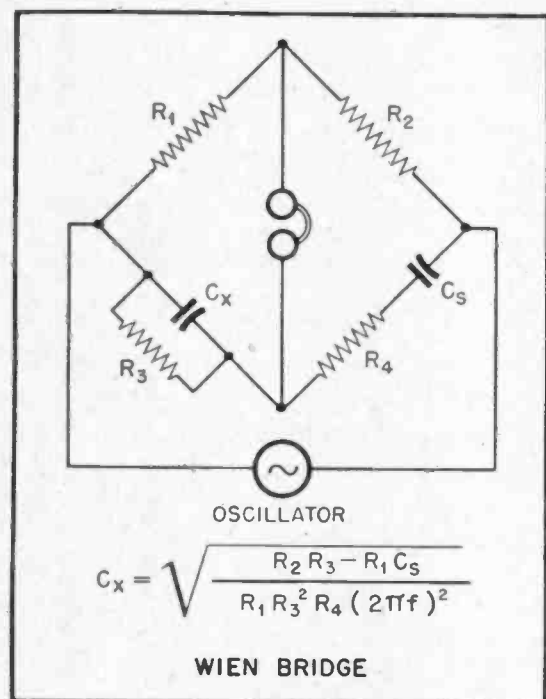


Fig. 3.

appropriate frequency and the detector must be a sensitive a.c. instrument, such as a v. t. voltmeter, cathode ray oscilloscope, electron-ray tube, or high-resistance headphones.

In this article, we will describe a.c. bridge circuits and will give their balance equations. These are the circuits which are employed in instruments designed both for laboratory and maintenance applications. Please bear in mind that the a.c.-type bridge may be used for resistance measurements, as well as for the determination of capacitance and inductance. Many combination bridges take care of resistance in addition to capacitance. The well-known **impedance bridge** measures resistance as well as capacitance and inductance. Resistance measurement, however, is an added feature of these bridges and unless a multi-purpose

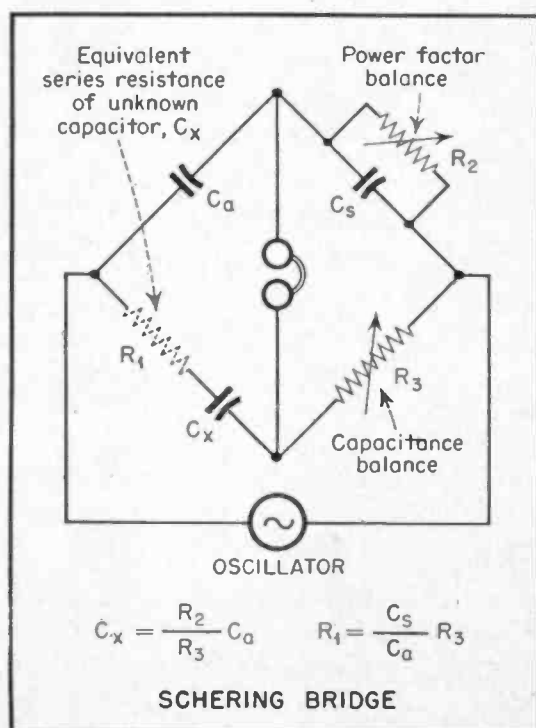


Fig. 4.

equivalent series resistance of the capacitor or inductor under test. The equivalent series resistance value subsequently is used in the computation of power factor, dissipation factor, or Q. Direct-reading bridges intended for

rapid manipulation, such as those designed for the radio service trade, show power factor values directly. Unless specified otherwise, a.c. bridge measurements ordinarily are made with an input signal of 1,000 cycles frequency.

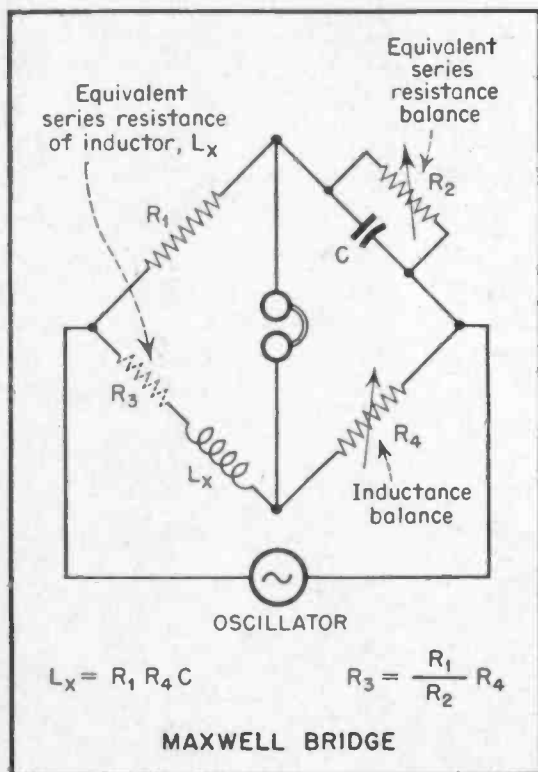


Fig. 5.

For simplicity, radio service bridges employ 60 or 120 cycles, since these frequencies are easily obtained without an oscillator.

The various circuits commonly found in a.c. bridges are described separately in the following paragraphs.

Rudimentary Capacitance Bridge

In this circuit shown in Figure 2, an unknown capacitance, C_x , is compared with a known standard capacitance C_s by means of the ratio arms R_1 and R_2 . By means of a suitable calibration, the dial of R_1 may be made direct-reading in microfarads. The bridge is balanced for capacitance first by adjusting R_1 for null. Further adjustment of R_3 sharpens the null point on R_1 . The resulting final setting of R_3 is used in calculating the

power factor of the capacitor (C_x) under test. Equations for computing capacitance and power factor are given in Figure 2.

The rudimentary bridge has the advantage that it permits determination of capacitance without calculations involving the bridge signal frequency.

Wien Bridge

The circuit of the Wien bridge is given in Figure 3. This bridge, while requiring use of a much more complicated balance equation than the preceding type, permits determination of capacitance in terms of resistance and frequency, the standards of which can be known with considerable accuracy. The Wien bridge has other important applications, other than capacitance measurement, which are discussed later in this article under the heading **Miscellaneous Bridge Applications**.

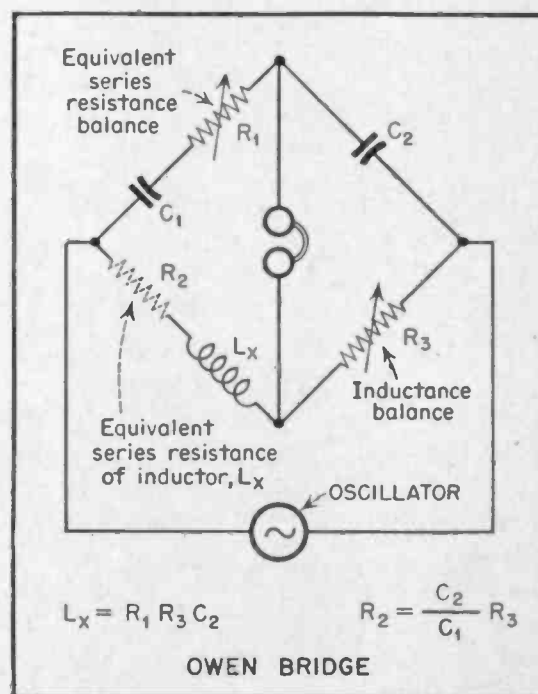


Fig. 6.

Schering Bridge

The Schering bridge (see Figure 4) is widely used in capacitor laboratories and in the testing of cable characteristics. Its balance equations are simple,

since they do not contain complex frequency terms.

The Schering bridge has the special advantage that it allows a d.c. voltage to be applied to the capacitor under test (as in the checking of electrolytic capacitors at their rated d.c. working voltages) without the danger of having direct currents circulate through, and possibly damage the bridge.

Maxwell Bridge

The Maxwell bridge (see Figure 5) is extremely convenient for inductance measurement in that it permits an unknown inductance (L_x) to be compared with a known capacitance (C). This is advantageous since capacitance standards of sufficient accuracy usually are

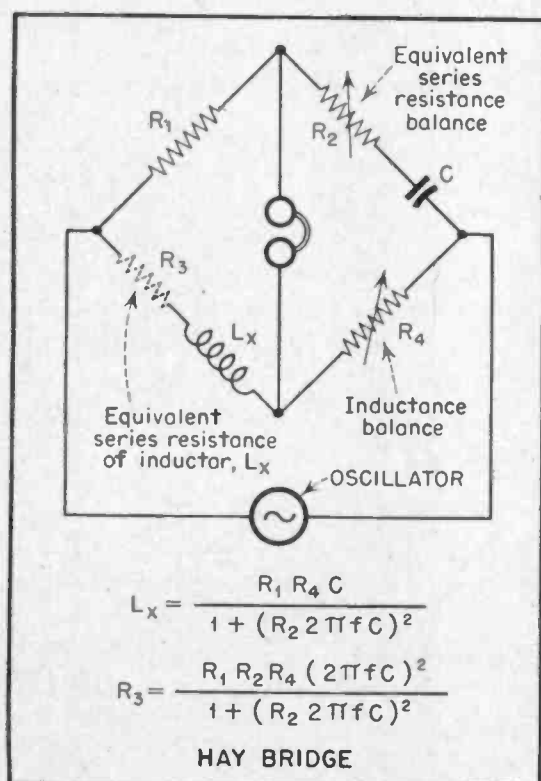


Fig. 7.

more readily available and are easier to handle than are inductance standards. The Maxwell bridge may be used to measure coils having a wide range of equivalent series resistance, or Q values. The balance equations are simple.

Owen Bridge

The Owen bridge (see Figure 6) is similar to the Maxwell in comparing an unknown inductance (L_x) to a known standard capacitance (C_2). Unlike the preceding circuit, however, the Owen bridge requires two capacitors. The simple balance equations of the Owen bridge resemble those of the Maxwell bridge.

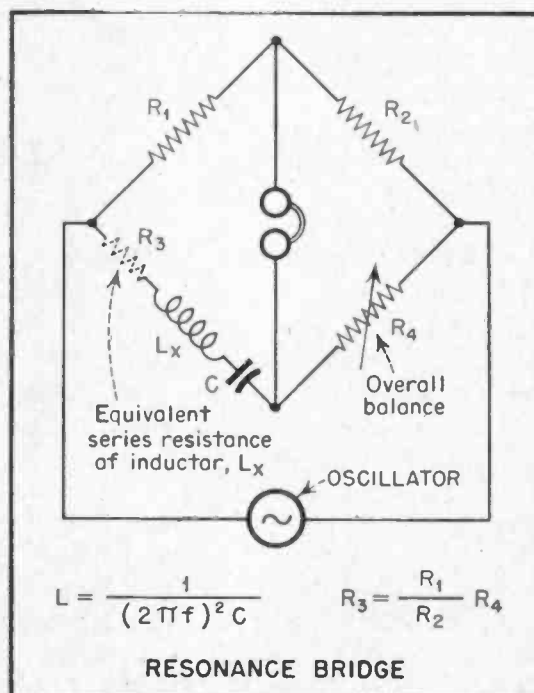


Fig. 8.

Hay Bridge

The Hay bridge (see Figure 7) generally is used only for the measurement of inductors whose Q (ratio of inductive reactance X_L to resistance R) is greater than 10. From Figure 7, it will be noted that frequency terms enter to complicate the balance equations of the Hay bridge. The Hay bridge often is arranged for the measurement of incremental inductance; that is, inductance of a coil with a direct current flowing through it.

Resonance Bridge

In the resonance bridge (see Figure 8), the unknown inductance (L_x) forms a series resonant circuit with the

capacitance C . The latter must so be chosen in value that resonance occurs at the frequency of the bridge signal voltage. At resonance, inductive and capacitive reactances, being equal in magnitude and opposite in sign, cancel. The bridge accordingly balances as if the reactive arm is pure resistance. The resonance bridge has the disadvantage that the range of the capacitor C must be rather large in order for the bridge to cover a wide inductance range at a given signal frequency. A further disadvantage is the fact that the equation for unknown inductance is not so simple as that for the Maxwell and Owen bridges.

Miscellaneous Bridge Applications

Aside from the purposes for which they originally were intended, several of the a.c. bridge circuits are useful in other applications. The most important of these are described briefly in the following paragraphs.

Frequency Measurement. Most of the bridges having balance equations containing frequency terms can be used for the measurement of frequency within the audio-frequency spectrum. This is possible because the bridge is balanced at only one frequency at a time. Consequently, a new null point must be found when the bridge signal frequency is changed to a different value. The variable arm of such a bridge accordingly may be calibrated to read directly in cycles per second. The result is a simple frequency meter of high utility.

The Wien bridge (Figure 3), because of its simplicity and the fact that it employs only resistors and capacitors, is readily adapted to use as an audio frequency meter. When R_2 is made twice R_1 and C_x made equal to C_s , and a dual ganged rheostat used for the two sections R_3 and R_4 , the null conditions for both resistance and reactance will be satisfied at all times, and the frequency applied to the bridge

may be determined (by means of the null settings of R_3 , R_4) from the equation: $f=1/(6.28 R_3 C_s)$.

Distortion Measurement. When frequency-selective bridges, such as the Wien and resonance types, are adjusted for null, any voltage appearing at their output terminals is due to harmonics of the test signal, the fundamental having been suppressed by the circuit. A measurement of this residual voltage therefore would be expected to give an indication of the total harmonic content of the bridge signal. The accuracy of this simple method is not good, however, chiefly because the bridge circuit attenuates each of the harmonics unequally.

Frequency Rejection. For the same reason (namely, that the fundamental frequency of the bridge signal is suppressed by a frequency-selective bridge circuit), bridges of the Wien and resonance types often are employed as simple band elimination filters to remove the null frequency or a reasonably narrow band about that frequency. The sharpness of response of such a network in this application is improved by employing high- Q capacitors; and in the case of the resonance bridge, a high- Q coil as well.

Selective Networks. The Wien bridge is the basis of simple, selective resistance-capacitance networks employed to set the frequency of audio and supersonic oscillators, distortion meters, simplified wave analyzers, and peaked amplifiers. These circuits are connected into a degenerative amplifier in such a way that feedback occurs on all frequencies except the null frequency of the bridge circuit. The amplifier gain accordingly is cancelled on all frequencies except the null frequency. Signals on the null frequency therefore are transmitted readily by the amplifier.



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FOR SALE OR SWAP—One National RBL-3 Navy rec., excellent condition, freq. range 15kc's to 600kc's, \$50. Will swap for worthwhile photo equip. James J. Priestly, 14 Marion St., Brookline 46, Mass.

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TRADE—Radio test equip., amplifier and other radio gear for good tape recorder. E. S. Arnauld, 24 Arch St., Meriden, Conn.

SELL OR TRADE—Kalamazoo flat top guitar, natural mahogany and spruce, very good condition, with case; combination record changer and recorder; PA equip. Want anything in radio and phono equip. Community Radio Service, Aitkin, Minn.

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FOR SALE—Biophone magnetic pickup, 16", \$3; Solar elimostat, 5 pi section filters, \$2; Vibrapack, \$3; line filter for ARC 5, \$1; Dejur 1000 ohm wire wound volume control with vernier dial, \$1.50. J. E. Williams, Hornell, N. Y.

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FOR SALE—Supreme 504A tube and set tester; National NC46 and speaker, Utah 8" speaker 6-8 ohm voice coil. All in fine condition. Best cash offer. Martin Herbstman, 1806 Sterling Pl., Brooklyn 33, N. Y.

FOR SALE—Deluxe Kilowatt transmitter of commercial design, PP-250th's modulated by 810's. Bandswitching exciter, 6L6-807-100th, complete interchanneling chassis system, chassis on ball bearing wheels, price \$650 FOB. Bernard Gensler, 573 Chester St., Brooklyn 12, N. Y.

FOR SALE OR SWAP—Millen No. 90800 50 watt transmitter, complete, less power supply, new, \$25; Bud Code oscillator, \$5. Swap for "Black light" (ultra-violet light) or public address equip. Fred's Radio, 1040 Persia Ave., San Francisco 12, Calif.

FOR SALE—Army BC-454 rec., complete, A and B power supply for 110V ac, control knob adapter, extra tubes, perfect condition, tubes checked, aligned. Coverage 3-6mc 1-RF and 2-IF stages of amplification, \$10. Robert Flory, 29 Harold Ave., Princeton, N. J.

FOR SALE—DuMont scope 274; Solar analyzer CE 1-60; Vomax 900; Hickok, S.G. 288X; Riders', 6 to 15; RCP tube and set tester 802N, with roll chart; Wilcox disc recorder 6B10, 78 and 33½ r.p.m. Make offer. Jim's Radio Shop, 125 Chesnut St., Wrightsville, Pa.

WANTED—Any quantity BC-348, SCR-522, AN/APN-9, BC-312, any surplus test equip., tubes in quantity. Will pay cash or swap for other radio material. Benjamin Reber, 5742 N. Park Ave., Philadelphia 41, Pa.

SWAP—1 pair 7x50 binoculars with case, good condition. Want Riders' Manuals or a good sweep sig. gen. for FM and television work. James L. Tift, 86 Webster St., Lynbrook, N. Y.

FOR SALE—New Meissner radio-phonograph-recorder, with mike, \$95. Also a new Astatic JT-30 crystal mike for \$7.50. Paul M. Jenks, 417½ S. Gillespie St., Pampa, Texas.

FOR SALE—Reliance Bantam Electronic Speedflash. Use with synchronized shutters or open flash with any camera. Battery charger included, tax paid, \$65. ABC Sound Systems, 11 Thais Road, Averill Park, N. Y.

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FOR SALE—Supreme tube tester, \$15; homemade frequency gen., \$5. Henry Hoffmann, Jr., RD 4, West Chester, Pa.

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FOR SALE OR TRADE—Supreme No. 576 sig. gen., never used, cost \$67.57, complete express paid, \$63. Or Trade for Precision E200C new condition guaranteed. Frederick Schamu, Liverpool, N. Y.

FOR SALE—Electrical Contracting business, in area of 50,000 customers. Excellent reputation. Planning to retire. T. C. Rohn, Ann Arbor, Mich.

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FOR SALE—Silver model 906 AM-FM sig. gen.; RCP model 663A electronic multimeter. Both in good condition with instructions and leads. What am I offered? Walter V. Jandro, Bldg. 58, Apt. 218, Success Park, Bridgeport 8, Conn.

FOR SALE—Liqua-Lens for RCA 721, Philco 1000, and 1001 television sets. Lucite, oil filled, enlarges 52 to 120 sq. inches. Distortionless at 80° angle, excellent condition. Best offer over \$15. Ralph Alner, 275 - 56 St., Brooklyn 20, N. Y.

WANTED—Feb. '46 CQ; instruction manual for SCR-274, BC-348, Navy LM-7 freq. meter, VHF ARC-5 and low freq. ARC-5. Also want Radar Electronics Fundamentals, TM-11-466, and Radio Operators' Information File AFF form 24R. State price and condition. Milton Kalashian, 2 Congress St., Newburyport, Mass.

FOR SALE—Riders', 15 \$15, 16 \$7; RCA 155A scope, perfect condition, \$65 prepaid; Radio City Electronic multimeter, model 663A, perfect, with orig. instruction booklet, \$40 prepaid. Horace D. Westbrook, Box 281, Griffin, Georgia.

FOR SALE—Solar CE Exam-eter, new, instructions, test leads, perfect; Sprax 905 sig. tracer, perfect, test leads, instructions, schematic; Triumph 130 sig. gen. good condition, 5" dial, 3.2mc to 3200kc. Best offer takes. Radio Service, Box 73, Versailles, Mo.

FOR SALE OR TRADE—New radio tubes, up to 80% discount or will exchange for others needed. Have approx. 100 assorted used tubes. Make offer for lot or those you need. John Andrew, 740 Maple Street, Bethlehem, Pa.

FOR SALE OR TRADE—Dual turntable recorder with 78 and 33 r.p.m. G.I. units. Includes preamplifier, suppressor, and 10 watt hi-fi amplifier in one portable case. Separate 12" speaker. \$225 FOB or will trade for Contax or Speed Graphic. John Stinerock, 2312 Forest Park, Fort Wayne, Ind.

FOR SALE—Riders' Manuals, vols. 1 and 4 to 13 inclusive. B. Shulman, 88 Nye Pk., Rochester 5, N. Y.

FOR SALE—Power transformers for Philco, G.E. and RCA radios at pre-war prices. Write stating model and part number required. Berman Distributing Co., 1188 Broadway, Brooklyn 21, N. Y.

FOR SALE—"Kathograph II" German 2½" test scope, 110-245 volts, 40-100 cycles, in operating condition, \$25. D. L. Roberts, 609 E. Mo. St., Kirksville, Mo.

FOR SALE OR TRADE—Riders' vol. 12, new condition, \$12.50. Trade for surplus or ham equip. M. E. Ryland, 4200 Stockton St., Apt. 2F, Univ. of Calif., Vets' Village, Richmond, Calif.

TRADE—First 7 complete vols. Riders' for Meissner FM tuner 8C or equal. A. E. Macatee, 2515 Cedar St., Philadelphia 25, Pa.

SWAP—Automatic Record Changer, Olympic brand, plays 10" or 12" records, magnetic pickup for dual speed motor, turntable with good regulation 33 1/3 r.p.m. Robert F. Anthony, 150 W. Euclid, Detroit 2, Mich.

FOR SALE AND WANTED—Table radio 4 tube ac-dc, \$7.50; Auto bat. eliminator 6V and 110V dc, \$5; Converter, tube tester to 117V, 3 primaries, 150V meter, \$6; Power packs, \$1.50 up. Want C-D condenser analyzer and meters. W. F. Onder Radiotricians, Rt. 1, Box 330, Arnold, Mo.

FOR SALE—Sig. gen., Simpson 315, very accurate, like new, \$40. C. W. Saatkamp, 2977 N. Bartlett Ave., Milwaukee 11, Wis.

SWAP—Motorola 67F12 radio-phono combination, walnut, new; 125 tubes, new, cartoned, popular types, list over \$260. Want Precision E-200 sig. gen. and standard make VTVM. John A. Crocker, 415 Central Bldg., Fort Wayne, Ind.

ATTENTION—Don't throw away old worn out, burned up, test equipment. We want commercial, surplus, or home made test equip. that has seen better days. Write, giving make, model, condition, and price wanted. Scotty, 1460 SW 151, Seattle 66, Wash.

FOR SALE—Ernemann reflex camera. f-1.8 Ernostar coated lens; F. P. shutter; 127 film pack adapter; 3 sheet film holders; series 8 lens shade; ring adapter; K2 filter to fit camera; complete, \$120. Write for terms. C. E. Bergman, 68 Elm St., Potsdam, N. Y.

WANTED—Position by young man, 22, as radio technician in vicinity of New York City or will travel. Recent graduate of RCA institute, New York City. Charles Roth, 1580 Metropolitan Ave., Bronx 62, N. Y. C.

FOR SALE—12" electrostatic television cathode-ray tube "12GP7" replaces 7JP4 and 7GP4 without changing pin connections. Perfect condition, \$18.50. Herbert Cohen, 8102 - 20 Ave., Brooklyn 14, N. Y.

SELL OR SWAP—Audio tone control units, comprising A. C. Shaney's Audio Spectrum Control. Used for individual control of bass, treble, and middle frequencies in amplifiers. Want audio or radio equip. Paul Schultz, Hq. Sq., 82nd Fighter Wing, Grenier A. F. Base, Manchester, New Hampshire.

SELL—New Thordarson 300W modulator components 11M77 multi-match, 19D04, 811's with D-161937 6.3V 10A, \$39.50. Matched Thordarson power supply 1,000/1,250V dc 300MA and dual bias on 8 $\frac{3}{4}$ " gray ripple panel and chassis, \$69.50. M. E. Lawson, 4010 River Drive, Houston 17, Texas.

WANTED—Sylvania Polymeter, V.T.V.M. trade or cash. For sale, one Leeds-Northrup type "S" testing set, has galvanometer unit—cash or trade. Charles S. Brotzman, 173 Main St., Mexico, Me.

FOR SALE—Power supply for xmitter. 1,500V dc at 350ma; 12V ac at 15A; 12V dc at 2.5A; Relay control, with overload, complete in BL. Cr. cabinet. Cloyd's Radio Shop, 454 S. 3rd St., Hamilton, Ohio.

SWAP—For photographic equipment. 7" Viewtone television receiver, excellent condition. Also 12" 12GP7 electro-static deflection cathod ray tube. Interchangeable with 7GP4 or 7JP4. Michael L. Tortariello, 151 Clifton Ave., Newark, N. J.

FOR SALE—Precision 920 P multitester and tube tester, A1 condition, \$60; 6x30 binoculars, \$25; Bentzin Primarflex camera, f2.8 lens, \$135. Edward B. Schofield, 9031 Fort Hamilton Parkway, Brooklyn 9, N. Y.

FOR SALE—Army transmitter. BC-325; 400 watts; CW or 100 watt fone; 1.5 to 18mc; temp. controlled MO or crystals; PA 2-803's; 11-3" meters; 110/220 single phase 60 cycle; complete, \$449. G. W. Abell, 5 E. Biddle St., Baltimore 2, Md.

FOR SALE OR TRADE—79 Western Electric Crystals, 1" square, prongs $\frac{1}{2}$ " apart, housed in felt lined metal box, frequencies 20.0 to 27.7mc. Will accept cash, binoculars, or typewriter. Presley J. Vincent, Box 98, Ville Platte, La.

FOR SALE—Mobile BC-499 AM-FM rec., Pre-Max police-type ant, RCA 6V-250V dynamotor, \$20; Converted 110V BC-499 ten meter rec., \$20, less speaker; 4 heavy wood speaker baffles, \$32. Also used sound equip. Paul Crum, 751 N. Central Ave., Chicago, Ill.

SELL—New television booster, Jerrold model 30db, guaranteed perfect. First \$15 takes it. R. S. Bailey, 4701 $\frac{1}{2}$ Homer Ave., Baltimore 15, Maryland.

FOR SALE AND WANTED—400 volt 150 ma. Mallory vibrapack, never used, \$25; S-29 Sky Traveler and National 1-10, make offer. Want National HFS rec. Randolph Neal, 713 Spring St., N. W., Apt. 7, Atlanta, Ga.

FOR SALE OR TRADE—Brand new 7" Tele-tone 22 tube television rec., complete with all channel antenna, 10" enlarger, 900' transmission line. Want recording outfit, P. A. system, or cash. John's Radio Shop, 379-A Hampshire St., Lawrence, Mass.

FOR SALE—Kodak metal tripod No. 2, originally \$8.75, like new, \$4.50; Kodak flashholder with bracket for Kodak Reflex, like new \$5 postpaid. Charlie's Photographic Service, 134 Garden St., Cambridge 38, Mass.

WANTED—Will buy or borrow, to have photostated, schematics or other information on "Breting 14" communications rec. P. E. Vivian, 1811 Portage Ave., Winnipeg, Manitoba, Canada.

SALE—K & E Neptune drafting set never used. Retail price \$20. First \$15. Paul Kniss, 189 E. Mc Millan St., Cincinnati 19, Ohio.

FOR SALE—Argus C-2 35mm camera, carrying case, lens accessory kit, daylight film loader. All like new. \$75 or best cash offer. F. M. Keller, 26 Trull St., Somerville 45, Mass.

FOR SALE—10 ua meter in wood carrying case; transformer 110-120V ac 60 cycle, 1,200vct sec.; 20H 200MA choke; 2MFD 1,000V condenser; watt meter, single phase 60V ac. H. S. Ward, 206 Elmwood Ave., Ithaca, N. Y.

FOR SALE—Carbon resistors, 3.3 meg. 1/2 watt 40,000 ohms 1 watt. 2 1/2 cents ea., \$2 per hundred. Tony Mullins, Clintwood, Va.

FOR SALE—Custom built transformers to your specifications. Send sketch or circuit details for free estimate. Engineering Repair Service, 1717 East 31 St., Brooklyn 10, N. Y.

FOR SALE—Presto model K-8 portable recorder, unused, \$282 takes it. Ray Brunt, 330 Miner Terrace, Linden, N. J.

FOR SALE—Meissner 3-tube regenerative receiver, 550kc to 15mc, complete with tubes. Otto Pollei, Jr. 2122 Edgeland Ave., Louisville 4, Ky.

SWAP OR SELL—One 35 watt phone-CW transmitter, custom built, sold as "W.R. L. 35," works all bands; Practical Radio Communications, Radio Operating Questions and Answers, both by Nilson and Harning. Want sig. gen. or service parts. Alden Sanford, 327 Cleburne Ave., West Helene, Ark.

FOR SALE—25 cycles 115V Seth Thomas electric clock, with built-in time switch. Modern, white plastic, desk type, time switch rated 20 amps at 250V. Like new, \$4.75. Bud Nastoff, 3885 Washington St., Gary, Indiana.

FOR SALE—Misc. radio parts, tubes, and accessories. All new, selling out, no trades. Send for list. R. C. Wilmarth, P.O. Box 368, La Mesa, Calif.

SELL OR TRADE—Feiler TS-3 professional signal tracing analyzer (stethoscope). Used 60 days, A1 condition, \$29. Or trade. Elwood Brown, Rt. 4, Lucasville, Ohio.

WANTED—Burned out panel meters. Rep-utable make with zero adjustment. Eddie Howell, General Delivery, Gastonia, N. C.

SALE OR TRADE—American Bosch, model 58, working condition, complete or any part for sale, make offer. Want circuit diagram Fidelitone, model 210, urgent. Bob Holtzhauer, 2656 W. Washington Blvd., Chicago 12, Ill.

WANTED—6-10 meter or 10 meter converter in A1 shape for mobile operation. Will pay cash or trade high grade transformers. Send for list of stock on hand. Nelson K. Stover, Box 722, York, Pa.

SELL OR SWAP—Paragon 0-60 min. electric timer for seconds timer or \$8; WE 0-600 AC VM, \$8; 0-115V Variac, \$12; 1/8 hp Redmond motor, \$8. Al Pratt, 956 N. 15th, Milwaukee 3, Wis.

SELL OR TRADE—Triumph model 351 multitestors; Triplett model 1621 tube tester; R.C.P. model 414 multitester; Weston model 571 output meter. 60 meters, many types and ranges. Send your list. Roby's Swapmart, 1119 Milwaukee Ave., Chicago 22, Ill.

FOR SALE OR TRADE—UTC transformers, 137, 133, 233, 135, 45, 102, 103, 445, 425, all are PA type. Want signal generator. Arvid Andresen, 378 - 94th St., Brooklyn 9, N. Y.

FOR SALE—Misc. radio tubes and radio magazines. Send for list. C. W. Cassel, R.D. 4, Irwin, Pa.

SWAP—Vomax 900 V.T.V.M. for Sprague Tel-Ohmike, or Solar CF-1-60 capacitor analyzer. Myers Radio Shop, Glenalum, W. Va.

FOR SALE—Well established radio shop, sales and service, completely equipped. Excellent location. Sacrifice. Vernon W. Presuell, 468 Salem St., Medford, Massachusetts.

FOR SALE OR TRADE—Precision, jeweled, new Japanese voltmeter, in felt lined case. Picked up in Japan. Paul M. Jenks, 417 1/2 S. Gillespie St., Pampa, Texas.

FOR SALE—10 meter, 20 watt, rig 1B modulation, no power supply. Includes all coils, tubes, \$20. Also C. W. rig, 40 watts, coils, tubes, and xtal for 40 meter band supplied. No power supply, \$15. Carmen Rodriguez, 3131 N. Percy St., Philadelphia 33, Pa.

FOR SALE—Transvision 7", assembled, \$139; Echophone EC1 rec., \$22; RME DB 20, \$35; HRO-M with 4 coils and power, no speaker, \$145; BC 348 and BC 312; Prop pitch motors; etc. A. Livingstone, 12-02 Ellis Ave., Fair Lawn, N. J.

FOR SALE—Supreme laboratory type combination a.f. and r.f. sig. gen., model 561, \$125; R.C.A. cathode ray oscilloscope, model 160-B, 5", \$160; C-D capacitor analyzer, model BF-50, \$40; Triplett volt-ohm-milliammeter, model 2400, \$40. All new, leads and instruction books furnished. Edward K. Wait, Waverly Road, Chesterton, Indiana.

FOR SALE—A.T.R. A. battery eliminator, model EL1A, in original carton, \$20. T. J. Ambrose, 211 Farren Ave., New Haven 13, Conn.

WANTED—Two-speed 12" turntable; 12" overhead cutting mechanism; two input amplifier. All reasonable offers considered. Fred A. Baer, 90 Riverside Drive, New York 24, N. Y.

FOR SALE—One K.W. phone transmitter, all Thordarson and Johnson components. Albert LePage, 10 Portland St., Fall River, Mass.

WANTED—Technical Manual for BC 659, (SCR No. 510). Elferd Eidson, Jr., Box 143, Springfield, Tenn.

SELL OR SWAP—R.C.P. 423 multimeter, \$20; 0-1 ma. meter, triplett, \$3; 0-2.5 volt meter, Edison, \$1.50; N.R.I. tester with batteries and tube, \$15. Want Riders' Manuals, or what have you? Stratfield Radio Service, 18 New St., Bridgeport 4, Conn.

FOR SALE—7 piece German drafting set, including ruling pens, drop compass, case, etc. Good condition, \$12. George R. Zirblis, 243 W. First St., Mt. Vernon, N. Y.

TRADE OR SELL—Federal enlarger, with one gross each of 8 x 10" and 14 x 17" photo paper; communication rec., model DAQ, 14 tubes, freq range 1.5-30mc, ac only; collectors rare phono. records, hundreds of them. Want TV set or sound movie projector. Fred Simonian, 85 Shepard St., Lynn, Mass.

POSITION—Electrical estimator (retired) wishes to check or estimate large and medium size jobs, for contractors in this locality, or write specifications and inspect electrical work for architects. Shellman T. Stewart, 425 Central Ave., Orange, N. J.

FOR SALE OR TRADE—BC 312 rec. converted for ac use, has 120 mil transformer, with a 5Y3, tunes 1500kc to 18mc (18,000kc) in six bands; excellent condition. Want Riders' Manuals in good condition. Patrick Radio Service, Box 195, Orleans, Indiana.

FOR SALE—4 x 5 Graphic view camera, complete outfit; Spot-O-Matic enlarging meter; Pako Jr. printer; leather carrying bag; developing tank; and film hangers. R. H. Safford, 3104 Flesher St., Dayton 10, Ohio.

SELL OR SWAP—New Webster wire recorder, model 80, \$110. Or swap for tube tester or radio course. Dunn Electric Hardware, Lake Placid, N. Y.

WANTED—1936-38 car in exchange for combination tube and set tester, sig. gen., tubes, condensers, resistors, volume controls, line cords, transformer, etc. Value \$450. Lawrence Frohlinger, 76 First Ave., New York 3, N. Y.

FOR SALE—Gon-Set ten and eleven meter converter in perfect condition, \$22. Norman Howard, 229 Alberta St., Bridgeport 4, Conn.

SELL—Television cabinet, beautiful custom-built hand carved walnut modernistic table model. 24 x 22 x 18". No shaft holes. Complete with fine quality built-in lens for blowing 10" tube up to 12". Never used, special \$40 F.O.B. Goldberg, 2151A Virgil Place, N. Y. 61, N. Y.

FOR SALE—BC-929-A Indicator Manual, with full details for converting to service scope, \$2 postpaid. W. R. Batten, 1309 Vernon St., Rockford, Ill.

SELL—1 Univex 8mm camera, Univar f5.6 lens; and 1 Erwin 8mm projector, good condition. \$75 takes both. Wimpy's Radio Shop, Main St., Vicco, Ky.

SWAP—McMurdo-Silver "Sparx" for 6V power pack. Mar-Val Radio, 177-40 119 Road, St. Albans, L. I., N. Y.

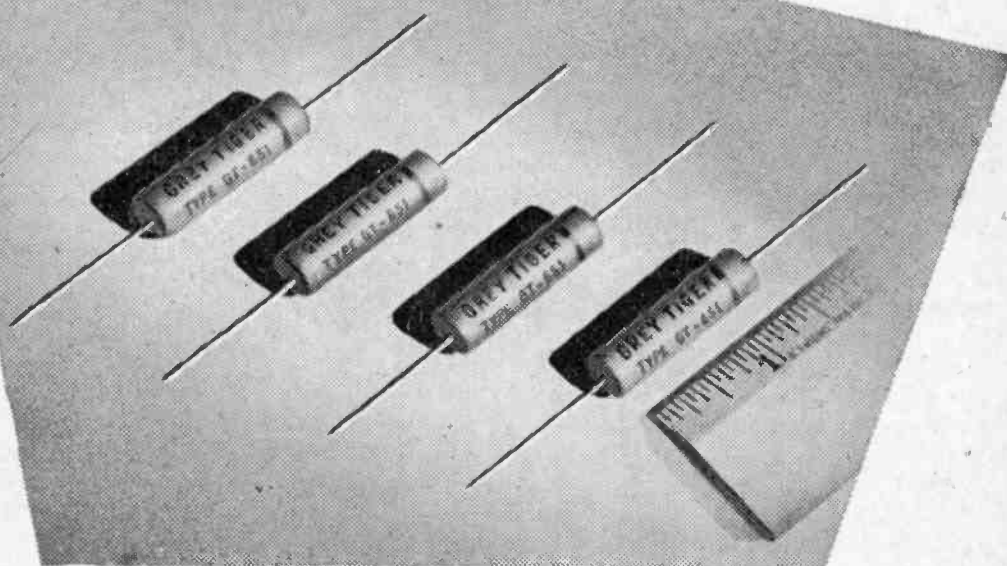
WANTED—High quality 10 watt amplifier for phono and F.M. Submit circuit diagram. Will return same or will buy amplifier if circuit looks O.K. R. C. Barley, 61 Chestnut St., Wyandotte, Mich.

FOR SALE—John F. Riders Manuals, 1, 2, and 3, new and clean. Sell for cash. Joseph Stadnik, 8 Warner St., Blackstone, Mass.

FOR SALE—Limited number 4 Hy. 900 ma. filter chokes in good condition (Thermadore) and 5 volt 60 amp hi insulation (Kenyon) transformers, new, \$15 each FOB. George Swey, 701 - 8th St., Modesto, Calif.

WANTED—(Kine Exacta) camera. Have Hickoks 203, 305, 534; Riders 2 to 8; guns; 8mm movie; and cash. E. Sujak, 5321 W-30 Place, Cicero 50, Ill.

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