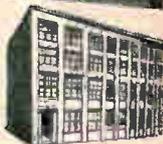


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Vol. 17

NOVEMBER, 1952

No. 11

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# ELECTRONIC FILTERS

An electronic filter is an amplifier specially designed to have a selective transmission characteristic. In many applications, this device performs the function of separating desired frequencies from undesired ones more advantageously than do ordinary L-C and R-C filter circuits. Some of the desirable properties of electronic filters are: (1) high input impedance; (2) zero insertion loss, or actual gain; (3) sharper response; (4) elimination of iron-cored coils in some instances with sharper response than can be obtained with ordinary R-C circuits alone; and (5) tuneability in some cases.

The electronic filter is an instrument in itself and usually is used independently. It also is incorporated into other instruments, such as distortion meters, wave analyzers, sound analyzers, noise meters, and frequency meters. Other applications of the electronic filter include electronic control circuits, frequency-selective signalling, tone control, and radio interference elimination.

In most electronic filter circuits, the desired transmission characteristic is obtained by means of negative feedback through a frequency-selective network. In a few others, selective feedback is not used at all, but instead amplification is provided to overcome the insertion loss of a frequency-selective transmission network. Examples of both types are described in this article.

Development and acceptance of the electronic filter has been rapid in recent years. Several commercial models now are available. Low-pass, high-pass, bandpass, and band-suppression types may be obtained with the advantageous feature of continuously-variable tuning, thus providing the laboratory with an invaluable experimental tool and design aid. An important fact is that the electronic filter is relatively simple

and can be built easily by the experimenter.

While it is entirely possible to design electronic filters for radio-frequency use, the greatest field of application for these units has been in the audio spectrum. It is important, therefore, to point out that the circuits described in this article have their principal use in the frequency range 20 to 50,000 cycles.

## Basic Principle

The block diagrams in Figures 1 and 2 serve to illustrate the basic arrangement of electronic filters. Figure 1 shows the feedback type; Figure 2 the transmission type.

In Figure 2, block B represents a high-gain amplifier having a flat audio response curve. Negative feedback is provided from the output to the input of this amplifier. The feedback voltage is transmitted through a frequency-selective network, D. Obviously, the maximum amount of degeneration (and therefore cancellation of the gain of the amplifier) occurs on those frequencies passed by network D. On frequencies excluded by the network, there is no degenerative feedback and the amplifier operates at full gain. Isolating amplifier stages (A and C) may be provided at the input and output respectively, of amplifier B to prevent external source and load circuits from affecting the frequency-selective feedback network.

From this mode of operation of the feedback amplifier, it is seen that the transmission characteristic of the electronic filter of the feedback type is the reverse of the frequency characteristic of the feedback network. For example, if a null network is used in the feedback loop, there will be no degeneration at the null frequency (since that frequency is not transmitted back to

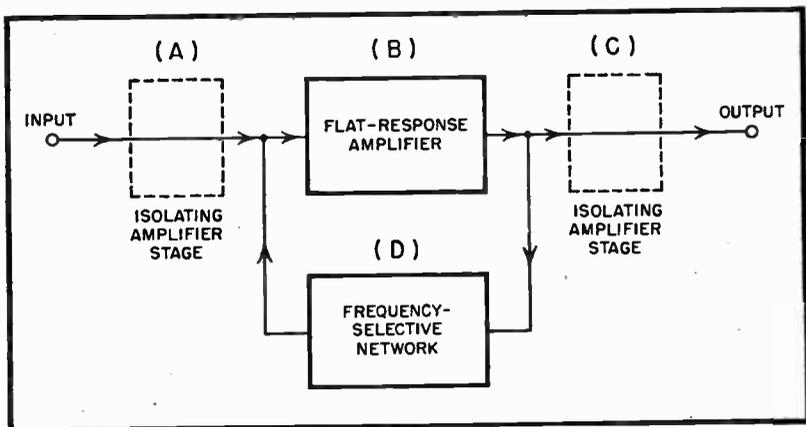


Fig. 1. Basic Feedback-Type Electronic Filter.

the amplifier input) and the amplifier will have full gain at that frequency. On each side of the null frequency, amplifier gain will be reduced by degeneration, and the amplifier will have reduced or zero transmission. Thus, a null network (band-suppression filter) in the feedback circuit produces a bandpass electronic filter. Similarly, a low-pass feedback network makes a high-pass electronic filter; a high-pass network, a low-pass electronic filter; and a bandpass network, a band-suppression (null-type) electronic filter.

The feedback-type electronic filter usually displays sharper filter action than is obtained with the frequency-selective network (itself a non-electronic filter) alone. This is because the

amplification provided by the electronic circuit produces sharp and rapid attenuation of all undesired frequencies in the operating range. Because amplification sharpens the response of the electronic filter, the feedback loop should include as many stages as practicable. In the process of design, due attention must be paid to the phase shift characteristics of the frequency-selective feedback network chosen, in order that signal polarity at desired operating frequencies will be correct for negative feedback and that the possibility of positive feedback and oscillation will be avoided.

Operation of the transmission-type electronic filter (See Figure 2) is the opposite of that of the feedback type.

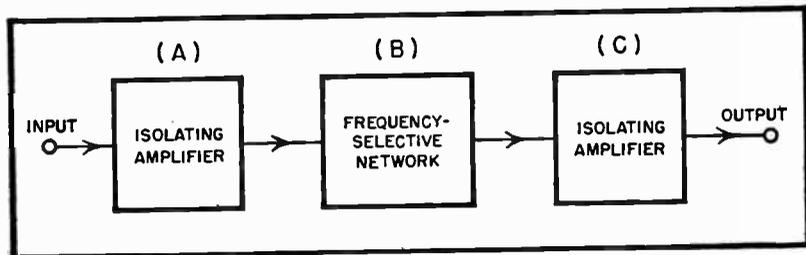


Fig. 2. Basic Transmission-Type Electronic Filter.

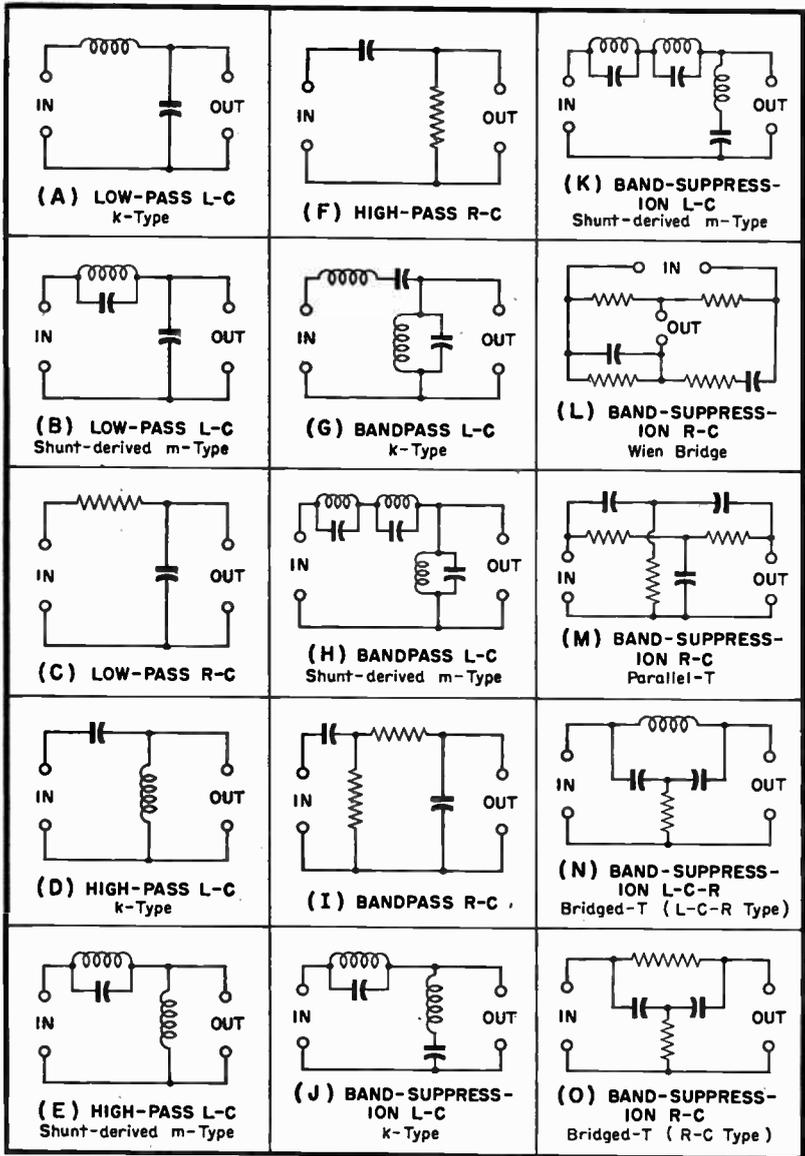


Fig. 3. Frequency-Selective Networks for Inclusion in Electronic Filters.

This latter type (Figure 2) has the same transmission characteristic as that of the frequency-selective network itself. Thus, when a low-pass filter circuit is used as the frequency-selective network, an electronic low-pass filter is obtained. The amplifier stages serve only to provide high-impedance input isolation from source and load devices, and to overcome the insertion loss which would result if the network were used alone. Negative feedback often is incorporated into the amplifier to provide stability, linearity, and flat frequency response, but the frequency-selective network is not a part of such a feedback circuit.

The transmission-type electronic filter has the disadvantage that its frequency characteristics never are any better than those of the frequency-selective network itself. In many applications, however, this will be of little consequence.

Each type of electronic filter has the ability to provide overall amplification. This is an important property, since insertion loss is a noteworthy disadvantage of non-electronic filters. Where desired, the overall gain may be adjusted for zero insertion loss (output and input signal voltages equal in amplitude), or any desired amount of amplification may be obtained. In many applications, the electronic filter serves the dual purpose of filtering and amplification.

The other outstanding advantage of high input impedance provides efficient filtering in applications where loading due to a filter must be kept to a minimum, and where suitable high-impedance non-electronic filters would entail costly design and construction. It also enables the use of a single set of frequency-determining components for a wide variety of source and load impedances. This is not possible with non-electronic filters.

In many cases where resistances and capacitances are used in the frequency-selective networks of electronic filters of both types, tuning may be accomplished by continuously varying either

the R or C components. Tuning is a feature not available in audio-frequency filters of the non-electronic type because of inability to vary the large coils and capacitors except over very narrow ranges.

Resistance and capacitance may be employed in feedback-type electronic filters to secure filter characteristics possible in non-electronic circuits only with expensive coils. The feedback-type electronic filter also improves operation of the L-C-type circuit, when the latter is incorporated into the feedback loop.

### Practical Examples

Any desired combination of elements may be fit into the arrangements shown in block diagram in Figures 1 and 2. Individual requirements will determine, for example, the type of frequency-selective network and amount of amplification which will be used. The "best" combination will depend upon the conditions of application.

Figure 3 shows fifteen of the common frequency-selective networks normally employed as filters and which may be incorporated into the feedback or transmission paths of electronic filters. Both L-C and R-C circuits are shown. In each instance, operation of two or more of the network sections will give improved performance.

In the conventional filter sections, both k-type and m-type circuits are shown. While the shunt-derived m-type has been chosen for presentation in Figure 3, the series-derived type is equally applicable. Filter design formulae, for determining the L and C values required for various operating frequencies, may be obtained from the various radio handbooks. The following issues of the C-D CAPACITOR contain information regarding selective network characteristics: January 1949, September 1951, and November 1951.

Figures 4 to 8 show, for illustration, typical skeleton circuits for electronic filters. In this space, it is not possible to describe every workable combina-

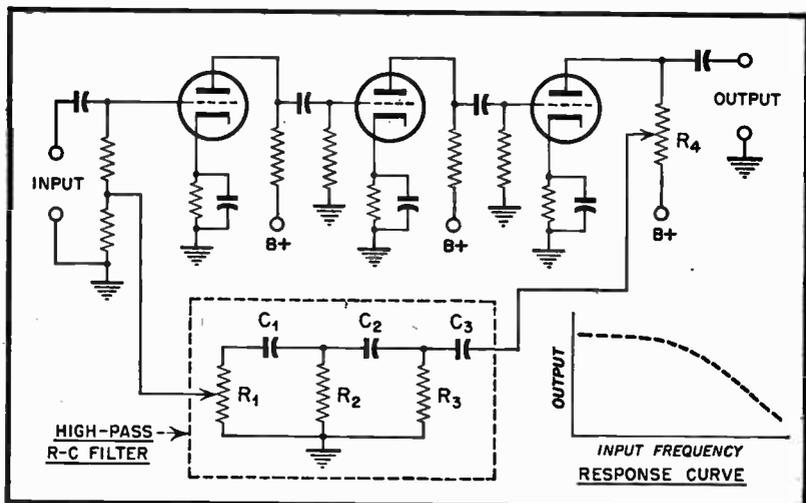


Fig. 4. Low-Pass Electronic Filter.

tion which might be made. The circuits selected typify the general schemes. For simplicity, triodes are indicated, but the reader will understand that other types may be more suitable.

**Low-Pass.** A low-pass transmission characteristic is obtained in Figure 4 by returning negative feedback through a high-pass R-C network ( $C_1, C_2, C_3, R_1, R_2, R_3$ ). The "fixed-tune" potentiometer,  $R_4$ , selects the maximum desired amount of feedback. Potentiometer  $R_1$  (which is part of the filter network) then permits the feedback voltage applied to the grid of the first tube to be varied.  $R_1$  thus becomes a "sharpness" control.

**High-Pass.** High-pass transmission is obtained in the circuit in Figure 5 by returning negative feedback through a low-pass R-C network ( $C_1, C_2, R_1, R_2$ ). Otherwise, the circuit is identical with Figure 4. Capacitor  $C_3$  is needed to isolate the grid of the first tube from the plate voltage of the last tube.

**Bandpass.** Figures 6 and 7 show simple bandpass electronic filters. In both examples, the bandpass transmission

characteristic is obtained by returning negative feedback through a null (band-suppression) network. In Figure 6, the network is a parallel-T circuit ( $C_1, C_2, C_3, R_1, R_2, R_3$ ); and in Figure 7, a bridged-T circuit ( $C_1, C_2, L, R$ ) is used.  $C_1$  and  $C_2$  in Figure 6, and  $C_1$  in Figure 7 are isolating capacitors.

Note the increased sharpness (narrower bandwidth) of the response curve in Figure 7, as compared with the one in Figure 6. This sharper response is due to the higher Q of the feedback network in Figure 7, L-C networks normally providing higher Q than R-C networks for the same frequencies.

**Band-Suppression.** Figure 8 shows one type of band-suppression electronic filter. Here, a Wien bridge null network is inserted between the two amplifier stages. The amplifier accordingly transmits all frequencies except the null frequency of the network and the relatively narrow band on each side of that frequency. The input amplifier stage provides isolation and high-impedance input, while the output ampli-

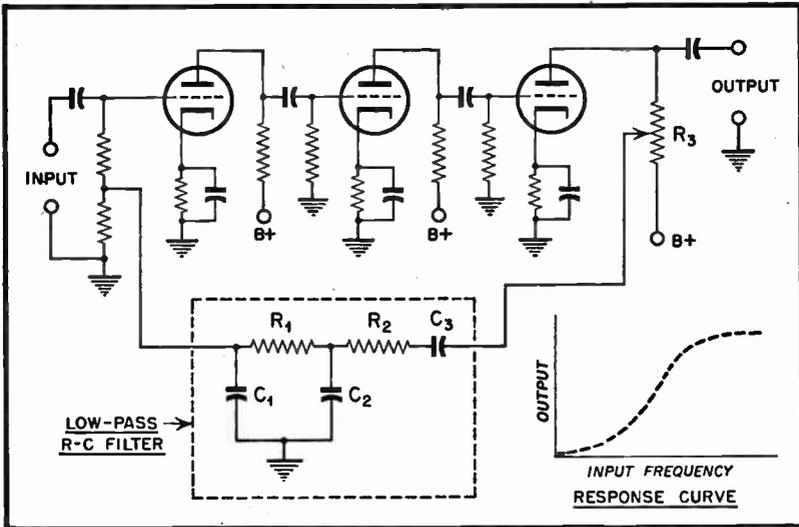


Fig. 5. High-Pass Electronic Filter.

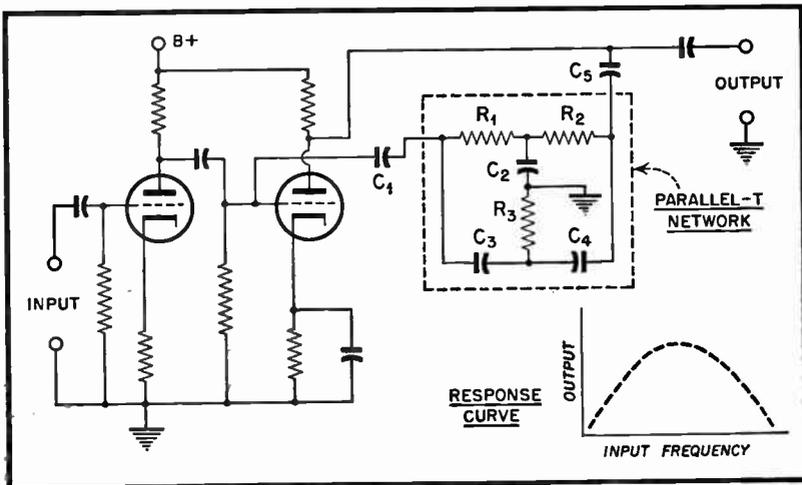


Fig. 6. Bandpass Electronic Filter.

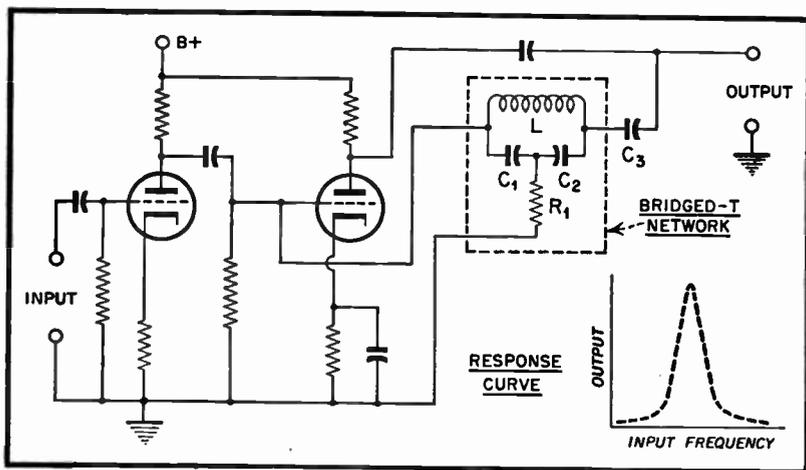


Fig. 7. Bandpass Electronic Filter.

fier supplies gain to overcome losses in the null network and at the same time provides output isolation.

#### Isolation

The circuits shown have been simplified for the sake of clarity. Nevertheless, they are practical and correct.

As indicated in the block diagram in Figure 1, however, an isolating amplifier stage at both input and output is advantageous. Such stages will provide isolation from source and load circuits when added to either of the electronic filter circuits shown in Figures 4 to 7.

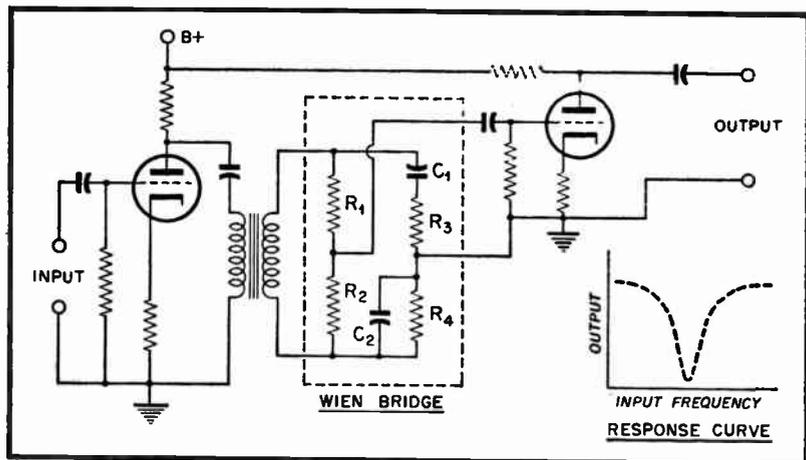


Fig. 8. Band-Suppression Electronic Filter.



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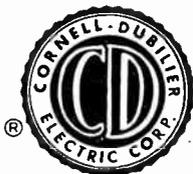
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**SELL OR SWAP**—Globe King, NC183, HT-18, modulation monitor, meters, parts, beams. Free list. 5000 parts less than 25% of list. Wm. T. Clark, 3664 Derry St., Harrisburg, Pa.

**FOR SALE**—Riders 2, 3, 12-18; TV man. 1-4; record changer man. P.A. vol. 1, all exc. cond. \$165; Hickok TV gen. mod. 610; scope mod. 505; VTVM mod. 209; pattern gen. mod. 620; Precision analyzer mod. 620, all exc. cond. Albert Corideo, 51 Ridgefield Ave., Waterbury 4, Conn.

**FOR SALE**—Repair business setup; tube tester, multimeter, generators, marker, tracer, scope, tubes, condensers, resistors, etc., all like new. William Bashta, 17741 Bullock, Encino, Calif.

**FOR SALE**—GI port. 3 speed rec. changer with 4 tube amp., 8" spkr and mike \$60. 8 tube 3 band Delco 6 v. radio \$40. R. L. Firmature, PO Box 528, Lake Charles, La.

**SALE OR SWAP**—Brush BK 414 recorder; Stancor ST. 203A; Gonset 10-11 noise limiter, Premax 10 m. whip; Telvar T60 coils 10-80 antenna tuner all coils 10-80; Meissner EX sig. shifter extra 160 meter strip; all A-1 cond. Edward B. Schofield, 9031 Ft. Hamilton Pkwy., Bklyn. 9, N. Y.

**FOR SALE**—Rider Man. 1-13, like new, and Rider record changer book \$80; Dialbelts, speakers, resistors, condensers, etc. Write for list. Max Hollmann, 26 Post Ave., New York 34, N. Y.

**WANTED**—RCA mod. K80 radio chassis and 1947 Hudson custom built radio. State price and cond. in first letter. John J. Hartenstein, 1 Fifth Ave., Brooklyn, Baltimore 25, Md.

**FOR SALE**—Heathkit sig. gen. SG-6 \$16; Heathkit TS-2 TV sweep gen., like new \$35. Richard M. Cahill, 130 Rombout Ave., Beacon, N. Y.

**FOR SALE**—BC-221 freq. meter, orig. calibration charts, bad case \$65; SCR522 transmitter and rec., usable rack and case \$35; some BC-375 tuning units. R. Naugle, Box 1686, Fayetteville, Ark.

**SELL OR TRADE**—RCA floor mod. TV set; Hunter Cyclemaster 20A exciter; National NC-183 rec.; 3000 and 2000 v. power supplies; meters; crystals; George Pasquale, 9421 Thornhill Rd., Silver Spring, Md.

**WANTED**—Any back issues of Electrical Experimenter magazine from 1913 to 1919. Leland I. Anderson, 127 Seymour Ave., S.E., Minneapolis 14, Minn.

**SALE OR SWAP**—7" Emerson port. TV set in exc. cond., \$35 or swap for test eqpt. Pat Blamey, New Straitsville, Ohio.

**FOR SALE**—Speco sig. tracer amp. mod. STAP., exc. cond.; tracer probe, instr. book inc. Will ship exp. prepaid up to 1,000 miles from Phila., Pa. for \$25 cash with order. Louis Leibovitz, 3835 Cambridge St., Philadelphia, Pa.

**WANTED**—Mutual conductance tube tester. Will trade Eico and cash. Will pay \$5 per vol. for Rider Man. from no. 13 up. John A. Kimm, 934 Judson St., Evansville 13, Ind.

**FOR SALE**—W. R. Brown breather type air compressor, hose, spray gun, a.c. capacitor motor, value \$48, used only 10 minutes, \$30. Henry A. Pierce, 138-28 77th Ave., Flushing, N. Y.

**SALE OR TRADE**—Supreme mod. 650 3" oscilloscope. John G. Perkovich, RR 1, Box 150, Waldo, Wis.

**SALE OR TRADE**—ABA-1 radio trans. rec.; 4 CBY-46104 1.5 to 3 m.c. airc. radio rec.; BC696-A radio trans.; CWD 21AAX dynamotor keyer unit. Need VTVM and 5/8 printing press. Lovett's Radio & Key Shop, P.O. Box 143, Newland, N. C.

**SWAP**—Phono turntable and pickup; 1/4" elect. drill; vib. unit for Truetone radio. R. C. P. 447 multitester; Elwood 35 mm. enlarger; wet batteries and charger for flashlight, transformers; dynamotor for BC 455 rec. Thomas R. Rohland, RD 2, Huntingdon, Pa.

**SALE OR TRADE**—Riders 1-14, good cond. Want \$80 or trade for 1951 Ford custom radio, or Ford heater. John T. Deave-reaux, 940 Everett St., El Cerrito, Calif.

**WANTED**—Collins 32V2 or 32V3 xmtr.; 75-A2, HRO 50 T1, or National 183 D rec. Cash or what do you want? Have many items. Leo H. McKinnon, 1676 Overton Pk. Ave., Memphis 12, Tenn.

**FOR SALE**—Heathkit VTVM mod. V-1 with instr. man. \$18; Audar mod. FMC 12 FM tuner, 88 to 108 MC. \$10; Charles V. Commo, 5826 N. Fairhill St., Philadelphia 20, Pa.

**SALE OR SWAP**—U.T.C. S-42 transf., cost \$15; Iner-Matic TS-41 time switch, cost \$13; 5 2-lamp 40 w. fluor. fixtures, cost \$25 ea.; 4 20 w. fluor. strip fixtures with lamps, cost \$10 ea.; all in good cond. Best offer or what have you? Need VTVM and scope. Metairie Electronics, 730 Homestead Ave., Metairie 20, La.

**FOR SALE**—Novice xmitter on alum. chassis and power supply (QST), good cond. \$20; pair 2 mtr. transceivers \$10. Robert Schumacker, 100-06 75th Ave., Forest Hills 75, N. Y.

**WANTED**—Good SX42 Hallicrafter rec. Cash or trade. E. R. Cresap Radio Service, Box 1107, Beckley, W. Va.

**SWAP**—Lincoln radio engineering course for pistol, rifle, radio or what have you? Clinton Weddle, PO Bx. 265, Bassett, Va.

**FOR SALE**—Clough-Brengle sig. gen. mod. 110, in A-1 shape, had recent factory overhaul. Best offer. Chas. S. Brotzman, 173 Main St., Mexico, Me.

**FOR SALE**—Hallicrafter SX-43 rec. and spkr., used 15 hrs.; Sam's Man. on post-war receivers, \$130 or best offer. Kurt Reinbacher, 2409 S. 16 St., Sheboygan, Wis.

**SELL OR TRADE**—Heathkit 0-3 5" oscilloscope, A-1 cond. \$25 or trade for G1-R90L recorder-phonograph. Milo G. Burston, 320 Tawas St., Alpena, Mich.

**FOR SALE**—Rider Man. (7) 1 to 5 abr., through 11, \$75 or best offer. Mail-A-Voice recorder and discs like new \$33; movie projector, 35mm silent \$25; Movie films exchanged. Lewy, 853 N. Eutaw, Baltimore 1, Md.

**SALE OR TRADE**—Zeiss Super Ikonta BX 2 1/4 x 2 1/4 coated Tessar 2.8, 2 supp. lenses, yellow filter, case; 6 x 30 Leitz Wetzlar binoculars. Trade for tape recorder or \$225. Capt. Martin Modica, U.S. Army Hosp., Ft. Devens, Mass.

**WANTED**—Glass dial scale for RCA rec. mod. A30, five bands from 530 k.c. to 22.7 m.c.; must be like new C. A. Fortier, 315 Clewom Ave., Ottawa, Ont.

**FOR SALE**—Remington Rand port. typewriter, mod. 5, hardly used. Best offer. M. Goldman, 1806 Church Ave., Brooklyn 26, N. Y.

**FOR SALE**—Test eqpt., parts, tubes, Photo-facts, Riders from small radio shop. \$465 value for \$245 cash. Ruth's Radio Repair, 626 Eastern Blvd., Essex, Baltimore 21, Md.

**FOR SALE**—National NC-183 comm. rec., perf. cond., late '51 mod. Make offer, prefer Eastern area. John J. Oskay, 70 Senior St., New Brunswick, N. J.

**FOR SALE**—Riders 2-17 \$6 each. V. Iavarone, 1218 Leland Ave., Bronx 72, N. Y.

**WANTED**—110 v. gen., AC or DC; Gon-set 3-30 converter. Have approved A-200 sig. gen.; diagrams for BC-229, 429, RU-18, 50c ea.; BC-430 25c. W. H. Bauer, 119 N. Birchwood Ave., Louisville 6, Ky.

**SWAP**—NRI tester less batteries, with complete book; Ghirardi's Radio Troubleshooter's Handbook, both exc. cond. Want 3-speed phono motor and cart. or 3-speed auto. changer. L. W. Satterfield, 3605 S. Selby St., Marion, Ind.

**FOR SALE**—Truetone single compact unit car radio like new. Best offer. Max Spitz, Bldg. 1 Apt. 7-G, McLean Blvd., Paterson 4, N. J.

**FOR SALE**—Heath oscilloscope, condenser tester, sig. gen. and sweep gen. \$80. Clough Brengle mod. OCA battery operated sig. gen. \$5. Andrews, 740 Maple St., Bethlehem, Pa.

**SELL OR TRADE**—Mod. 8073 RCP Servishop, exc. cond. and modernized \$70; Weston 770 tube checker; Motorola Golden Voice radio, comp.; phono preamplifier. Will trade for 7" TV or best offer. A. J. Schwarz, 7211 N. Damen Ave., Chicago 45, Ill.

**SELL OR SWAP**—National Radio & TV course, good shape, for photo enlarger, must take 2 1/2" x 3 1/2" negatives. Bill Hagara, Box 224, Slickville, Pa.

**FOR SALE**—Converted BC-348: 110 VAC, 5-meter, separate AF-RF gain controls and AVC switch, gray ripple rack panel, HR series knobs, comp. with spkr and headsets \$150. A/lc Kenneth A. Weimer, AF 14372705, 3381 Tr. Sqdn., Box 439, Keesler AFB, Miss.

**FOR SALE**—Comp: Sams Photofact sets 32-120 except 81 and 82; Servicars, TV Course, and 8 binders inc., like new \$90. Boyd C. Owen, 214 1/2 E. First St., Logansport, Ind.

**FOR SALE**—Model airplane engine and supplies; motor-gen. set; 33v3 and 45 changers; RCA self charging port. mod. 65BR9; 35mm Acme silent proj. and many others, all fair to new cond. Send stamp for list. Geo. E. Tyler, Branford, Conn.

**SALE OR TRADE**—2 Wesco stroboscopes, like new, trade for Pilotuner, 35mm camera, Weston exp. meter, oscilloscope, VTVM or \$20 each. S. J. Magasin, 125 N. Sycamore Ave., Los Angeles, Calif.

**WANTED**—VTVM and scope, other TV test eqpt. Must be in good cond. and rec. I. J. Rohsler, 224 York St., Bklyn. 1, N. Y.

**FOR SALE**—RCA Navy fixed tuned 75 meg xmt'r and rec.; 220 v. xmt'r has 807's and 808's, rec. has 110 v. built in power supply, \$35; BC 312-M, 6 v. tubes, 15 to 18 megs with dia. \$25. Edward Nutter, 105 Calder St., Harrisburg, Pa.

**SALE OR TRADE**—200 w. xmt'r using an 813, V.F.O., N.B.F.M. Best offer over \$90 or will trade for Mek xmt'r. N.Y.C. area. Robert Hersh, 847 Lincoln Pl., Brooklyn, N. Y.

**FOR SALE**—Dynamotor PE 98 for SCR 522, with 12 v. DC input, 300 v. 200 ma., HV-150 v. neg. Bias-13 v. filament. Comp. overhauled and refinished with new ball bearings. Comp. with case, filters, and start. relay, \$32 FOB Boston. By Grant, 16 Saco St., Dorchester 22, Mass.

**FOR SALE**—Hammarlund Super Pro comm. rec., in Bud deluxe table mod. cabinet rack, comp. with external power sup., spkr. and instr. book. All in exc cond. \$190 FOB. R. J. Ledet, 443 Hopkins, Biloxi, Miss.

**FOR SALE**—2 Weston 267 4" fan-type, 0-150 ma. DC meters, new cond. \$5 each. Warren Gilman, Winter St., Tilton, N. H.

**FOR SALE**—Gon-Set deluxe FM unit in 30 to 40 meg. band, used only 6 mos., perf., \$45. Meryle Hansen, Box 126, Ruthton, Minn.

**FOR SALE**—Radio and TV repair service, all eqpt. except tools, low rent store, reasonable. A. A. Stanley, 3611 Kingsbridge Ave., Bronx 63, N. Y.

**FOR SALE OR TRADE**—Supreme late mod. set and tube tester in very good cond. \$65; Special lab battery made by Enterprise, 6 v. on one side and 9 v. on the other, like new \$7.50. Evan H. Griffiths, Rock-Creek Sta., Ohio.

**FOR SALE**—Hallicrafters S-38, used only few hrs.; range 540 kc. to 31 mc.; retails \$49.95, \$25. Jerry Adkins, 4037 Locust, Kansas City 4, Mo.

**FOR SALE**—Schematic diagram and parts list, 35c or 3 for \$1: 1 tube code practice set; 1 tube phono amplifier; 3 tube phono amplifier; 2 station intercom system; 4 tube short wave rec.; radio tube filament welder; auto wiring system. Messenger Radio Workshop, Dept. CD, 81 Mechanic St., Foxboro, Mass.

**FOR SALE**—Mobile 10 m. xmt'r, built-in dual vibros now on air; RCA 7184; also Gonset. Ted Fisher, 1385 H St., Washington 2, D. C.

**WANTED**—SWL aged 14 wishes to contact someone of approx. same age interested in ham radio, living in vicinity. Merrell Hicks, 1136 Margray St., Pittsburgh 7, Pa.

**SELL OR SWAP**—National NC-173 comm. rec.; Balda 120 folding camera, Compur rapid shutter, Trioplan 4.5, 10 sec. Want ship-shore radiotelephone, BC-221, cash. Martin Herbstman, 1806 Sterling Place, Brooklyn 33, N. Y.

**FOR SALE**—Fairchild 541-A1 magnetic cutterhead with equalizer, microgroove advance-ball mechanism, thermostylus attachment. Also new standard and microgroove thermostylus for Fairchild and Presto 1-D cutter. Hi-Fi Recording, P.O. Box 101, St. Albans 12, N. Y.

**WANTED**—3" Pilot TV rec. in any cond. Will swap radios or larger size TV rec. or pay cash. L. H. Wilson, Radio-TV Service, 510 Nightingale Drive, Miami Springs, Fla.

**FOR SALE**—Riders 8-16, good cond. Make offer. I. Horowitz, 1781 E. 16 St., Brooklyn 29, N. Y.

**WANTED**—Late mod. typewriter, must be in good cond. Will trade tubes, radio-TV types, sig. tracer-amp., or audio oscillator. S. Consalvo, 2507 Southern Ave., SE, Washington 20, D. C.

**FOR SALE**—National HRO 7 with spkr and 4 coils A, B, C, D, exc. cond. \$200. Thos. Putalik, 3141 Sedgwick Ave., Bronx 63, N. Y.

**WANTED**—Riders, late issues; late model scope, Precision or Hickok pref.; Have 5 x 8 Kelsey printing press with lots of type; worth \$250, sell for \$150 or trade. Rinn Studio, Yuma, Colo.

**POSITION WANTED**—Electronic technician with 5 yrs. exp. wants part time work. Hours open. Now a senior in engineering. Have car, tools, eqpt., basement shop. V. Johannes, 1541 Metropolitan Ave., Bronx 62, N. Y.

**WANTED**—Heathkit 0-6 or 0-7 scope; TS-2 sweep gen.; Eico 425-K scope, 315-K sig. gen., Superior 660 and Precise 630K sig. gen. State cond. and price. J. Mroczak, R 4, Lapeer, Mich.

**SELL OR TRADE**—Garrard 78 rec. changer with motor board; Capehart 78 record changer in walnut cabinet. Want reflex or movie camera, FM tuner, or what have you? S. Sandler, 29 Niagara St., Providence, R. I.

**WANTED**—Good reasonable used 16mm sound projector. W. J. Sherek, Lankin, N. D.

**FOR SALE**—Intercom, Operadio Executive 10 series, three masters, each consisting of 10 pushbutton stations, exc. cond.. Best offer. L. Buddine, 4624 Old York Rd., Phila. 40, Pa.

**WANTED**—A good buy on a Peerless S-265-Q audio output transf.; Rek-O-Kut, RMC or Presto phono 2 or 3 speed turntable. Want only eqpt. in exc. cond. Fred H. Schellmat, 19733 St. Mary's, Detroit 35, Mich.

**WANTED**—Brush tape recorder and about 2 kw. 60 cps. 110 v. or 110/220 v. gen. with 4 cycle gasoline motor. Both good cond. J. W. Faltin, 482 N. Windsor Ave., Brightwaters, N. Y.

**WANTED**—Collins 32V2. State cond. and price first letter. D. J. Meade, 111-25 202nd St., Hollis 12, N. Y.

**TRADE**—Precision tube tester, mod. 912 in exc. cond. with instr. and acc., or home made disc recorder less mike, value \$60. Want TV set in exc. cond. John Glaive, 36 Irving St., Wilkes-Barre, Pa.

**FOR SALE**—BC348Q rec. converted to 110 VAC and like new HQ129X rec. Best offer or trade. K. H. Stello, BOQ Room 215, Naval Sta., Orange, Tex.

**FOR SALE**—TV sets, perf. cond.; 7" sets \$35, 10" sets \$55. Need radios, \$8 and up. Jones Radio Co., Douglassville, Pa.

**SALE OR TRADE**—Nilson Master Course in Radio Comm., sec. 1 and 2, \$50 cash or tape recorder, guns, ham eqpt., or what have you? Gene Lyons, R 1, Box 173, Springfield, Mo.

**FOR SALE**—Clip-on ammeter "Amprobe" type A3, 0-10, 25, 50, 100, 250 amp. and 0-150, 600 v., with leather case. FOB. Walter Richman, 3438 90 St., Jackson Hts., L. I., N. Y.

**FOR SALE**—Vibroplex lightning bug \$7; Canon telephoto lens, 1/4 100 mm with case; fits Leica, \$40. N. Merzino, 138 S. Grove St., East Orange, N. J.

**FOR SALE**—Radio City mod. 805 tube and set tester \$35; Triplett VOM 321 \$10; Riders Man. 6, 9, 12, and 14 \$34 or \$9 each; Shure mod. 55 mike \$17.50; R.M.E. 45 comm. rec. and preselector, both \$135. G. R. Calvert, P.O. Box 637, Auburndale, Fla.

**WANTED**—5 v. 190 amp. filament transf. and 5 v. 60 or 120 amp. transf. Howard R. King, Welch, W. Va.

**FOR SALE**—Dumont 224 3" oscilloscope with front cover and probe, cont. following tubes: 6Q5G, 6J5, 6SN7, 6V6, 6SJ7, 6AC7, 6AG7, 6SG7, 80, 5Z3, \$95 FOB. Joseph Bentley, 246 Ivan Court, Salt Lake City, Utah.

**FOR SALE**—FM tuner mod. 612 DeWald, like new \$15. Earl Fleissner, c-o Wired Music, Inc., 407 Pine St., St. Louis, Mo.

**FOR SALE**—Audax Polyphphase phono cartridge mod. L-6 Hi Z, turn over type that plays regular and LP; new, comp. with Audak 16" arm mod. N-20 \$25. Alan Kaufman, 12-23 Orchard St., Fair Lawn, N. J.

**SWAP**—BC 221 J conv. to AC with orig. book and extra crystal, perf. cond.; Budd VFO 21 perf. cond.; 522 rcvch conv. to 2 meters with built in pwr. supply. Want Leica with coupled range finder or equiv. M. R. Green, 38 Gautier Ave., Jersey City, N. J.

**WANTED**—Tape recorder in trade for Gibson Mastertone tenor banjo, Ludwig Kingston tenor banjo. MaLaFa Radio Service, Lankin, N. Dak.

**SWAP**—Riders 1, 5-15 unused, with comp. indexes, for oscilloscope and sweep gen. J. Bellber, 281 Ruis Rivera, Hyde Park, Rio Piedras, Puerto Rico.

**WANTED**—RCA Chanalyst converter, stock no. 164. State cond. and lowest price. C. H. Rieth, RFD 4, Troy, N. Y.

**SALE OR SWAP**—Silvertone wire recorder with auto. clock, 5 1-hr. rolls, for movie camera and projector, 8mm or 12" TV set. A. O. Dominguez, 418 S. Santa Fe St., El Paso 7, Tex.

**FOR SALE**—Operadio master intercom and one station; Howard mod. 482 FM tuner; 20 w. amp. with tubes and spkr.; Superior utility tester. E. K. Chenoweth & Son, 845 Union St., Warren, Ohio.

**FOR SALE**—W. E. 728B spkr., like new \$25; Triplett 726 multimeter (VOM) \$12; rotary converter with built-in RF filter 110 VDC to 110VAC 275 w. like new \$35. Simon Friedland, 213 W. 16th St., N. Y. 11, N. Y.

**FOR SALE**—NRI radio-TV course, inc. 78 theory lessons, 9 practical experiments, electronic multimeter with case, comp., in perf. cond. A. C. Cuomo, 778 N. Oak Dr., Bx. 67, N. Y.

**FOR SALE**—Rider TV manuals 1-5, best offer. Also RCP mod. 805 tube-set tester \$20. I. Horowitz, 1781 E. 16th St., Brooklyn 29, N. Y.

**SALE OR SWAP**—Eico mod. 425 5" oscilloscope for tube checker. Send data; will sell for price. George Kappos, 3027 Hamilton Ave., Baltimore 14, Md.

**WANTED**—RCA type MI-6785 AM-FM short-wave tuner. T. W. Bryan, 3734 Appleton St. N.W., Washington 16, D. C.

**SALE**—35 w. CW xmt. with tubes and ant. tuner, coils and crystals for 2 bands \$11.50; power supply with tube for above \$8.50; Clipper-filter for rcrv as described in handbook, \$5.50. Larry D. Reavis, 3619 Bellefontaine, Kansas City, Mo.

**FOR SALE**—Bud deluxe 17½" panel rack cabinet like new; 1500 v. 300 ma. components; unused 813, meter, typewriter. Prefer local deal at bargain prices. Will not ship. G. Samkolsky, 527 Bedford Ave., Brooklyn 11, N. Y.

**FOR SALE**—BC-221-0 freq. meter with cal. book and built-in voltage regulated a. c. power supply, with instr. man. \$75. Will swap for 16mm movie proj. or mobile ham gear. Monroe Corn, c-o Gen. Del., Red Bank, N. J.

**FOR SALE**—Turner xtal. mike mod. 22-X with base and cord, new cond. \$10; National Sel-O-ject mod. SO2-J, new cond. \$16, both post paid to purchaser. M. G. Wheeler, 1531 Catalpa St., Louisville 11, Ky.

**SELL OR SWAP**—RCP sig. gen. mod. 705A; German 35mm, 2.9 lens Welta camera; Zeiss Jena 8x30 binoculars; Kelsey 5x8 hand printing press with rollers, furniture, type and ink, all in good working order. Peter Kacoure, 148-09 Jamaica Ave., Jamaica 35, N. Y.

**FOR SALE**—2 V.H.F. BC-222 "Walkie-Talkie" transceivers comp. with all accessories, exc. cond., plenty of volume, reasonable. James Small, R. R. No. 3, Evansville, Ind.

**WANTED**—Hickok indicating traceometer in A-1 cond. mechanically and electrically. Describe and quote price. Paul A. Myers, 815 E. Walnut St., Kokomo, Ind.

**FOR SALE**—Technical books and magazines, photog. magazines; surplus radio eqpt. Send for list. B. Soroka, 5341 Cordelia Ave., Baltimore 15, Md.

**WANTED**—All types of rec. and transmitting tubes, surplus transmitters and receivers. Williams Electronics Co., 168 Washington St., New York 7, N. Y.

**FOR SALE**—10" Philco mod. 48-1001 TV \$28; 10" Tele King TV mod. 210 \$25; Spkrs. 50c-\$2.50; power trans. 50c-\$1. Local dealer preferred. Len Sporn, 74 Belmont Ave. cor. N. 6th St., Paterson 2, N. J.

**FOR SALE**—Clarkston RV cartridge and needle .0025 \$6; Gen. Ind. phono motor, 80 rpm, 115 v., 60 cycle \$4; Reliance Tachometer, 500 to 6000 rpm in brass case \$5; Jaeger Tachometer, 0 to 35,000 rpm \$3. Send for list. E. F. Vanicek, 1265 Olmstead Ave., Bronx 61, N. Y.

**FOR SALE**—Hickok 288X sig. gen. used 18 months \$125; Precision series 912 tube tester used 18 months \$50. Keith Sutton, Seven Springs, N. C.

**SWAP**—Amateur mobile eqpt. inc. NC 183D, etc. for other eqpt. and special purpose tubes. What have you? B. N. Gensler, 136 Liberty St., New York 6, N. Y.

**FOR SALE**—Rider 9, 11, 12, 13 like new; Heathkit scope 5" mod. 0-3 modified \$45. Swan's Radio Service, 839 Fillmore Ave., Buffalo 12, N. Y.

**WANTED**—Kit diagram for Triplett volt-meter mod. 1200, purchased in 1937. Unit has double meter, one a.c. and one d.c. James Humphrey, 1656 E. 33rd St., Los Angeles 11, Calif.

**SWAP**—Sams Photofacts 1-33 and 38-43 for U. S. or foreign stamps. Joseph Palmer, 786 E. 94th St., Brooklyn 36, N. Y.

**SELL OR TRADE**—Crystalliner AM sig. gen., Superior AM gen, 6-volt trickle charger, Motorola radio 46-48 K-F auto. 48 Plymouth radio. Want VTVM, pocket VOM, condenser tester. C. C. Chocket, 3365 W. Rosita Circle, Memphis, Tenn.

**FOR SALE**—Riders TV man. 4-9, exc. cond. \$90 FOB. Alco Electronics, 102 Marston St., Lawrence, Mass.

**FOR SALE**—Browning RV-10A FM tuner, 10 tubes, selective AFC, perf. cond. Cost 154, will sell for \$75. Maxwell Strange, 673 Colrain Rd., Greenfield, Mass.

**SWAP**—Remington "60" electric shaver with case, used 2 mos., for late model VTVM, 20,000 ohms per volt, in good cond. Will Collins, 450 25th St., Oakland 12, Calif.



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