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A PRACTICAL HUM STETHOSCOPE FOR AMPLIFIER TROUBLESHOOTING

Hum is one of the most annoying troubles experienced in audio amplifier operation and troubleshooting. Low hum level is a good selling point for any circuit. Arising as a general rule from the amplifier power supply, hum may reach the amplifier also from external sources such as neighboring power lines and a. c.-operated equipment. While a large amount of hum is at the power-line frequency, some disturbance arises occasionally on harmonics of that frequency.

Various workaday methods have been devised for hum testing. However, most of the work in this direction, as it is performed by practical audio technicians, is far from systematic. The most widely-practiced method consists simply of applying various remedies at the point of interference, while listening for reduction of the hum signal in the terminating loudspeaker or headphones. The more analytical-minded troubleshooters also check the hum amplitude at the same time with a voltmeter, usually connected as an output meter.

In general, this method, while successful in many instances, has little regard for the source of hum. Very often, a better procedure is to find the source of interference and to replace or relocate an offending component.

When the hum originates external to the amplifier or other audio circu-

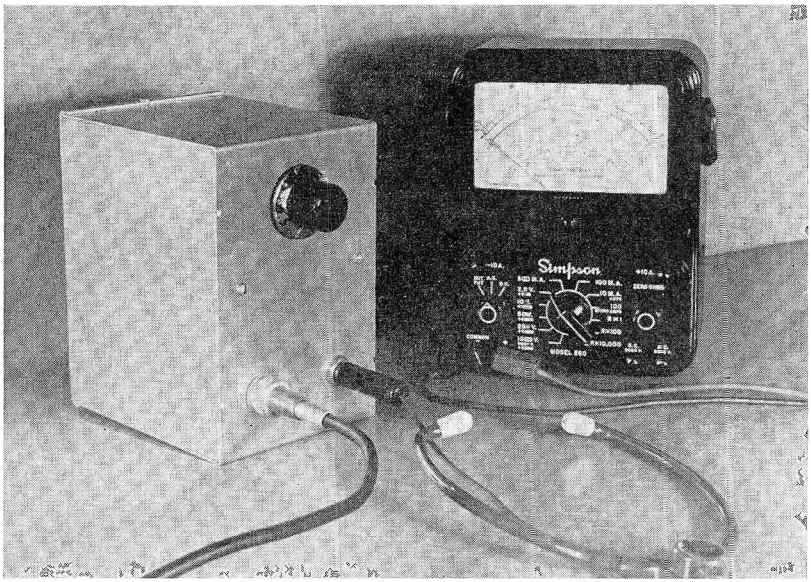


FIG. 1. EXTERNAL APPEARANCE OF THE HUM STETHOSCOPE.

The complete instrument is built into a small, metal, radio utility box. Either headphones or a regular a. c. voltmeter may be used as the output indicator, as shown above. The coaxial input on the left accommodates the hum probe, while the output jack on the right handles the output indicator. Refer to Figure 4 for the front panel layout.

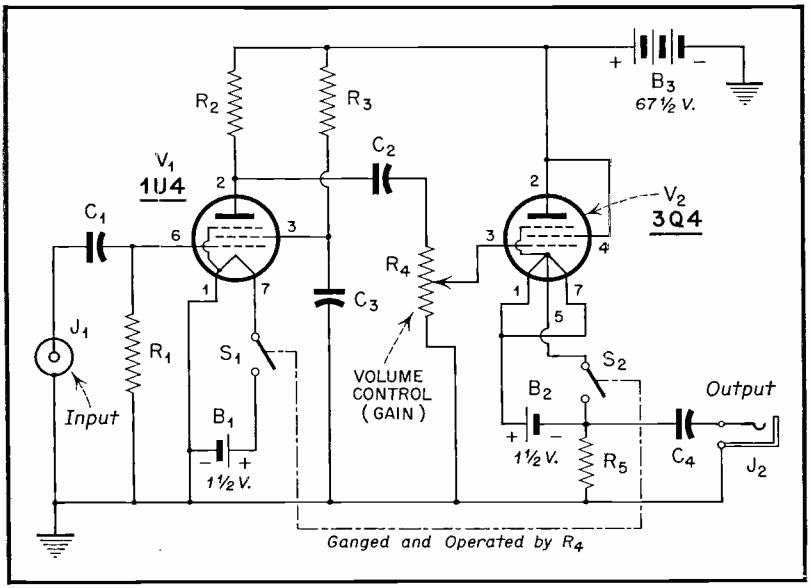


Fig. 2. Complete circuit of the Hum Stethoscope.

itry, it is imperative that the source itself be located and corrected.

A separate small amplifier with an inductive pickup probe is an effective device for searching out hum *sources*. The amplifier is used like a conventional signal tracer, except that no contact is necessary between the probe and source. Searching amplifiers are familiar in many types of a. c. field tracing aside from hum location.

Tracer Amplifier Requirements

While it might appear that any small amplifier might be satisfactory for hum tracing, certain features are particularly desirable in this sort of instrument. Summarized, these are; (1) self-powered operation; (2) moderate gain, since excessive gain causes susceptibility to distant fields not of interest and to inconsequential fields; (3) ability to drive a common a. c. voltmeter for ordinary tracing operations, or a vacuum-tube a. c. millivoltmeter for low-amplitude fields; (4) accommodation for headphones to be used for aural monitoring of the hum signal; (5) isolation from the a. c. power line; (6) accommodation for input pickup probes of various sizes and types for specific tracing applications.

Requirements 1 and 5 dictate the use of self-contained batteries. When requirement 3 is met, either a non-electronic a. c. voltmeter (with as low a sensitivity as 1000 ohms per volt) or a conventional a. c. vacuum-tube voltmeter may be used to monitor relative amplitude of the hum level. The manner in which these requirements are met in the hum stethoscope described in this article may be seen from an examination of the complete circuit diagram, Figure 2.

The importance of hum elimination in all serious audio work, as well as the need for tracing hum in various other electrical and electronic operations, makes feasible a separate device for this purpose.

Circuit Description

Referring to Figure 2, the amplifier portion of the stethoscope consists of

a filamentary pentode (1U4) resistance-capacitance-coupled to a filamentary cathode follower (triode-connected 3Q4). Since cathode-coupled output is employed, a separate filament battery is required for the 3Q4. The concentric input jack, J_1, accommodates a pickup probe. Headphones or voltmeter may be connected to the output jack, J_2. Signal output level is adjusted by means of the gain control potentiometer, R_4.

D. C. plate and screen voltages are supplied by the small 67½-volt B-battery, B_3. The double-pole, single-throw ON-OFF switch, S_1-S_2, operated by gain control R_4, switches the A-batteries only. A B-battery switch is not required, since no current flows from this battery when the tube filaments are extinguished.

Isolated, high input impedance is supplied by the 0.1-ufd. input coupling capacitor, C_1, and the 0.3 megohm grid resistor, R_1. Offhand, high-impedance input might seem unnecessary, since low-impedance inductive pickup probes normally are used with the amplifier when tracing hum. However the high input impedance permits the amplifier to be used for other purposes, such as a. f. signal tracing, where a low input impedance would be detrimental.

It is interesting to note that only one value of capacitor is used throughout the circuit (in each of the four positions). This fact plus the modest requirement of only four fixed resistors and one potentiometer simplify both circuit and construction.

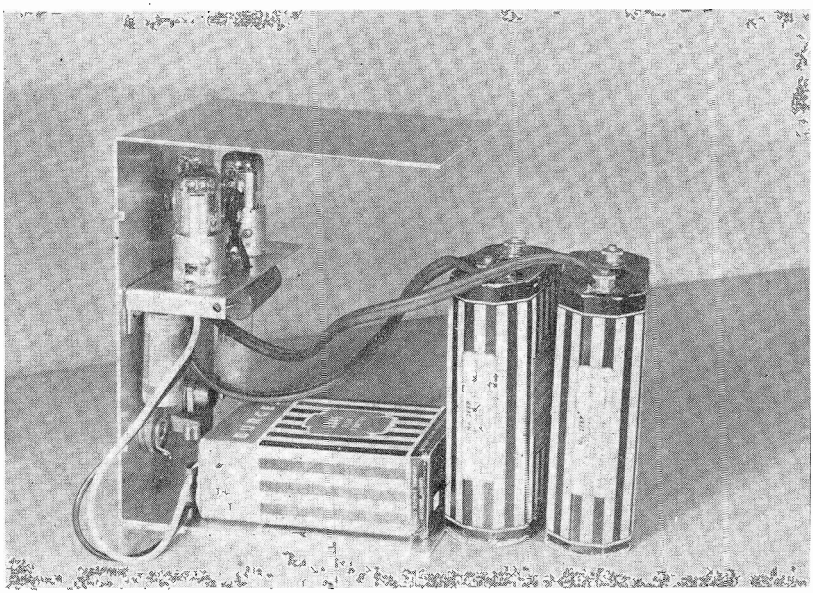


FIG. 3. INSIDE THE INSTRUMENT.

The tubes and most of the circuit components are mounted on the small bracket-shelf in the upper portion. The volume (gain) control is mounted on the front panel between the two tubes. The input and output capacitors are shown connected directly between their jacks and the tube socket prongs. The batteries stand inside the case (the A-batteries) upright on top of the horizontal B-battery. Complete self-contained battery construction provides "isolated" operation and complete portability, so necessary in an instrument of this type.

The output signal is capacitance-coupled through C_4 to the output jack, J_2. This capacitor isolation protects the combination bias-output resistor, R_5, from short circuit by external load devices such as headphones and direct-connected voltmeters.

Operation and Performance

Inductive pickup is best in most hum-tracing applications. Figure 5 shows two types of inductive pickup probes which may be connected to input jack J_1. In operation, the probe is moved through areas suspected of hum fields and oriented for peak signal pickup, as indicated by maximum response of headphones or voltmeter connected to the amplifier output. If the signal strength is too high and the probe must be kept in the pickup area, the gain control (R_4) may be turned down to reduce the output signal amplitude.

The probe shown in Figure 5 (A) consists of a small bobbin jumble-wound full of No. 40 enamelled copper wire. The bobbin is pressed, after winding, into the end of a plastic tube which serves as the probe handle. This probe gives comparatively high output for a given field strength and is recommended for use in weak fields. The one shown in Figure 5 (B) gives somewhat lower output and is intended for use in stronger fields. Its active "nose" consists of 10 turns of No. 20 iron wire space-wound on the end of a plastic tube or test prod handle. Both probes are provided with lengths of shielded single-conductor microphone cable terminated with Amphenol Type 80-M plugs for insertion into the input jack of the amplifier. In each instance, the center conductor of the cable is used as the "hot" lead and the outer shield braid as the ground lead. The cables may be any reasonable length desired, although 3- or 4-foot lengths will be sufficient in most cases. In an emergency, a small AC-DC-type filter choke attached to a suitable non-metallic rod as a handle will suffice as a pick-up probe.

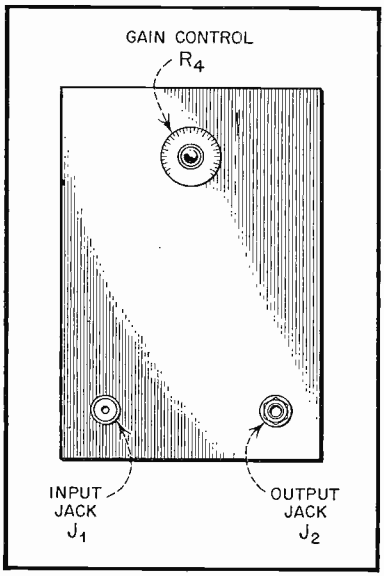


Fig. 4. Front-panel layout.

The voltage gain of the amplifier, with potentiometer R_4 set for full gain, is 42 throughout most of the frequency range. (See the response curve in Figure 6). After considerable testing, this amount of gain was deemed best for most applications of the instrument. With an a. c. voltmeter (as low as 1000 ohms per volt, if necessary) connected to output jack J_2, hum-level inputs as low as $2\frac{1}{2}$ millivolts can be detected, using the $2\frac{1}{2}$-volt a. c. scale. For still higher sensitivities, a vacuum-tube a. c. millivoltmeter can be used. Because of the low output impedance of the amplifier, both a voltmeter and headphones (2000 ohms or better) can be used at the same time for the simultaneous aural and visual monitoring of the signal.

It may appear, from an inspection of the response curve in Figure 6, that the amplifier gain is considerably lowered at the low frequencies. However, a closer consideration of the performance shows that the decibel difference is not great. For example, the response at the power-line fre-

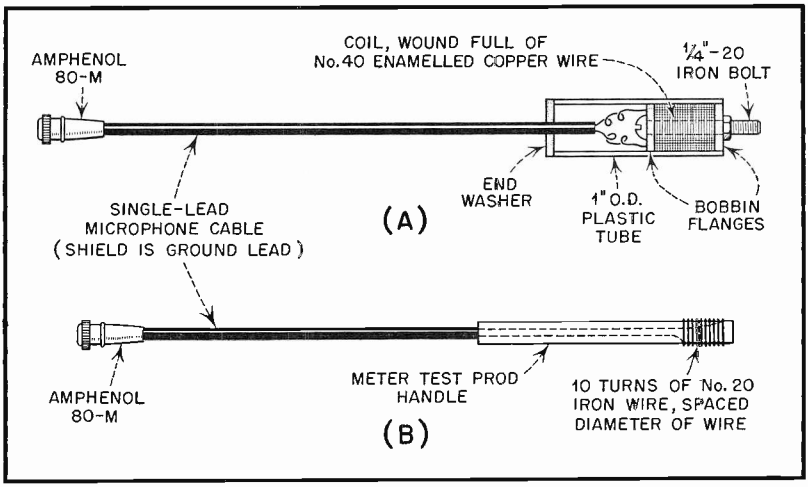


Fig. 5. Practical hum probes.

quency of 60 cycles is less than ½ db down from the 1000-cycle response.

RESPONSE AT IMPORTANT HUM FREQUENCIES

(Referred to Response at 1000 Cycles)

Frequency	Response
40 c.p.s.	—1.09 db
50	—0.87
60	—0.43
80	—0.52
100	—0.42

Zero db at all other frequencies between 100 and 2000 cycles.

TABLE 1.

Table 1 gives the response in db (with respect to response at 1000 cycles) at various important hum frequencies. At all other hum frequencies not shown in the table, there is zero db difference.

In an instrument of this type, there is no substitute for full battery operation. An a. c.-operated instrument, however well-filtered its power supply may be, never is entirely free of hum itself. Even though the internal hum level may be minute, some interference is present to complicate measurements. The use of self-contained batteries also has the advantage of providing complete portability.

Battery operation provides instant operation. No standby period is required, since there are no tube cathodes to heat. The unit is ready for use as soon as the ON-OFF switch (S_1-S_2) is closed.

Construction

The complete instrument is built into a stock, metal, radio utility box; 6 inches high, 4 inches wide, and 5 inches deep. Figures 1, 3, and 4 show details of construction.

The tubes, resistors, and capacitors are mounted on a small right-angle bracket seen in Figure 3. The two jacks are mounted along the lower edge of the front panel, and the gain control along the upper center portion between the tubes. A wide range of latitude is possible in the individual construction of duplicates of this instrument, since the circuit layout is not in the least critical. The tubes have been mounted just as close together as the size of the other com-

ponents would permit. However, it is quite possible that the use of component-supporting turret-type sockets would allow an even more compact assembly.

The batteries are placed simply in the case. The B-battery is laid on its side (See Figure 3) and the A-batteries stand on top of it. An insulating fiber cap is slipped over the top of the A-batteries to prevent grounding of their brass terminal screws to the inside of the case. The standard fiber clip-on board for the B-battery automatically insulates the terminals of this battery. No mounting brackets were used in the instrument shown in the photograph, since the amplifier operation was found to be unaffected by movement of the batteries inside the case.

It would be entirely feasible to use jumbo-size flashlight cells as the A-batteries, especially if the instrument is to receive only short-term usage. But the author preferred the larger batteries shown in Figure 3 for their longer life.

Because of the moderate gain of the amplifier, no trouble is experienced from microphonics. This makes unnecessary the use of shock-mounted tube sockets and the attendant mechanical and wiring complications.

Point-to-point wiring is employed for simplicity, compactness, and short leads. For example, capacitors C_1 and C_4 are wired directly between the associated jacks and the tube-socket terminals. This arrangement is shown clearly in Figure 3.

No pilot light is employed, as it would impose an additional drain on the A-batteries. For this reason, the operator must be careful to switch-off the instrument as soon as he has finished using it. A reasonable amount of care and discipline in this direction will make turning off the battery switch habitual and will pay off in long battery life.

All of the batteries must be enclosed in the instrument case. Batteries on the outside form a surprisingly effective antenna for picking up troublesome hum.

The concentric input jack (J_1) and the shielded cables provided for the pickup probes give complete input shielding. This shielding is imperative in the prevention of extraneous pickup due to body effects. Shielding

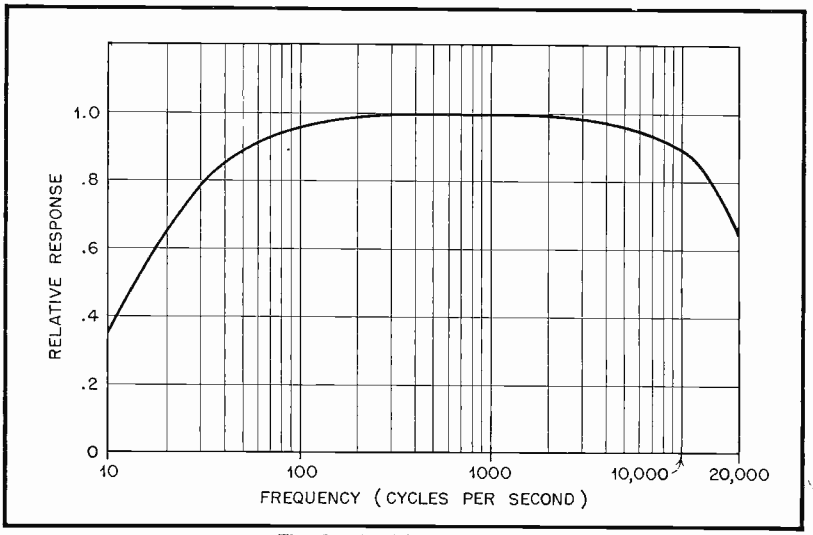


Fig. 6. Amplifier response.

is not required at the output jack, although it does no harm in this position.

While most operators undoubtedly will want to use an already-owned a. c. voltmeter as the temporary output indicator, some builders may prefer to build such a meter into the amplifier. This, of course, is entirely permissible. A suitable meter indicator might be made with a 0-1 d. c. milliammeter and a full-wave meter rectifier (copper oxide or germanium diode-type). The rectifier input terminals would be connected in parallel with jack J_2 through a 2000-to 5000-ohm series multiplier resistor.

Operators who are not inclined to trust their memories in connection with turning-off the batteries might use a triple-circuit phone jack for J_2. The two extra pairs of jack terminals then might be employed to switch the A-batteries automatically as the output plug moves in and out of the jack. Here, the assumption is that the output plug usually is pulled out after use to release the headphones or output meter for other applications.

Using the Stethoscope

To use the instrument for hum tracing: (1) Plug the hum probe into jack J_1. (2) Plug headphones or an a. c. voltmeter ($2\frac{1}{2}$- or 3-volt range) into jack J_2. (3) Switch-on the batteries. (4) Set the gain control to maximum. (5) Explore with the probe, until a deflection of the meter or audible signal in the headphones indicates hum pickup. (6) Orient the probe for maximum signal. (7) If the signal is excessive, retract the probe somewhat; or, if the probe must be kept in the same region, reduce the setting of the gain control. (8) Investigate and plot distribution of the hum field by exploring the entire region with the probe, and noting relative amplitudes of the signal. The indicated signal voltages will be proportional to the strength of the hum field.

It is good practice after first completing the power supply section on an amplifier chassis to explore the entire chassis (with the power supply in operation) for strength and distribution of the hum field due to the power transformer and filter choke. All critical amplifier circuit components, such as input tubes which are susceptible to hum pickup then should be mounted in areas of minimum hum field. Similar tests also should offer guidance in the orientation of transformer and chokes for minimum hum fields in certain directions

Comparative measurements may be made of the hum radiation from energized transformers and chokes by checking each with the hum probe placed at a fixed distance. The effectiveness of transformer and choke shielding thus may be determined.

By studying the hum radiation from a. c. wiring on a chassis, new routes may be worked out for this wiring so as to minimize hum interference. The routing of tube heater wiring often is important in reducing hum disturbance in amplifiers and electronic instruments.

Hum currents in metal chassis themselves frequently give trouble. Such currents result when multiple grounds are employed in single amplifier stages, and occasionally when separate stages are grounded separately to the chassis. Chassis currents can be detected with the nose of the pickup probe pressed closely to the chassis at various points while the equipment is in operation. As each corrective measure is applied, the improvement obtained may be appraised by the change in the stethoscope output signal.

Supplementary Uses of the Stethoscope

Searching Out Power Lines. Hidden power lines and their paths through walls, under floors, and close underground may be checked by searching out the area with the hum probe. This is invaluable in tracing the route of a. c. wiring throughout a building, and in locating elusive sources of hum fields external to disturbed electronic equipment.

Checking Shields. The effectiveness of shield boxes and cans which are

closed on all sides can be checked by placing a small transformer or choke, energized with a. c., inside the completely-closed shield and exploring all around the shield with the stethoscope. If the energizing power is derived from the a. c. line, the stethoscope gain first must be reduced to eliminate any response due to pick-up from the a. c. cord running into the shield. Any subsequent reading then will be due to radiation from the transformer or choke inside the shield. This test may be performed also with the choke or transformer energized from an audio oscillator operated at any frequency within the response range of the stethoscope. If the shielding is too tight to permit entry of wires, a small battery-operated buzzer may be enclosed, with its batteries, inside the shield and connected in series with a small, low-resistance filter choke as the radiator.

A. F. Signal Tracing. The stethoscope may be employed very efficiently as a signal tracer for audio circuits. A test signal is applied to the input of the amplifier or circuit under test, and its progress through the circuit checked at various circuit points. For this application, a regular meter test prod is connected to input jack, J_1 (See Figure 2). An a. c. voltmeter, headphones, or both may be connected to the output jack. Disappearance of the signal indicates failure of the circuit at the test point being checked, signal increase shows amplification, and constant signal strength indicates straight transmission without amplification or loss. If the stethoscope amplifier is to be used to any great extent as a signal tracer, the input grid resistor, R_1, should be increased to 5 to 10 megohms to permit tests to be made in the high-resistance circuits of amplifiers.

Instrument Amplifier. With a standard meter test prod or a pair of leads connected to the input jack, and an a.c. voltmeter to the output jack, the stethoscope amplifier will provide the necessary amplification to convert the voltmeter into a high-impedance a. c. millivoltmeter. For best accuracy, an individual voltage calibration should be made with the meter connected which is to be used.

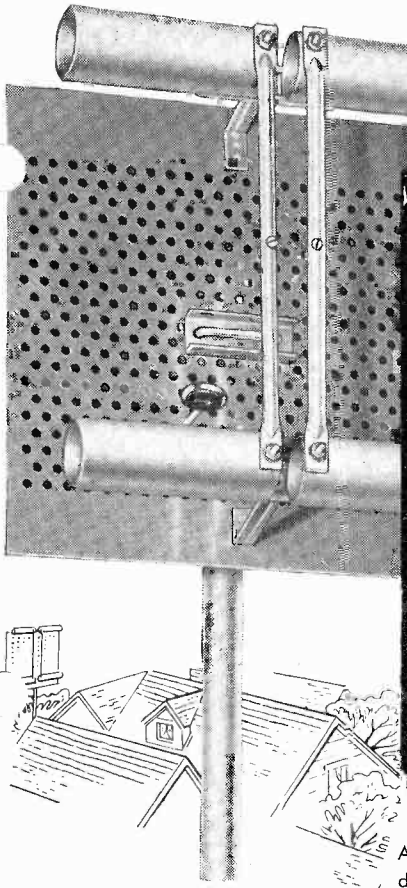
Bridge Null Detector. The input of the stethoscope amplifier may be connected directly to the detector terminals of an a. c. bridge for use as a null detector. Either an a. c. voltmeter or headphones, or both, may be operated at the stethoscope output for null indication.

Meter Adaptor. The stethoscope will increase the utility of a conventional a. c. voltmeter as an output meter by providing high-impedance input for bridging across loudspeakers and lines. This application is handy for routine audio checks and for radio receiver alignment with a modulated signal. The voltmeter is connected to the stethoscope output jack, and a pair of conventional leads to the input jack.

Oscilloscope Preamplifier. Where the frequency response of the stethoscope amplifier is acceptable, this instrument may be employed as a 32 db audio-frequency preamplifier to boost the input sensitivity of an oscilloscope. The low-impedance output of the stethoscope allows the use of a comparatively long line to the oscilloscope. This often is of advantage in demonstrations involving use of the scope.

PARTS FOR FIGURE 2

B_1, B_2—Each, 1½-volt A-battery—Burgess 2FBP (or equiv.)
B_3—67½-volt B-battery—Burgess XX-45 (or equiv.)
C_1, C_2, C_3, C_4—Each, 0.1 ufd. 200-volt tubular (C-D type PJ-2P1)
J_1—Concentric microphone jack (chassis receptacle)—Amphenol 80-C
J_2—Single-circuit, midget phone jack—Carter
R_1—0.3 megohm ½ watt carbon
R_2, R_3—Each, 1 megohm 1 watt carbon
R_4—5-megohm potentiometer
R_5—3000 ohms 2 watts carbon
S_1, S_2—d. p. s. t. switch mounted on potentiometer R_4
V_1—1U4
V_2—3Q4



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FOR SALE—Heath 0-6 scope; BC-412 radar scope; Feiler VTVM TS-9; Fada 795 FM tuner; all items good working order. Make offer. J. Mrofchak, R. No. 4, Lapeer, Mich.

FOR SALE — Jackson-model—637 dynamic output tube tester with complete universal meter ranges (voltmeter). Has 9 functions and 27 ranges. Portable carrying case. Will not ship. $40. L. Matushelske, 2 Elmont Road, Elmont, L. I., N. Y.

FOR SALE—R. C. P. multitester model 446 in excellent cond.; also radio TV books in excellent cond.; Miles Bay rod and Reel,cond. fair. L. E. Smith, R.1, Silver Creek, Ga.

FOR SALE — Radio and TV tubes and parts cheap. Send self addressed stamped envelope for list and prices. Charles J. Needham, Maple Ave., P. O. Box 87, Hebron 3, Ohio.

SELL OR SWAP—Heathkit V. T. V. M model V-5, complete with inst. bk., leads. $25, plus express chges. or swap for VM-Triomatic 3-speed player mod. 950. R. P. Frohwerk, 4330 SE. Woodward, Portland 6, Ore.

WANTED—30—50 mc FM receiver. Have a 40 Buick and 48 Pontiac auto radio for sale or trade. W. E. Fuller, 4620 Stafford Rd., Lansing, Mich.

FOR SALE—Three ARC-5 xmitters, two converted ready to go with power supplies, 7 to 9.1 Mcs. $15 each. Other in original carton, $10. ARC-5 receiver converted for 10 meter with power supply complete, $20. W. L. Baird, 3811 Ridgeway Drive, Los Alamos, N. M.

FOR SALE—Stancor ST202A transmitter with tubes and 40-80 meter coils; like new, $150. Morton Goldman, 345 West 88th St., New York 24, N. Y.

WANTED — Altec Lansing 604B speaker with crossover network. Tuner Craftsman C-10, Browning RJ-12B or RV-10A. Equipment must be guaranteed in excellent condition. Conrad Fong, 4025 Union Bay Circle, Seattle 5, Wash.

SWAP—2 new Eimac 304TL tubes; Eico 320 Sig. gen., like new. Want-tube tester, 3" to 5" scope, or What have you? Donald Schuder, Rte. 3, Box 370, Woodland, Calif

FOR SALE—Model 458 Chicago Industrial Vt x etc., AC DC 5" meter, $18. ICA Signatone type 4301, 30-40 Krag Custom A-1, write for information. Stanley Strangle, Trout Creek, Mich.

FOR SALE—Riders manuals abridged, vol. 1-5 volumes 5 to 14, make offer. Will sell 11-13 separately, like new. Jackson model 636C dynamic tube checker. Dynavox 78 rpm portable automatic record player. Sears Roebuck automatic mimeograph machine. Like new, $42. C. Probe, 300 W. Apsley St., Philadelphia 44, Pa.

WANTED—Bass reflex cabinet for 10" to 15" speaker. Cash or swap. Have monitone, 6AK5 preselector, BC457, VFO not complete, crystal mike, tuning condensers, coils, transformers. Joe Nester, RD 1, Emporium Pa.

FOR SALE—R R Devry sound projector; rotary converter 110v. ac. to 110v. dc.; converter, 12v. dc. to 110v. ac. Webster all speed turntable. All less than half price. John Gabrenya, 1415 Stevenson Drive, Tallahassee, Fla.

FOR SALE—Like new Western Electric 728B speaker, $35; Masco IMP-12 master intercom with 800 ft. 2 cond. cable, $40. Portable hi-fi record player, 78 rpm 4 tube pp amplifier flat 20-20,000 cps., HD 6" PM spkr, brown leatherette case, $25. Al Bielek, 359 High St., Nutley 10, N. J.

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SELL OR TRADE—Instruction Manuals—SC 16, RD 14 A, SCR 211, TCB 2P, BC 312, 342, 314, 344; BC 779, 794, 1004; RA 74, 84, 94; BD 71 and 72, SCR 214, SA 3, I 72, BE 77, I. J. Chapel. 916 Southern Boulevard, New York 59, N. Y.

FOR SALE—Resistors 150w, 350 or 4600 ohm; 100w, 1000 ohm; 50w, 0.65 ohm C. T., 33 ohm C. T., 400, 2700, 3600, 5000 ohms, 50c each. $5 doz., others. Want tube tester, LCR checkers, thyratrons. Paul Kilpatrick, 1030 Curtis, Albany 6, Calif.

FOR SALE OR TRADE—Motorola portable radio; Mobile 6v. sound system with record player; P A trumpets, driver units; PE-103; microphones: also other parts. R. H. Parker, Riverside Drive, Augusta, Me.

WANTED—Perfect used Heathkit 5" oscilloscope, VTVM, 6 vol power-supply, sig. gen. cond. checker, sig. tracer, other equipment. State Price and condition. Connie Dromgoole, Clarendon, Tex.

FOR SALE—Meters of all types. Tubes such as klystrons, lighthouse, selsyns, high and low voltage condensers, resistors, prop pitch motors, vaccum condensers, etc. also ham equipment. Bernard Parafin, 430 N. Silvery Lane, Dearborn, Mich.

FOR SALE OR TRADE—McMurdo Silver 2-meter recvr. McMurdo Silver 903 wavemeter pr. Handy-Talkys 2 meter, Meissner sig. splicer. Want N. R. I. tube tester mod. 70—VTVM mod-11. R. C. Hequet, 795 N. 10th, Kankakee, Ill.

FOR SALE—Color code charts showing 17 codes—3 for resistors, the rest for all types condensers. 50c each—coin only. N. S. Brown, 5522 Merrimac Ave., Dallas, Tex.

FOR SALE — Antiques-Paragon Regenerative rec. RA-10, Western Electric 4A rec. with spare set tubes and 560 AW speaker, Fada Amplydine, Motorola III. Make offer. B. Bartel, 6166 Anita, Dallas 14, Tex.

FOR SALE—134Z Sylvania VTVM $25. MIL 5 watt outdoor spkr. $2.50 Anchor Single Stage booster $10. 2 Vision boosters $5. each. Varitran Mfr's No. V-O voltage control $2. All items FOB. John Gort, 1752 Gaylord Ave., Butte, Montana.

WANTED—Multimeter meter made by Dale Instruments, Omaha, 3½" flange, fit hole 3" dia., as sold by "WAL Wholesale Radio Lab." of Council Bluffs, Iowa, in multimeter. L. C. Chapman, Fairhope, Ala.

WANTED—Supreme TV Service Manuals 1 thru 6 and Vol 12 Radio Diagram Manual., also May '52 QST. Good condition. State price. Have Post 19 scale slide rule with case and book. $10. J. Nichols, 709 E. 11th, Ellensburg, Wash.

FOR SALE OR TRADE — One BC-224-F comm. rec. w/manual. Modified for operation with a. c. power supply. P. S. not included. Best offer, or will trade for Heathscope 0-7 and cap. checker. Geo. W. Fischer 561 Sunnyside Ave. Elmhurst, Ill.

FOR SALE OR TRADE—Superior model 247 tube tester with adapter for checking 9 pin tubes, model CA 11 sig. tracer, and Superior model 670, V. O. M. (just back from factory check) want scope and battery eliminator. (All above in good condition). George Crist, Litchfield, Mich.

FOR SALE—Masco 17 watt amplifier with phono. Completely rebuilt, has new phono cartridge. Highest bidder gets it. Write Robert F. Cyphers, Bartonsville, Pa., for details

SELL OR SWAP—Superior tube and set tester model 777, Eico tube tester model 625, with TV picture tube adapter, precise VTVM model 909 with RF Probe and high voltage Probe., also Sams Photofacts. Ron's Radio Service, 4549 Wilcox Rd., Holt, Mich.

FOR SALE—Precision 920 tube and set tester, Premier 570 Signal gen., Electronic lab., 976 Rectifier. All A-1. Will sell together or individually. Irving M. Mark, 81-35 251st St., Bellerose 6, N. Y.

SELL OR TRADE—2-speed 5/8" electric drill, motor needs work. Want voltage control transformer, Radio Craftsman AM-FM tuner, H. P. Audio Oscillator. Clifford Junkins Jr., R. F. D. No. Box 272, Holyoke, Mass.

WANTED—C. D. Capacitor back issues. Volumes 1, 2, 3, complete No. 1 to 12 and vol. 4. Jan., Feb., March & April. J. N. Leon Daoust, Windsor Radio Electronics & Sports, 4195 Seminole Road, Windsor, Ont.

WANTED—Two model 70-D Bell & Howell 16 mm. movie cameras. State lowest cash price with or without lens. Have pockette scope & lots meters & parts for part payment if desired. W. W. Wehr, 35-B-Glendale Manor, Pleasantville, N. J.

FOR SALE — Heathkit 03 scope—$25; Heathkit VT VTVM,—$20; Superior 670 VOM—$15; Supreme 501 tube tester $10. All ok. Barry Sales & Service, Albion, Mich.

SALE OR TRADE—Webster recorder with wire; BC-191F all band xmtr; pr. 4-65A, 829B's; 3 bugs; panel meters; 40 pwr. telescope; wood lathe & turning tools. Will swap for Sams, Riders, or test equipment. Jim McCoy, Box 41, Whitehall, Mont.

WANTED—Model CG 318 Emerson radio chassis only, all parts intact. Amplifier for PG 170 16mm sound motion picture projector. Neither need be in working order but in repairable condition. Melvin Kilhefner, 270 Duke St., Ephrata, Pa.

SELL OR SWAP—Ranger sig. gen. model 557, battery type. What have you? Meryle Hansen, Box 126, Ruthton, Minn.

SALE OR TRADE—Radio & TV tubes. Will exchange trading lists. Philco 78 RPM record player chassis with cutting head and microphone in good condition. Make offer. Andrews, 740 Maple St., Bethlehem, Pa.

WANTED—Top prices paid—Navy Selsyns 1F, 1CT, 1G, 5CT, 5D, 5DG, 5G, 6G, 7G, etc. BC-348, BC-221, AN/ART-13, AN/ARC-1, AN/ARC-3, RTA-1B, AN/APR-4. B. Bernbaum, Lectronic Research Lab., 719 Arch St., Philadelphia 6, Pa.

FOR SALE—1 to 10 Riders manuals, like new. For best offer. H. Opel, Melbourne, Ky.

FOR SALE—TV Sweep gen. Heath—$20; Sylvania 3" scope, $50; precision tube set tester 20,000 ohms per voltmeter, $50; RCA 630T's channel tuners, $10 ea. Charles Sovatsky, 443 DeKalb Ave., Brooklyn 5, N. Y.

FOR SALE OR TRADE—Waterman 2" Scope, almost new; 2 Duplicators; S-38; Riders 8, 9, 11-14; Sams No. 1 manual; Cort automatic watch. E. G. Bartlett, Atlanta, Mo.

SELL OR TRADE—BC475-A transmitter; BC 654 Tranceiver; 1940 Ford custom radio; Hawkins elec. guide 1-10; Johnson 9.8 hp. outboard; RCA modulated oscillator for microphone, phono or code. Make offer. Armen Markarian, 184 Corliss Ave., Johnson City, N. Y.

FOR SALE—Latest model Heath V-6 VTVM carefully constructed and accurately calibrated—$30. Want installation instructions for D & L narrowband fm adapter. J. Abramowitz, 111 Albermarle Rd., Brooklyn 18, N. Y.

SALE OR TRADE—E. H. Scott custom built 5 band AM-FM radio chassis, chrome plated, 15" dynamic spkr., separate pwr. and audio chassis. Want: Omega 4 x 5 enlarger or audio test eqpt. J. Stone, 793 Tremont St., Boston, Mass.

SWAP—304TL's, 872A's, TV tubes and parts. Want receiver, tube checker, E200C, tape recorder, photo eqpt., Springfield, gas welding eqpt., Willard ER-6-2B batteries, or what have you? J. R. Cook, 507 21st St., Sacramento, Calif.

SALE OR TRADE—Brush crystal reproducer head and arm, PL 20, like new, for photographic item. City Broadcasting Co., 3 Golden Cove Rd., Chelmsford, Mass.

WANTED—RAO Teceiver—made by National Co., model—NC-100-ASC, condition immaterial. Coil Winders, Inc., New York Ave., Westbury, L. I., N. Y.

FOR SALE—BK403 Soundmirror tape recorder with (2) speeds, perfect shape—Electro Voice Hi & Lo Imp Velocity mike, like new, $35. LC Smith typewriter, good shape, $25. Victor Maychek, P. O. Box 485, Passaic, N. J.

WANTED—Driver transformer 500 ohm line to pushpull grids class B; orig. Thordarson multi-match Cat. No. T15D82 or T15D83. E. J. Bergstraser, 11 Cottage Pl., Baldwin L. I., N. Y.

WANTED—Old Band 40-50 MC FM receivers and tuners, cash or trade. Give price and condition or what you want. Abery Radio, 35 Colonial St., Hartford 6, Conn.

FOR SALE—FM (Pilotuner) Pilot Radio-Model T-601 AC operation tuning range 88-108 Mc, good condition, $24. Will trade Remington rifle for other rifles or electronic eqpt. Write for information. William Hintz, Rte. No. 4, Hutchinson, Minn.

FOR SALE—2 6B5 tubes, $2, like new. Frequency modulation by Rider (1940), $1.50; television simplified by Rider, (1946), $250. L. Matushefske 2 Elmont Rd., Elmont, L. L.

FOR SALE—NRI. Radio TV course less lab., complete Philco TV course included. Shipped exp. col. $20. T. J. Englert, 1601 France St., New Orleans 17, La.

FOR SALE—Tubes, transformers, power resistors, condensers and other surplus 66% off list price or 20% below ANY published 1952 price. Want tube tester, LCR checkers, thyratrons. Paul Kilpatrick, 1030 Curtis, Albany 6, Calif.

WANTED—Instruction booklet for Model 906 Silver signal generator. Pat Reynolds, Coello, Ill.

WANTED—Tape recorders—wire recorders. Cameras — Sound projectors. Will trade good used TV sets, any size—have many used TV sets to sell or swap. Sid Lubert, Stanhope, N. J.

WANTED—Good quality FM-AM tuner, and 7" electrostatic TV picture tube. Joseph Krimsky, 4232 Ave., M. Brooklyn 34, N. Y.

FOR SALE—Precision sig. gen. E-200-c, $45; Jackson dynamic tube tester, model 103, $35; Eico 145K sig. tracer, $25; C-D capacitor Bridge, $15, (model BN); all for $100. John Brennan, 129-36 135 Place, So. Ozone Park 20, L. I., N. Y.

FOR SALE—Westinghouse elapsed time meter, 0-99,999.9 hrs—110v, 60 cy. 3 x 3 "flush mtg." $12.95 ea. H. J. Lewis, 548 Brompton, Chicago 13, Ill.

FOR SALE—BC—459, good cond. with power supply, $25 or best offer; pair handsets H-231U in orig. carton $9. Glenn Blizzard, 70 Lenox Ave. New York 26, N. Y.

WANTED—Hickok 288-X sweep generator or Sylvania 216 sweep gen. Cash deal. Frank York, Hi-Fi Recording, P. O. Box 101, St. Albans, 12, N. Y.

FOR SALE—100 RCA 6AG5's in original, cartons, 45c each. Shipped postpaid. S. Consalvo, 2507 Southern Ave., SE, Washington 20, D. C.

SELL OR TRADE—Webster model 80. wire recorder complete with mike and 4 spools of wire. A-1 cond. for TV set, or what have you? Larsen's Radio Service, Madison, Minn.

WANTED—Radio and TV test equip. Must be reasonable and reliable. Maurice McCann, 712 Romayne Ave, Racine, Wis.

WANTED—Plug-in coils for National HRO-50T, and Select O-Ject. James G. Doherty, 165 Palmer St., Arlington 74, Mass.

FOR SALE—Riders 1-12, almost new. Very good cond. Best offer. O. F. Hamm, 4751 Louisiana Ave., St. Louis 11, Mo.

FOR SALE—Gar Dipper $16; Bud WM 78 wavemeter $4.50; code oscillator $3.50; 6J5-6V6 CW. Rig and many other parts. Send for list. Alfred Freitag, 1437 Patapsco St., Baltimore 30, Md.

FOR SALE—67 issues of "Radio-Craft—Radio Electronics." 1946-1951 and 20 older issues $4.50 plus shipping, 46 of "Service" 1943-1948 $2.50 plus shipping; also old SF magazines. V. Johannes, 1541 Metropolitan Ave., Bronx 62, N. Y.

FOR SALE—L-M frequency meter with calibration chart and wired for A. C. power supply $45. Bob Lien, 1300 S. Second St., Mt. Vernon, Wash.

WANTED—7" or 10" TV set, in good cond. Reasonable. A. White, Jr., 3642 Elon St., Shreveport, La.

FOR SALE—Riders manuals. vol. 1 to 5 abr. $9, 5 and 6 $7 each, 7 to 14 incl., $10 each. TV manual No. 1 $15 excellent cond. You pay express. Lonnie Mills, 11206 Dalerose Ave., Inglewood, Calif.

WANTED—Borrow, buy, or rent circuit diagram for Solar model C. E. Capacitor Analyzer. Jack Seligman, 1116 Carroll St., Brooklyn, N. Y.

SELL—Washington area: twin trax tape mech., $70; ARC-4 xcvr. rack-tubes-xtals instructions, $22; W. E. 2KVA 90-130v line adjusting auto xfmor. $10; 1947, 48, 49 QST $2.50, Arvin car heater clamps hose $7. J. E. King, Apt. 7—8191, College Park, Md.

WANTED—Excellent condition back issues Proc. of I. R. E., prior to 1949. Have Journals of S. M. P. T. E. to sell or trade. Eddie Howell, Box 126, Lumberton, N. C.

SELL OR TRADE—National Schools Correspondence course with or without parts for model equip. A. Jacobowitz, 1695 Topping Ave., Bronx 57, N. Y.

FOR SALE—Test equip.; 5" Hickok 195B scope; 288x sig. gen.; Hickok traceohmeter; precision tube checker. All in excellent cond. Best offer. H. C. Ellis, Trailer Haven, Melbourne, Fla.

REPAIR SERVICE—All makes instruments repaired and calibrated by factory staff: Simpson, Triplett, Heath, Hickok, etc. Ship instr. P. P., ins. Immed. service. Douglas Instrument Laboratory, 176 Norfolk Ave., Boston 19, Mass.

FOR SALE—Radio, TV, and Appliance Sales & Service. Good business. Nets approx. $600. per month. Authorized warranty station for Philco, Motorola, and United Motors. Service 11 auto dealers. Skyway Radio & TV, 711 E. 6th Ave., Denver, Colo

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SELL OR SWAP—Rider's manuals 1-5 combined, 6-15, 11 vol., and Sam's Photofacts 1-67., all perf. cond. Make offer. Julio Bellber, 281 Rius Rivera, Hyde Park, Rio Piedras, P. R.

WANTED—Riders 15 and up. State price and cond. Stephen Barniak, 2426 Perot, St., Philadelphia 30, Pa.

SELL OR SWAP—Hallicrafter T-54; 7" TV, metal case; radio-phono, 2 sp., 7" records. Want 209 meter, TV tubes, 7" scope, Co-AX speaker and cabinet. John Pellock, 703 W. William, Decatur, Ill.

SELL OR TRADE—Philco model 610 radio in good cond.; Photofacts 29,36, 37; Supreme diagram books 1926-1938, '40, '46. Want 3-way portable and cash. B. Fogelman, 227 Riverdale Ave., Brooklyn 12, N. Y.

FOR SALE—Record changers, perf. cond. 78 rpm; Garrod 10" or 12" intermix. $10 ea. F. O. B. Marvin Radio & TV 14 E. 208th St., Bronx 67, N. Y.

TRADE—For photo equip.; like new, Motorola control heads, BC-1206 rec.; Audels Radiomans Guide; Coyne Electrical guide; Personal portable radio; 5" CRT; 2" CRT; many other items. Charles C. Gohn. Clarinda, Iowa.

SELL OR SWAP—Assorted bathtub condensers; CW3 Wilcox rcvr; prop pitch power unit, extra motor; BC 645; sig. gen. model A-200; BC375E with 6TU units dynamotor. Best offer or 16mm. sound films. Caesar Arena, 1942 Pennington Rd., Trenton 8, N. J.

SELL OR TRADE—Hickok gen. 288X, scope 305, tube checker 532; C-D capacitor checker BF50; Electronic Mfg. Co. VTVM 100 with peak to Peak AC probe. A1 condition. Want Hi-Fi audio parts and astronomical telescope. The Radio Shack, 1602 W. Pratt St., Baltimore 23, Md.

WANTED—Emerson TV model 700D chassis 120158-B, strait chassis or with cabinet, have cash and the following to trade. 2-stage channel chief booster, 16mm. movie projector (Kodascope) model A sig gen., sig. tracer 905. 10 in. Olympic TV tabel model, A-1 shape. John Arnold, P. O. B. 84, Bluffs, Ill.

SWAP—Two GE phono. motors, model 5SY1A160 8 amps, 60 cy, 110v., 3/4w, 78.26 rpm for a late model VTVM. Landry's Radio Shop, 2600 Pauger St., New Orleans 16, La.

FOR SALE—National—HFS with power supply; Meissner-sig. shifter Panadapter; Viking 1 transmitter; Hallicrafter super Skyrider SX28; Millen 2 meter-transmitter 327-crystals, all freq. over 100 new ham tubes. Local. Harry Deansr, 671 So. Saybrook Ave., Los Angeles 22, Calif.

WANTED—Will pay $75 to $90 for used cross Hatch gen. Must generate Sync. pulses. Latham Radio Shop, Cuba City, Wis.

FOR SALE—Transmitting tubes 2.813's, 811, 4 24G's, LM-10 freq. meter complete with orig. crystal, cal. book, shock mount & cord. L. D. Dillin, 6616 Olcott St., Tujunga, Calif.

SWAP OR SELL—Complete NRI Commun. Course, and kits. Desire 8mm. equip. projector; camera; enlarger; 35mm. camera. Brody, 8565 Fayette St., Phila., Pa.

FOR SALE—3 vols. Silvertone manuals. $10; 1 and 2 vols. Zenith manual, $5; Supreme tube and set tester No. 502, needs small repair, $25. Albert C. Hart, 207 N. Raymond St., Griffith, Ind.

FOR SALE—Heathkit Sine and Square Wave Audio gen., model G-2 (5 tubes) like new con. with instruction man. $30. Joseph F. Dineen, 9 Winter Terrace, Westwood, Mass.

SWAP OR SELL—Stromberg-Carlson 30W model No. 20 amplifier. Ryder's Television manuals 2 and 4, Radio City Prods model 446 multitester. Want tape or wire recorder, late model 3C221. Local preferred. S. A. Hirsh, 386 Berriman St., Brooklyn 8, N. Y.

TRADE—Tele-tone 7" table model, good cond., $30, 16mm. Keystone projector, extra reels and films, $15, complete Lionel 027 train set, $15. All for $50. FOB. Need AM-FM chassis with phono-jack, Philco preferred. Vincent Amatrudi, 1133 Morrison Ave., Bronx 72, N. Y.

TRADE OR SELL—Webster wire recorder and mike—latest model—new cond. Cost $150, sell for $85, or trade for National HRO receiver. John C. Cain, 10229 Capitol View Ave., Silver Spring, Md.

FOR SALE—Hallicrafter SX42 in excellent cond., $150; R-42 matching bass reflex speaker $20; Jackson 115 tube checker still under factory guarantee, used once $50; two Remington electric foursome razors in good cond., $8 each. Walter E. Niemiec, Fairway Drive, New Hartford, N. Y.

FOR SALE—Shure mod. 710 crystal mike; astatic FLC pick-up and two crystal cart's diamond stylus and FL filter; Stancor A2313 output trans; RCA tubes. J. Holloway, YMCA, Philadelphia 2, Pa.

FOR SALE—Precision VTVM-EVIO; tube checker 612; rig. gen E-200-C; "radio repair" neon sign, $200. Manuals and test cables included; A-1 cond. John W. White, 403 Sterling Ave., Winona, Miss.

WANT—Photo enlarger and enlarging equip. Have misc. radio parts, Weston meters, xformers, radio books, 8mm movie proj. 35mm slide proj. 30 x 40 screen. I. Gursh, 147 Chester St. Brooklyn 12, N. Y.

SELL OR TRADE—Auto radio, good cond., for 1939 Buick, may fit up to 1946; also Motorola pre-war auto radio. Want battery elim. Hyman Levine, 243 Heyward St., Brooklyn, N. Y.

SELL OR TRADE—Hickok model 5.40 mutual conductance, A-1 tube tester. Want good communications receiver. W. R. Fox, Jr., 88 Leroy Drive, Riverside 15, R. I.

SELL OR TRADE—Cinex camera, with time, instant, case, $2. Mineral specimens, gold, Jasper, quartz, calcite, opal, sulfur, ect. $2. Postpaid. Want tubes or what have you? Armen Hanjian, 102 Floral St., Roselle, N. J.

FOR SALE—Comm. revr. BC-224-D, RCA model. 1.5M. to 18M. with built-in Q-5er, audio filter, and additional AF stage. Also commercial Broad band converter for 10 MTRS. Like new. Fred G. Knowles, 63 Oakridge Dr. Rochester 17, N. Y.

SERVICE—Draftsman, will make pencil or ink drawings from rough sketches of schematics. Reasonable. Paul J. Grandolfo, 1172 East 96th St., Brooklyn 36, N. Y.

SWAP OR SELL—Complete CREI course radio, TV, and math. Interested in hi pwr. trans. parts. Edward Theroux, 9 Clinton Ave., Holyoke, Mass.

FOR SALE—Like new, Radio City Products sig. gen. model 730, fixed frequency design for speedy alignment. Complete with output cable and instructions $30 P. P. in U. S. Anthony Szempruch, 34 E. Ward St., Springfield, Ohio.

SELL OR TRADE—Simpson capacity bridge mod. 381; supreme push-button set. tester mod. 592; precision cathode ray tube tester CR. 30 with cables, like new. Best offer or what have you? Frank Siegel, 107 Rodney St., Brooklyn 11, N. Y.

WANTED—Used radios, parts, and test equip. Edwin Lee Herman, 2479 Shirley Ave., Baltimore 15, Md.

WANTED — Rider's "The Oscillator at Work." Frank S. Dyba, 4712 North 29th St., Omaha 11, Neb.

WANTED—2 or 3 pocket-size ultra-short wave transceiver. Nelmar, 3424 W. Diversey, Chicago, Ill.

WANTED—Supreme audolyzer, VTVM, or? Have Eico sig. gen. Fieler sig. tracer, 10" GE Blonde table TV excellent cond., auto radio for sale or trade. Bill Phillips, 6 Rosanna Ave., Fort Lauderdale, Fla.

SALE—First sixteen vols. Sam's with complete television course, perf. cond., all field experiences and production changes noted on folders, $175. Marcus H. Moses, 35 Hamilton Place, New York 31, N. Y.

SELL OR TRADE—Mine Detector, Converter 20-30 mc, Philco automatic record player chassis, $5 each; like new code machine, crackle cabinet, pushpull 6L6s output, with 15 code practice tapes, Chas. E. Spitz, 1420 S. Randolph, Arlington, Va.

FOR SALE—Weston 692 oscillator-to 22 megs, needs batteries, must be calibrated. Schematic and instructions included $8. L. Matushefske, 2 Elmont Rd., Elmont, L. I., N. Y.

WANTED—Precision, 5" scope, model-ES-500A E-200C- sig. gen. E-400-Sweep sig. gen. EV-10A or EV-20 VTVM; CR-30 C. R. tube tester. Must be in excellent cond. Have model 100 Electronic Designs VTVM. Asking $25. Albert Casario, 2220 Wallace Ave., Bronx 67, N. Y.

SELL OR TRADE—10" Emerson television set, table model. Will swap for comm. recvr., or what have you? Joseph M. Malak, Center and Sperry Rds., Chesterland, Ohio.

FOR SALE—Hallicrafters S-52, link tranceiver, 12 tubes, also BC454. Have many more items,send for list. Murray Cohen, 2078 Wallace Ave., Bronx 60, N. Y.

WANTED—VTVM, TV tube tester, AM, FM sig. gen., etc. Prefer Fieler, Eico, or Heathkit. Have cash or Speco sig. tracer, also will trade Schick razor with shaverest for what have you? F. E. Prestel, 3747 N. Olcott, Chicago 34, Ill.

WANTED—Hickok model 156 or 156A Traceometer also model 209A in new cond. only. Paul Capito, 637 W. 21st St., Erie, Pa.

SELL OR SWAP—Parts no longer available for GE LB-530 radio. Cash or swap for 3-speed phono. L. W. Satterfield, 3605 So. Selby St., Marion, Ind.

SELL OR TRADE—NRI VTVM, 22X Telescope; 46-48 Dodge custom-bilt radio. Want Eico test instruments and 10"-12" TV with cabinet. Karl Nester, Box 76, Van Meter, Pa.

SWAP—Foreign stamps in sets and singles, mostly unused for Sam's Photofacts. Wm. R. Roy, 199 Circuit Ave., Waterbury 8, Conn.

FOR SALE—350 radio magazines from 1941 to 1953: Riders, Radio News, Radio Electronics, Sylvania, Radio Craft, Radio Maintenance, GE Television and Radio. Radio television retailing. Reference annuals, 1000 circuit annuals, $15. Thomas Byrne, 331 Calhoun Ave., Bronx 61, N. Y.

FOR SALE—Rider's manuals 1 through 19, good cond., $150. Roger Cain, 513 S. 6th St., Columbia, Mo.

SALE OR TRADE—RAX-1 recvrs., (units 2 and 3) excellent cond. Want S-20R or what have you? G. E. Cline, General Delivery, Boise, Idaho.

SELL OR SWAP—Station Allocator; rectifier power unit NRI tester; NRI radio course; Simpson, model 240. Hammeter. Want TV or guns or tools. Dana D. Davis, Unionville, Rt. 4; Mo.

FOR SALE—Like new, sealed raytheon RK707B tube, resale price, $68.85. Any reasonable cash or trade offer. A Brindley, 212 Olds Boulevard, Fairless Hills, Pa.

FOR SALE—3CP1 cathode ray tube (same as 3DP1) in orig. box, $6.50. C. R. Watson, 306 G Peabody Apts., Columbus, Ga.

WANTED—Complete NRI TV course with orig. kits—not the NRI radio & TV servicing course. I. Herkowitz, 7222 Jackson St., Philadelphia 35, Pa.

WANTED—Book of operating instructions for Test Craft Inst Co. Model TC-75. R. R. Linville, 2813 Glenn Ave., Winston-Salem, N. C.

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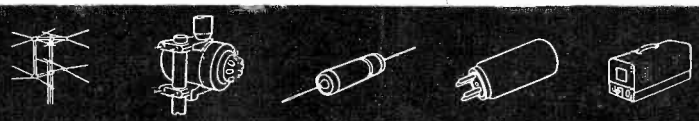

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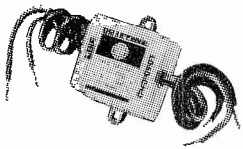
...Sure!  there's a C-D filter just for it!

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