

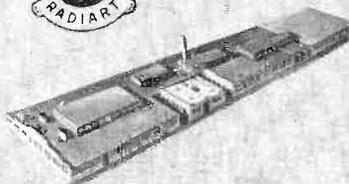
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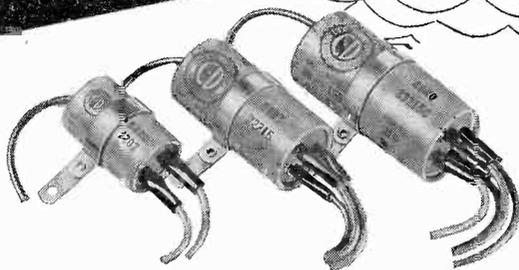
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MODERN OSCILLOSCOPE ACCESSORIES

The utility of the oscilloscope is undisputed. Its value as a research instrument and service tool is increased, however, by attachments and accessories which adapt it to certain types of measurements. Many such accessories have appeared over the years. In fact, their number has been so large that the student is puzzled as to which offers real advantage and which are merely gadgets.

In this article are described several of the useful oscilloscope accessories which may be made a part of the permanent operating equipment of the service technician and experimenter. Most of these devices can be built readily by the technician, although they are available also as factory-made items.

To appreciate fully the thinking back of oscilloscope attachments, it should be recognized that the oscilloscope basically is an electron-stream type of peak voltmeter. Its unique advantage is its ability to show waveform and phase as well as the amplitude of an a. c. signal voltage. Just as voltmeters of other types may be applied to functions other than voltage indication by converting various phenomena into voltages, so can the oscilloscope be made to function as an ammeter, frequency meter, phase meter, etc. Also by modifying certain voltages of interest, much important data may be obtained (a familiar example is the measurement of audio distortion by removing the fundamental frequency voltage component and viewing with the oscilloscope the amplitude and waveform of the remaining harmonic voltage).

The accessories chosen for description here have been arranged into groups which we believe to be logical

and which are conducive to easy reference by the reader. There are many other special-purpose accessories which have been omitted from the discussion because they obviously are of interest only to specialized research laboratorians and have little value to the service technician.

Voltage Calibrators

High on the list of oscilloscope accessories is the voltage calibrator. By means of this device, peak-to-peak voltages may be measured by comparison on the oscilloscope screen. It no longer is necessary or even advisable to pre-calibrate the gain control and vertical axis of the screen and to undergo the annoyance of inaccuracies due to tube and component aging.

AC Voltage Calibrator. The conventional a. c. voltage calibrator generates a 60-cycle square wave. The output amplitude is adjustable by means of an attenuator which reads directly in peak-to-peak volts.

In using this device, the vertical distance between the top and bottom of the signal waveform under test first is noted on the oscilloscope screen. The signal from the calibrator then is substituted, feeding the calibrator signal into the vertical amplifier input terminals without disturbing any of the oscilloscope adjustment. By means of the attenuator in the calibrator, the square-wave calibration signal amplitude next is adjusted carefully until the peaks of the square wave fall upon the same screen points formerly touched by the positive and negative peaks of the signal. The peak-to-peak voltage of the signal then is determined directly from the readings of the attenuator in the calibrator.

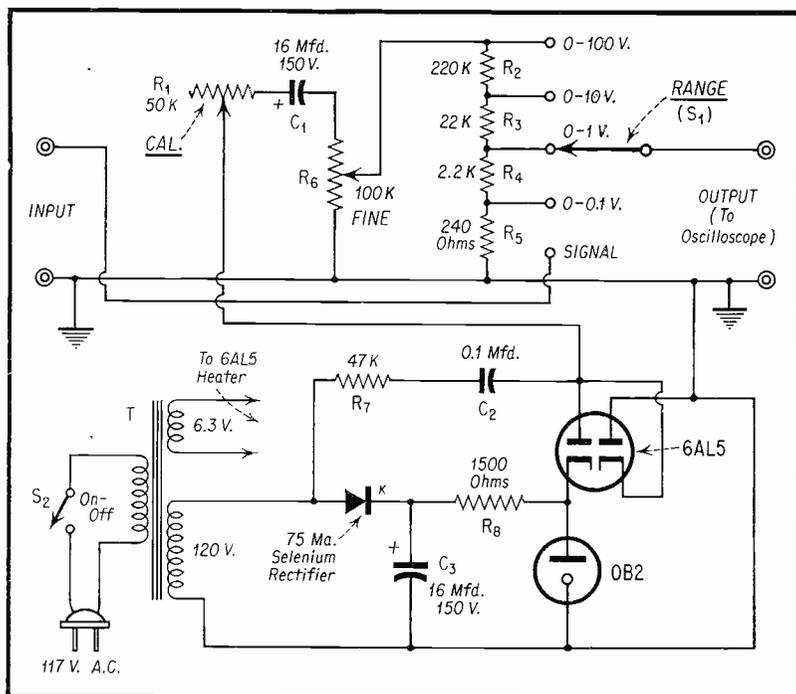


Fig. 1 A.C. Voltage Calibrator.

Peak-to-peak a. c. voltage is twice the peak voltage. The peak voltage in turn is 1.414 times the more familiar r. m. s. value. The peak-to-peak voltage hence is 2.828 times the r. m. s. voltage. To determine the r. m. s. value of peak-to-peak readings made with the calibrator, divide the indicated peak-to-peak reading by 2.828. Example: A peak-to-peak reading of 50 volts is obtained. The corresponding r. m. s. voltage equals $50/2.828 = 17.68$ v. Approaching the problem from the other direction, we might consider what peak-to-peak deflection is to be expected for a given r. m. s. value. For example: What peak-to-peak deflection will be obtained when the r. m. s. signal voltage is 50 milli-

volts? Here, the correct peak-to-peak value is $50 (2.828) = 141.4$ mv.

Although the calibrator signal frequency is low, easily-readable square waves (or a pair of parallel horizontal lines) will be obtained even when the oscilloscope sweep frequency is high. In some instances, the tops and bottoms of the square waves will show a small amount of tilt. When this occurs, the extreme tips of the tilted "shelves" should be used for the peak-to-peak measurement along the vertical axis.

Figure 1 shows a simplified a. c. voltage calibrator of the low-frequency type. This is the circuit of the inexpensive Heathkit Type VC-2 unit.

The peak-to-peak output of the instrument is adjustable smoothly between zero and maximum in the following ranges: 0-0.1 v., 0-1 v., 0-10 v., and 1-100 v. The output attenuator with which this adjustment is made consists of the step-section (resistors R_2 to R_6 and RANGE switch S_1) and the continuously-variable FINE control potentiometer, R_8 . The scale of the latter is graduated 0 to 10, while the settings of switch S_1 are marked to indicate the voltage ranges as shown in Figure 1. When switch S_1 is in its SIGNAL position, the signal under study (which is applied to the INPUT terminals of the calibrator) is transmitted directly to the oscilloscope. In this way, both the signal source and the calibrator may be connected to the oscilloscope at the same time, and no wires nor leads need be changed-over when switching from the signal to the calibrator and back again.

The circuit consists of a 6AL5 60-cycle square wave shaper, biased with a constant 108 volts d. c. supplied by the OB2 voltage regulator. D. C. operating voltage for the OB2 is derived from a selenium rectifier and filter (C_3 - R_3). Transformer T supplies the rectifier, 6AL5 heater, and a 60-cycle voltage to the 6AL5 shaper (the latter through C_2 and R_7).

The voltage to the attenuator is set exactly to 100 volts peak-to-peak by means of the 50,000-ohm CALIBRATION control potentiometer, R_1 . Since this control requires adjustment only when the instrument is placed initially into service or is re-calibrated, it is mounted inside the instrument case to prevent disturbance.

Adjustment of the voltage calibrator is simple. (1) Apply an accurately measured 6.3-volt r. m. s. 60-cycle a. c. signal to the INPUT terminals. This voltage may be taken from a filament transformer. (2) Connect the OUTPUT terminals to the vertical amplifier input terminals of the oscilloscope.

(3) Set switch S_1 to its SIGNAL position. (4) Adjust the oscilloscope controls for two or three stationary cycles of signal voltage on the screen. (5) Adjust the vertical gain control for a vertical spread of the signal over three large divisions on the screen. (6) Set switch S_1 to its 0-100 v. position, and potentiometer R_8 to 17.8 volts. (6.3 volts r. m. s. = 17.8 v. peak-to-peak.) (7) Adjust the CALIBRATION potentiometer, R_1 , until the square waves or horizontal lines now seen on the screen accurately fill the same three large divisions on the screen formerly occupied by the 60-cycle sine-wave test signal. The calibrator now is ready for use.

The calibrator is used in the same manner. Adjust the attenuator so that the square-wave calibration signal occupies the same vertical displacement as the test signal and then read the corresponding peak-to-peak voltage from the attenuator.

Constructional details of an a. c. voltage calibrator which is used in the same manner, but which has been simplified still further to use sine waves instead of square waves was described in an earlier issue (See Simplified Oscilloscope Voltage Calibrator, C-D CAPACITOR, January 1952).

D. C. Voltage Calibrator. Many oscilloscopes in present use contain high-gain direct-coupled amplifiers which can be used for measuring small d. c. potentials, as well as a. c. voltages. Oscilloscopes with d. c. amplifiers were in wide use in industrial research and testing long before they were demanded for television use.

While the a. c.-type voltage calibrator can also be used to measure signals on this type of oscilloscope, it often is more preferable to have a source of calibrated low-level d. c. voltages for the purpose. The reason for this is that d. c. deflections on the

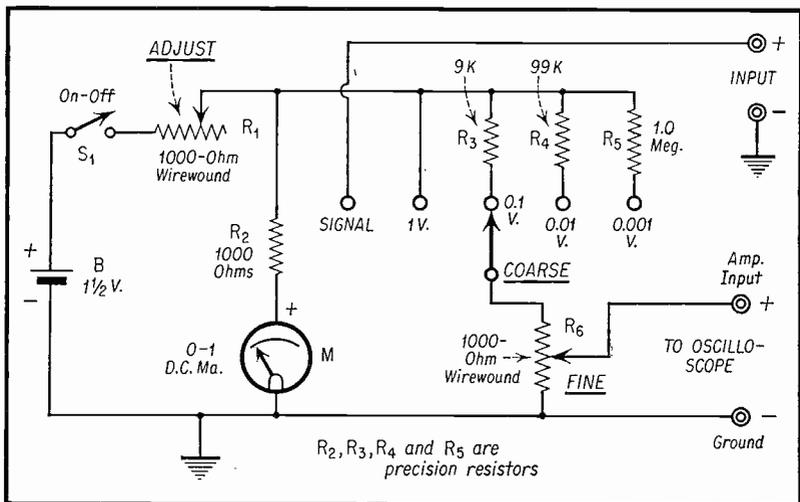


Fig. 2 D.C. Voltage Calibrator.

oscilloscope screen are in one direction (either up or down, depending upon the polarity of the voltage), while the a. c. calibration signal is in two directions, necessitating computations to convert the indicated peak-to-peak values into corresponding d. c. amplitudes.

The calibration voltages of interest in sensitive d. c. oscilloscope amplifiers usually will not extend higher than 1 volt. Well-filtered variable-voltage d. c. power supplies and d. c. voltmeters commonly are used for the purpose when occasionally the d. c. oscilloscope must be calibrated at higher voltage levels.

Figure 2 shows the circuit of a simple, accurate d. c. voltage calibrator which can be constructed by the technician or laboratorian. In this instrument, as in the a. c. voltage calibrator just described, the calibration voltage is delivered by a pair of output terminals and is applied directly to the vertical d. c. amplifier input of the oscilloscope. The calibration

voltage value is read from the setting of the output attenuator which consists of a FINE control potentiometer (R_6) and a COARSE range switch, S_2 . Ranges are 0-0.001, 0-0.01, 0-0.1 and 0-1 volt d. c. Potentiometer R_6 is specified as 1000 ohms to present a low impedance to the d. c. amplifier input of the oscilloscope.

The input to the attenuator system is held at 1 volt by adjustment of the ADJUST rheostat, R_1 . This standardizing voltage is indicated by the full-scale deflection of the 0-1 d. c. milliammeter, M. It is advisable for continued long-term accuracy to incorporate this meter into the calibrator, although for economy it can be omitted in favor of a jack for plugging-in an external d. c. voltmeter when adjustments are to be made. When the meter is self-contained, however, any drop in its reading will readily indicate a drop in the battery voltage, and this can be compensated by immediate adjustment of rheostat R_1 .

The d. c. voltage to be measured is connected to the INPUT terminals and is transmitted directly to the oscilloscope when switch S_2 is in its SIGNAL position. This obviates the need to change leads when the calibrator is substituted for the signal source, and vice versa.

The following procedure is followed when using the d. c. voltage calibrator. (1) Connect the d. c. signal source to the INPUT terminals. (2) Connect the calibrator OUTPUT terminals to the d. c. vertical amplifier input of the oscilloscope. (3) Set switch S_2 to its SIGNAL position. (4) Set the vertical gain control of the oscilloscope to obtain a vertical deflection of the spot a desired distance on the screen, when the d. c. signal source is switched-on. (5) Set switch S_2 successively to its various voltage positions while at the same time adjusting potentiometer R_6 until the spot again is deflected the same distance on the screen. (6) Read the corresponding volts or millivolts from the settings of R_6 and S_2 .

By means of the vertical beam-centering control of the oscilloscope, the spot may be zeroed initially to any desired part of the screen; for example it may be positioned at the very bottom so as to permit full-scale travel. Nor-

mally, the polarities shown in Figure 2 will cause the spot to be deflected upward on the screen. But when desired, this polarity may be reversed to secure downward deflection. A horizontal d. c. amplifier, when present in an oscilloscope, may be calibrated in the same manner with this instrument, using left or right deflections of the spot.

The lower ranges of this d. c. voltage calibrator enable the checking of low potentials such as those derived from thermocouples, strain gauges, photocells, crystal diode output, and the like.

A. C. Current Shunt

A potentiality of the oscilloscope often overlooked is its ability to measure peak alternating currents. In this application, the oscilloscope is invaluable for checking peak currents through capacitors and chokes, determination of peak power, measurement of peak operating loads, current transient study, etc. The technique is identical with that of using a high-impedance a. c. voltmeter to measure currents — the current of interest is passed through an accurately-known low-ohmage resistor and the voltage drop across this resistor measured with the oscilloscope, with the aid of an a. c. voltage calibrator.

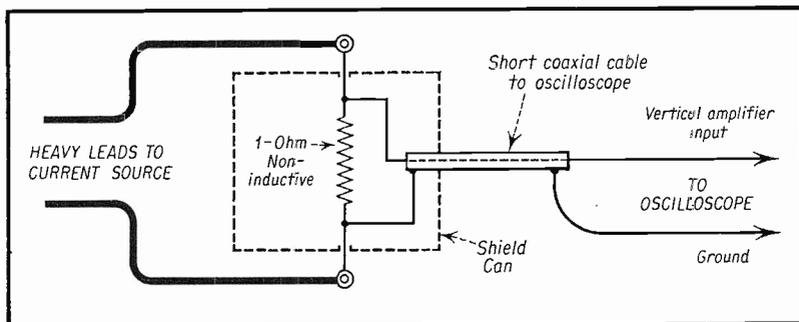


Fig. 3 Universal A.C. Current Shunt.

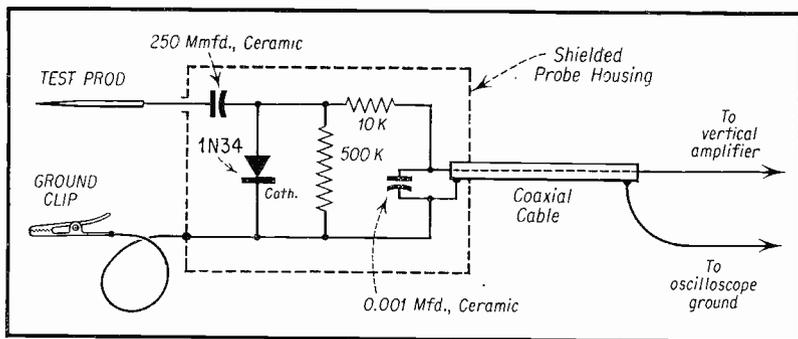


Fig. 4 Demodulator Probe.

When the resistance (R) and the peak voltage (E) are known, the peak current (I) equals E/R . By making R 1 ohm, the peak current becomes equal simply to the peak voltage. Since most oscilloscopes show peak-to-peak voltage values when used with a voltage calibrator, the peak current must be determined by dividing these values by 2.

Figure 3 shows the simple arrangement of the universal a. c. current shunt. This is a 1-ohm, 1-watt precision wirewound instrument resistor mounted in a small housing with jumbo binding posts. The leads to the current source must be heavy enough to carry safely and with minimum voltage drop, the continuous current of 1 ampere for which the shunt is selected. A higher-wattage 1-ohm resistor must be used if currents in excess of 1 ampere r. m. s. are to be handled. The 1-ampere unit will be useful also at all lower current levels. For example, 1 milliampere will develop 1 millivolt (0.001 v.) across this same resistor.

Use of the accessory is simple. (1) Connect the shunt to the vertical amplifier input terminals of the oscilloscope. (2) Pass the test current through the shunt and adjust the oscilloscope controls for a satisfactory display on the screen. (3) Measure the

peak-to-peak voltage indicated by the pattern on the screen (using an a. c. voltage calibrator) and divide by 2 to obtain the peak current. (4) Multiply this value by 0.707 to obtain the r. m. s. current value.

When using an a. c. voltage calibrator to measure the peak-to-peak voltage drop across the shunt resistor, the shunt output terminals may be connected to the SIGNAL INPUT terminals of the calibrator, and the SIGNAL OUTPUT terminals of the calibrator connected in the usual fashion to the oscilloscope.

Radio-Television Test Probes

The successful testing of radio and television receivers with an oscilloscope requires various input test probes which must be connected ahead of the vertical amplifier. Figures 4 to 7 illustrate several of these probes which, while commercially available, may be constructed at low cost by the technician.

Demodulator Probe. Because the vertical amplifier channel of the service oscilloscope will not respond to the high radio carrier frequencies employed in radio and t. v. receivers, and also because the signal modulation envelope itself often is of interest, a demodulator must be employed in various types of signal tracing, testing, and visual alignment with the oscillo-

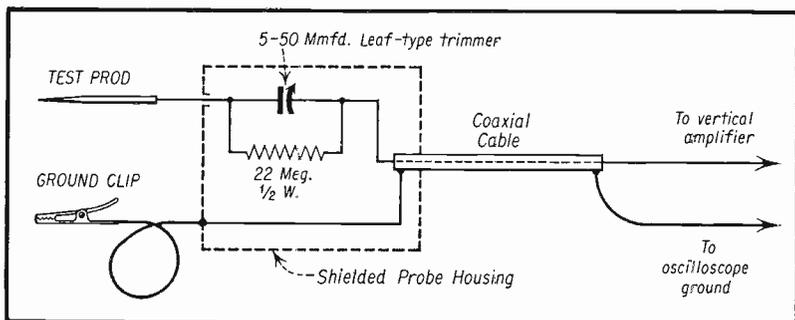


Fig. 5 TV Test Probe.

scope. Figure 4 shows a demodulator probe based upon the detecting action of a 1N34 germanium diode.

The crystal is connected in a shunt-diode rectifier circuit with an r. f. output filter consisting of the 10,000-ohm resistor and 0.001-ufd. capacitor. The unit has high input impedance and accordingly loads the circuit under test only to a negligible extent.

When this probe is used with an oscilloscope to trace signals through an AM receiver operated from an amplitude-modulated signal generator, the display will be of the modulation waveform. Similarly, when used to check the video i. f. of a television

receiver, the display will be of the video and sync pulse envelope.

TV Test Probe. Figure 5 shows a compensated probe for use with a wide-band oscilloscope when checking video stages and pulse waveforms in a television receiver. The trimmer capacitor is adjusted to a value equal to the combined capacitance of the probe cable and the oscilloscope input circuit. The trimmer's maximum capacitance, given as 50 uufd. in Figure 5, will be suitable in a majority of cases but it may have to be increased for some oscilloscopes. The cable should be a low-capacitance type, such as RG-59/U and its length must be restricted to 2 or 3 feet to minimize capacitance.

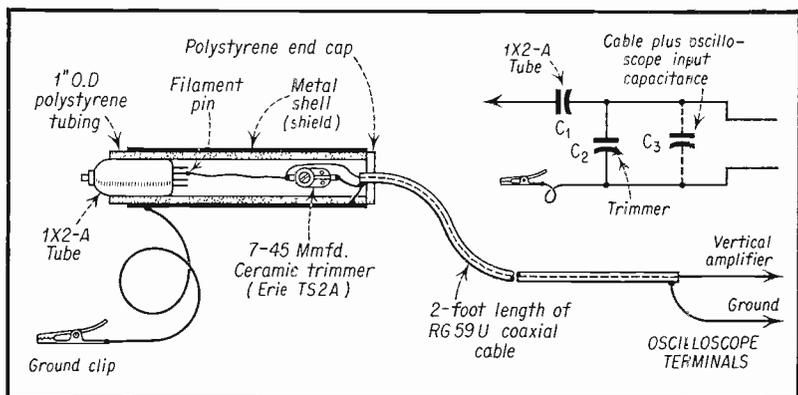


Fig. 6 Capacitive-Type High-Voltage Probe.

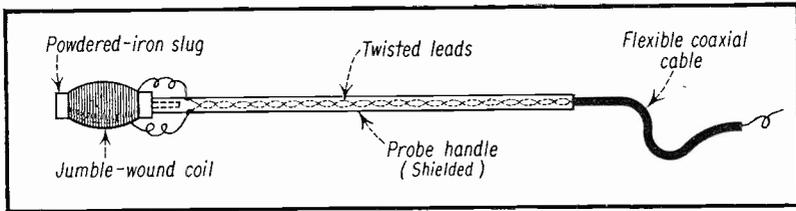


Fig. 7 Hum-Field Probe.

High-Voltage Probe. High-voltage power supply and pulse waveforms in a television receiver are of interest. Proper operation of the set depends upon peak values and waveshapes of these voltages. The meter-type resistance probe used for high-voltage d. c. measurement of t. v. power supplies is unsatisfactory for use with the oscilloscope.

The proper input probe is a capacitance-type voltage divider. The input capacitor of this device must be able to withstand the kilovolts to be encountered in t. v. high-voltage circuits. The output capacitor does not have to be of the high-voltage type. The probe itself must be suitably insulated to

protect the operator from dangerous electric shock.

Figure 6 shows a capacitance-type high-voltage probe. The input capacitor consists of the plate-filament interelectrode capacitance of a 1X2-A miniature high-voltage rectifier tube. This tube is rated at 18,000 volts maximum. The tube is cemented into the end of a length of polystyrene tubing and its plate top-cap is used as the high-voltage test prod. A wire lead is connected from one of the filament pins of the tube to a 7-45 uufd. ceramic trimmer capacitor mounted solidly inside the polystyrene tube opposite a hole in the wall of the tube provided for insertion of a trimmer-adjusting screwdriver.

The purpose of the trimmer is to adjust the total output capacitance (sum of the trimmer plus cable plus oscilloscope input capacitances) to 100 uufd. Assuming the tube capacitance to be 1 uufd., the voltage reduction ratio through the probe then will be 100 to 1. A 10,000-volt input signal then will give a 100-volt oscilloscope input signal. All voltages measured on the oscilloscope screen therefore must be multiplied by 100 to obtain the true input voltage.

The 1X2-A tube can be fit snugly into the polystyrene tubing by first wrapping a portion of the outside of the glass envelope with Scotch tape and then painting with coil dope.

Hum-Field Probe. The probe shown in Figure 7 is useful for exploring hum fields and checking hum currents in audio, radio, and television equip-

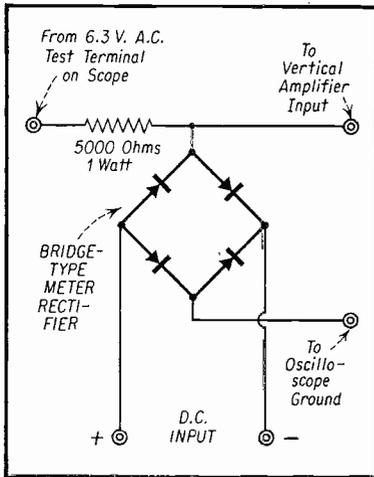


Fig. 8 DC-AC Millivolts Converter.

ment. It is connected directly to the vertical amplifier input terminals of an oscilloscope or through an a. c. voltage calibrator to the oscilloscope. The oscilloscope gain must be reduced so that residual hum display on the screen, due to stray pickup in the room, will be zero or negligible. When the probe is placed in a hum field, the increase in amplitude then will be proportional to the field strength.

The hum probe may be used to determine the best orientation of transformers, chokes, and leads carrying a. c. It may be used also to check hum currents in chassis by pressing its nose to the chassis and observing the amplitude of the hum pattern on the oscilloscope screen.

Miscellaneous Devices

DC-AC Converter. Figure 8 shows a simple bridge modulator which can be used to convert low-amplitude d. c. signals into proportional a. c. signals which then may be applied to the vertical amplifier of an oscilloscope for measurement. Millivolt d. c. levels thus can be checked with an a. c. oscilloscope.

Either a bridge-type meter rectifier or four germanium diodes can be used. The characteristics of the device will depend upon the rectifiers employed,

hence an individual calibration must be made by applying accurately-known d. c. voltages to the D. C. INPUT terminals and noting the a. c. voltages obtained on the oscilloscope screen.

Intermodulation Test Filter. Figure 9 shows a simple RC-type high-pass filter for intermodulation testing when the low-frequency component is 60 cycles and the high-frequency carrier is 3000 cycles, or higher. The INPUT terminals of this device are connected to the output of the audio amplifier under test, and the OUTPUT terminals to the vertical amplifier of the oscilloscope. The amplifier is supplied with a mixed signal of 60 and 3000 cycles. The oscilloscope display will be a smooth horizontal band (when the sweep is set to 120 cycles or some other convenient multiple of 60 cycles) when no intermodulation distortion is present in the amplifier. Otherwise, modulation humps will appear on the top and bottom edges of the pattern. The 60-cycle test signal may be switched-off momentarily and the height of the smooth band measured. The 60-cycle signal then is switched back on and the overall height of the humped band measured. The percentage of intermodulation then is equal numerically to 100 times the plain-band width divided by the humped-band width.

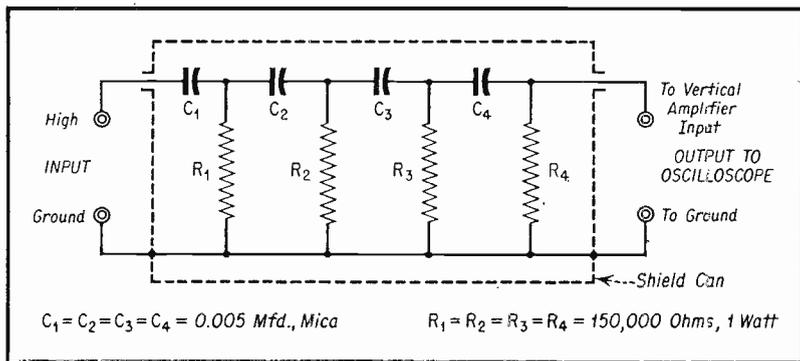
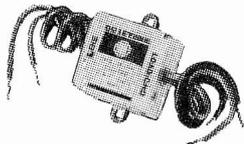


Fig. 9 Intermodulation Test Filter.



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TRADE—Riders TV manuals 1 thru 5, perf., six tubes, factory built Eico sweep gen. What have you? DeCoberts Radio and TV, 609 Henrietta St., Gillespie, Ill.

FOR SALE—Waterman Pocketscope, \$25; Precision VOM series 856, \$18; Rider Chanalyt, \$45; Hickok Sweep 610, \$85; Stancor Master Pack, 752, \$26; Riders TV 1-3, 5, 6, \$60. Robert Coffelt, 800 McKenzie, Bellingham, Wash.

FOR SALE—Radio - phonograph - disc recorder plays 33 $\frac{1}{3}$, 78 rpm records 5-tube radio, PA system, leather carrying case, \$85. George Bartko, 1317 Coal St., Wilksburg 21, Pa.

TRADE—Re-conditioned TV sets for boats or motors. Also have Howard comm. recvr and record, portable radios for swap or sale. Leferson Radio, 405 S. Walnut St., Bloomington, Ind.

SELL OR TRADE—Meissner regenerative recvr T3BK, long range reception, coils covering standard broadcast 8-18 mc., 15-30 mc., handspread, antenna tuning, self-contained or exterior antenna, \$15. Trade Hallicrafters recvr. D. Greunke, 12 Marjorie Court, Rochester, N. Y.

FOR SALE—Meissner 9-1091C Deluxe FM-AM Hi-Fi radio tuner. Still in manufacturer's carton, \$135. Clarence Romrell, 4134 S.W. Flower St., Portland 19, Ore.

SELL OR SWAP—Photoflash tubes (90c to \$7.00 each) and Willard type ER-6-2B storage batteries (\$2.50 each). W. Slack, 3038 Addison St., Chicago 18, Ill.

WANTED—Hickok Dynamic Mutual Conductance Tube Checker including light and noise tests, inexpensive comm. recvr, Transvision CRT Tester Sparker Reactivator. R. E. Cauble, 114-44 226th St., Cambria Heights 11, N. Y.

WANTED—Will pay up to \$4 for book TM-11-475 Principles of Long Distance Telephone & Telegraph Transmission. Roberto Mitrani, Orinoco Mining Co., Ciudad Bolivar, Venezuela.

WANTED—Bendix MN26 J or K radio compass or MN31 Loop Rotator, or both. State cash price and cond. as these are not for resale and must be unmodified. C. L. Neumann, 524 S. Darlington, Tulsa, Okla.

WANTED—Riders TV Manuals, Eico tube tester, Capacitor test set. Sell 7" TV, \$25, 10" \$39. Charles E. Spitz, 1420 S. Randolph St., Arlington Va.

FOR SALE—12 FM Pilot Tuners in original boxes, packed 6 to carton, 88 to 108 mc. Dawson-Ripley, 2141 E. Main St., Springfield, Ohio.

FOR SALE—Riders manuals 1 thru 5, abridged, and 6 thru 16, and Riders PA No. 1 manual. A \$219 value for \$85. Mark W. Ewald, 417 E. State St., Rockford, Ill.

WANTED—High potential-low current transformer. Must be at least 15,000 v., 75 mills, 1 kw. J. W. Telford, 147 Lewis St., Minersville, Pa.

FOR SALE—General Industries mod. 250 tape-disc recorder mechanism only. Needs mechanical adjustments, used little, new drive parts. Highest offer over \$20. R. J. Sandretto, 623 13th St., Richmond, Calif.

FOR SALE—Radio transmitting tubes, transformers, chokes, completed chassis, all kinds of components from 100 w. to 1000 w. Selling out. Power supplies, modulator, amplifier, PE-103, surplus equip. Will trade for guns. R. D. Chandler, 23 Sixth St. NW, Minot, N. D.

WANTED—Navy selsyns, 60 cycle types. Will pay \$35 each for 1G, 1CT, 1D and 1F, subject to inspection. Craig Corp., 50 Eastern Ave., Boston 13, Mass.

FOR SALE—Like new Eico model 425K 5" push-pull oscilloscope, \$45. Local transaction only. Frank J. Di Lustro, 204 Van Sicklen St., Brooklyn 23, N. Y.

FOR SALE—Riders radio manuals 1 thru 12, \$30 cash for the lot, good cond., you pay freight. T. Sidney Smith, 233 Fairfield Avenue, Bellevue, Ky.

SELL OR SWAP—Constant voltage transformer, portable radio, drafting set, Stecky camera, TV booster, meters. Want mobile rig or ?? Joseph Leeb, Kerhonkson, N. Y.

SELL OR TRADE—Hi-Fi amplifier, spkr., pilotuner, Webster changer, modern cabinet, \$100; BC-455 \$7; BC-453 \$10; Alliance rotator \$10. Need communications receiver. Ernest Palinkas, 335 E. 69th St., New York 21, N. Y.

FOR SALE—Triplett sig. gen. model 2432 in good cond., including manual, \$25. De Voe Radio Service, PO Box 414, Spring Green, Wis.

SELL OR TRADE—Harrington one-ton chain hoist, assorted unneeded radio parts, Kennedy machinist's tool box, two auto headlights, complete; spotlight, 12 v. power pack with meter. Want intercom or 1/4-inch electric drill. M. L. Braun, 202 Howard St., Bellevue, Ohio.

FOR SALE—New Bud cabinet rack CR-1741, \$8; chassis CB773, \$1.25; relay rack CR-1772 \$30; chassis brackets MB460, \$1 i.o.b. James Davis, 2034 N. Albany Ave., Chicago 47, Ill.

SELL OR SWAP—Precision E-200-C sig. gen. in A-1 shape with manual, \$55. April 1947 thru Jan. 1949 "Electronics" \$8. Unused transmitting and receiving tubes in original cartons, cheap. Cash or 35 mm. camera. R. Robinson, 1814 Robin Road, N. Augusta, S. C.

WANTED—Hallicrafter S-40B or National NC-57 comm. recvr. State age, cond. and price. C. R. Morse, 1636 Virginia Ave., Kingsport, Tenn.

FOR SALE—Newcomb model E50, 50 w. amplifier in very good condition. C. S. Collier, 190 Yoder, South Bend 14, Ind.

SWAP—Amplifier Class "A" 10 w. output with tubes; Kligl stage plugs with brackets, wire and accessories; baby spotlight 400 amp. bulb; NRI correspondence course book, for good pair of 7x50 binoculars. Charles Rosenberg, 471 Audubon Ave., New York 33, N. Y.

SWAP—NCS7 National comm. recvr. and 7" Motorola TV set, both in very good cond., for late model VTVM or oscilloscope — Want Eico or Simpson equip. Marstan TV Co., 13 Marcy Place, Bronx 52, N. Y.

WANTED—Used table model radios having old FM band. Do not have to be in working order. State cond. and price. Elvin L. Holley, Box 336, Vaughn, N. M.

FOR SALE—6 like new 0-1 M.A., 4 inch meters, square bakelite case, knife-edge pointers, VOM scale and in original boxes. Postpaid, \$5. L. Cohen, 151-09-34th Avenue, Flushing, N. Y.

FOR SALE—GE self-charge portable radio Mod. 250, perf. cond. \$50. Manuel Parez, 119 Ninth Ave., New York 11, N. Y.

SELL OR TRADE—Triplett foundation meter, high voltage transformers; Drake hi-pass filter; Leece Neville 80 amp. generators; ARC-5 transmitters; Cramer 10 amp., 60 second delay relay; Biddle tachometer. J. Dillon, 153 Hylan Blvd., Staten Island 5, N. Y.

TRADE—5 power microscope; 5BP4 cathode ray tube; GE Selenium Rectifier, 18 v., 12 amp.; Drake-cyclopedica of Radio by Manly. Want Dynamic microphone, recording tape, coaxial speaker, wide angle lens for Kodak 16 mm. magazine. Stanley Wellenc, 256 12th Ave., North Tonawanda, N. Y.

FOR SALE—Bliley CCO-2A crystal oscillator, \$5, exc. shape; like new Bliley AX3 crystal 24035.5 kc., \$3; Two AX2 used crystals 3988-1 and 3852.1 kc., \$2 each. Want good used auto radio batt. eliminator. Dudley Auto Shop, West Main St., Dudley, Mass.

FOR SALE—Back issues of Electrical Engineering .25 each and QST at .15 each; 5BPI \$9; parts for BC-412A oscilloscope. R. Lebowitz, 388 Avenue "S", Brooklyn 23, N. Y.

SELL OR TRADE—Rider Vol. 1B, like new, \$10 or trade for VOM in good cond. Arthur Ideker, 1505 West 14th, Pine Bluff, Ark.

SERVICE—Designer offers complete design and development or pencil or ink drawings from rough sketches or schematics at nominal rates. J. Bourke, 127 Great East Neck Rd., Babylon, N. Y.

FOR SALE—All parts including screen and lenses for U. S. T. projection and direct view set. Very reasonable. Superior TV Service Co., 772 Sutter Ave., Brooklyn 7, N. Y.

SELL OR TRADE—4x5 Nue-View press and view camera with Quick-Set deluxe elevator tripod, in like new cond.; complete line of photographic and dark-room equip., in A1 cond. Want good tape recorder, radio-TV test equip. or ? Selwyn Wynstock, 1837 S. Millard Ave., Chicago 23, Ill.

SELL—Hi-Fi tape recorder and playback amplifier, automatic reverse mechanism, exc. cond. Plays hour and fifteen min. automatically. Original cost \$300., sell reasonably. Leon Kuby, 1472 52nd St., Brooklyn, N. Y.

WANTED—Good line filter for severe TV noise elimination. Sidney Cutler, 1954 Unionport Road, New York 60, N. Y.

WANTED—BC221, with calibration book, in good cond., at reasonable price. Wm. R. Fonshell, 1109 Homestead St., Baltimore 18, Md.

FOR SALE—Considerable quantity ham gear for very low prices, if interested please mail 3c stamp for list. Continental Electronic Corp., 283 Berkeley Avenue, Newark 7, N. J.

SWAP OR TRADE—NRI TV service course VTVM with RF-AC head and leads, 7J4 picture tube, 7" Tele-tone TV in working order without tubes. Want late model capacity checker, sweep. gen., Heath preferred. Samuel R. Craig, 33533 Garfield Rd., Fraser, Mich.

SELL OR TRADE—Tube tester, Colt .22 pistol, portable typewriter, bench saw, record changer, radios, rifle, tubes, eliminator, watch, etc. Send your list. E. G. Bartlett, Atlanta, Ga.

FOR SALE—Pair current model Bell Tape Recorders. Never used. \$125. each net. R. B. Ritter, 612 N. Michigan Ave., Chicago 11, Ill.

WANTED—Lettine 240 transmitter; S-20R or NC-57 recvr; lab-type test equip. Buy or trade. J. E. Howell, WTSB, Lumberton, N. C.

WANTED—All band, TVI-proof, VFO; Brute force and low pass filters; 500 w. all band ant. tuner; CRT modulation indicator. Have used equip. or cash. Norval Wallen, Mansfield, Mo.

SELL OR TRADE—Service Magazine from April 1949 to May 1953 — for ham equip. Arthur Digby Jr., 214 N. Grant St., Bay City, Mich.

SWAP OR SELL—Heath TV2 sweep gen. Want Heath AM sig gen. and battery eliminator, or what have you? Thomas Boddie, 9410 Pierpont Ave., Cleveland 8, Ohio.

FOR SALE—Like new Heath sweep sig. gen. TS-2, modified with controllable (two) xtal markers containing a 4.5 mc. xtal value over \$60. Make offer. Joseph F. Dineen, 9 Winter Terr., Westwood, Mass.

FOR SALE—16 6-tube coin operated hotel radios in very good cond., in locked metal cases finished in gray. Also converters for D. C. current. Erwin Halverson, 2505 Meadow Lane, Manitowac, Wis.

FOR SALE—Preliminary Instructions on Operation & Maintenance books on SCR-578-A, \$1 ea. Radio Components, 28 N. Halstead St., Chicago 6, Ill.

FOR SALE—Command recvrs. BC453-454 and 455.. 457 Command transmitter; UTC S21 modulation transformer 120 w.; complete modulator-match final 813, Motorola P13 recvr. for IF strip for mobile converter. Power cables for PE103. Harlan Dewitzb, Wisner, Neb.

FOR SALE—Eico 425K scope and 360K sweep gen., factory calibrated, but slightly used; model 900 VOMAX, needs calibration, all three for \$115. Van Nest Radio, 717 Morris Park Avenue, Bronx 60, N. Y.

FOR SALE—Hickok 19X sig. gen. and RCP 805B tube tester, set tester. Exc. cond. Instruction books for both. \$100 for both. N. Almond, 118 N. Westmoreland Ave., Los Angeles 4, Calif.

WANTED—Small screen TV set in good working cond., cash or trade for electronic equip. Maurice Surrville, 421½ W. 20th St., Houston, Tex.

FOR SALE—2 7" CRT, Standard TV tuner, phono motor with turntable, 2 changers, etc. S. J. Lo Nigro, 52 Willowdale Ave., Montclair, N. J.

FOR SALE—American transformer, 110-220 v., 60 cycle primary, 1100-2200 secondary. KVA. Also several heavy chokes. Write for specifications. M. J. Nederostek, 848 Walnut, Allentown, Pa.

WANTED—Intercommunication sets by the name "Carrier-Call." working or not, so all the parts are together. A Robles, 1216 W. Houston St., San Antonio 7, Texas

SWAP — Olympic "tru-base" receiver, broadcast and short wave bands, AC operation, sent pre-paid for FM tuner, any cond., if all parts intact. William Bashta, 19447 Keswick St., Reseda, Calif.

WANTED—Superior sig. gen., model 1230, must be reasonable, and in good cond. Have Chevrolet hot water heater, and small AC motor for sale or swap, good cond. Lowe E. Smith, RFD 1, Silver Creek, Ga.

FOR SALE—Model 6N Presto portable 16' recording turntable and 87A portable recording amplifier, 50 ohm inputs, 10,000 cycle recording head. Used less than fifty hours. Albert Lewis, 2715 N. Garri-son Ave., St. Louis 6, Mo.

FOR SALE—Cheap, undrilled aluminum rack panels, easily worked; relay rack cabinet 26" space, gray; Adel clamps. 2 rounds 0-10 MA DC meters, Gruen and Simpson PE-104; BC654 transmitter only; RF connectors. Ken Palmer, 112 Lake, Blasdell, N. Y.

TRADE—Eico tube tester, used twice. Silver model 904 C.R. Bridge, very good cond., for a Gibson, Martin, or Kay Craft six string guitar. John Howland, Box 14, Concord, N. H.

FOR SALE—Short wave 2 meter transmitter; Motorola recvr; complete station Supreme Composite video gen.; frequency meter, Hickok audio sig. gen.; Solar Condenser Checker. Earl Silvers, 2501 Union St., Lafayette, Ind.

SELL OR TRADE—1951 Ford radio A-1, \$39.50; 22 Stevens 87 automatic rifle, \$29; pair 12" Utah PA speakers, 4000 ohm fields, \$5 each. Want target rifle and recvr. Harvey Van Erem, Box 1085, Jamestown, N. D.

FOR SALE—Hi-Fi 10 w. amplifier with microphone stage, \$34; like new Bogan TV Booster, \$16; Stromberg-Carlson record changer, \$15 in good cond. Albert Sturn, 89-47 198th St., Hollis 23, N. Y.

FOR SALE—Riders Manuals 1 to 6, 8, 11, NRI Manual No. 1; Triplett sig. gen., 2432; Weston tube tester and analyzer; NRI sig. tracer; batt. elim; 25 Sams photo-facts; tubes, 200 resistors, service bench, etc., \$375, local sale. Louis B. Exum, 1441 5th Ave., New York 35, N. Y.

WANTED—Precision E-400 Sweep sig gen. ES-500A Precision oscilloscope, Sams Protofacts Vol. VIII to date, in good cond. Give cash price and details. Latest model Hickok instruments considered. Earl W. Wells, 223 N. Phila. St., Shawnee, Okla.

WANTED—P32-4222-3 oscillator coil for channel 3, and P32-4115-4 aerial and r. l. coil for channel 4 for Philco TV model 48-700. Code 121. Dale C. Walker, Box 172, Superior, W. Va.

SELL OR TRADE—S40B and Millen 50 w. Tran 90800 with 10 meter coils, 6 mos. old, \$65, or trade. Bob Metke, 511 Oak St., Roseville, Calif.

WANTED—Good quality FM tuner reasonably priced, will pay cash or swap meters and radio gear. Clyde Keeler, 66 Franklin St., Port Jervis, N. J.

FOR SALE—3 10BP4 picture tubes, std. bds. used but good for many hours, \$8 each or \$21 for all three plus shipping. H. W. Siemann, 130-27 230th St., Laurelton 13, Long Island, N. Y.

FOR SALE—Dumont 12" TV, \$75; Motorola 10", \$45; Philco projection, \$75; Bogan 15 w. mike, 2 speakers, \$55; Waisco magnifier, \$25; Hanovia ultra-violet lamp, \$50. Emil Grauer, 30 Melrose Terr., Linden, N. J.

WANTED—Beco Impedance Bridge in good cond. McNeill TV Service, 263 4th St., Bremeron, Wash.

FOR SALE—Lab. model, high voltage mica variable condenser, two section, bronze cast fan type shoring switches, four terminal. Capacity unknown. Also, a transformer, 1/2 kw, 500 cycle, 4:1 ratio, Navy part. Make offer. B. Sunshine, 141-40 84th Dr., Jamaica 35, N. Y.

SELL—DeForest 1952-53 Radic-TV course, complete with oscilloscope, volt-ohm-milliammeter, and sig. gen. (converted to 6J5 and 6A8 for AC operation). All instruments and lessons in exc. cond. \$100 or best offer. E. C. Webber, 607-14th St. SE, Roanoke 13, Va.

WANTED—Antenna Installation Manual for SCR-268 radar set. I. Susman, 1052 Blake Ave., Brooklyn 8, N. Y.

FOR SALE—ATR Inverter Input 32 v. DC. output 110 volts AC; R-8 Keystone 8 mm. movie projector like new; Superior Utility tester model 50, good cond.; Professional model Harmony guitar. Vernon J. Kroh, New Salem 4, N. D.

SWAP—BC312-D comm. recvr., converted to 110 AC for good sig gen. — prefer Precision E200C or outboard motor. Frank O'Keefe, 223 Rindge Ave., Cambridge, Mass.

TRADE—Hyland Strob Lite and battery pack, like new; Kodak Medalist II with case; Solar Enlarger, electric print dryer and dark room equip. for SX28A, Viking II or Collins 32V3. Karl Lipscomb, 4319 Park Lane, Dallas, Tex.

FOR SALE—Hallicrafters HT-9 exc. cond., all coils 80 thru 10 meters, new 814 tube, \$200 f.o.b. Jack Goldfarb, 3521 Cedarbrook Road, Cleveland 18, Ohio.

FOR SALE—Beautiful home with electrical business, wonderful chance for adding refrigerating business. E. R. Eaton, 23 Fairview Ave., Derry, N. H.

FOR SALE—National NC-183D, less spkr, slightly used. Will deliver in U. S. A. Best offer takes it. Henry Peplinski, 145 Green St., Brooklyn 22, N. Y.

WANTED—tube tester, any brand; about \$10, good working order. E. Alberts, 424 Wilson St., Buffalo 12, N. Y.

SELL OR SWAP—Transmitters, power supplies, parts, tubes, meters, dynamotors, neon transformers, diathermies, used radios, phones and B eliminators, etc. A. Zambakian, 1259 Gaylord, Denver, Colo.

WANTED—30-'06 Springfield rifle in exc. cond. Will swap radio gear. Name your needs. Louis D. Welsh, RFD 6, Kokomo, Ind.

SWAP—Aircraft course books for NRI or Sprayberry Radio and TV course. D. Angelini, 825 E. 27th St., Wilmington, Del.

FOR SALE—Tube checker, sig. gen., appliance tester, TV set, tubes, transformers, circuit diagrams. Send stamped envelope. Ellison Radio Service, Centertown, Ky.

SELL OR TRADE—E.M.C. 106 VTVM with leads and papers like new, \$18; 12 16" transcription records, with Bob Hope, other stars, made during War II. Want .22 pistol. Walter Siuta, 4011 Lawndale St., Detroit 10, Mich.

WANTED—Rek-O-Kut turntable in exc. cond., will consider models LP 743, CVS-12, and T-12 Weathers cartridge and oscillator, mod. W-202 for Weathers arm. Conrad Fong, Dept. of Pathology, University of Washington, Seattle 5, Wash.

FOR SALE—Philco radio and phonograph in perf. cond. Beautiful walnut cabinet. Make offer. H. Blackman, 7530 S. Evans Ave., Chicago 19, Ill.

SELL OR TRADE—Hi standard 10-shot auto. pistol, nearly new with grips. Want tube tester or sig gen., or what have you? Lyle C. Newell, 5843 4th St. No., S. Petersburg, Fla.

WANTED—Batt. eliminator to operate 1½ v. radio; Philco push-pull output transformer part no. 32-8120. State make, cond., and price. Joseph A. Spalla, Plaza, N. D.

SELL OR TRADE—Industrial TV auto. booster No. 1T-75A with 6AK5 and 6CB6 tubes, \$10, p.p.; T-64 Hallicrafters TV chassis, spkr., 8 tubes, for 10" or 12". \$35. T. E. Larson, Ostrander, Route 2, Ohio.

SELL OR SWAP—Lindstrom 16 mm. proj. with 1750 ft. new film, \$25. Want radio parts, equip., or ? Robert C. Geinett, Liverpool, RD 2, Pa.

FOR SALE—"Radioear" hearing aid complete with new batt., charger, case, perf. cond., \$87.50 prepaid. Would consider Solar C-B 1-60 Condenser Analyzer, Eico 221K VTVM, Eico 625K tube checker, all in perf. working cond. S. Clayton, 911 Broadway, San Diego 1, Calif.

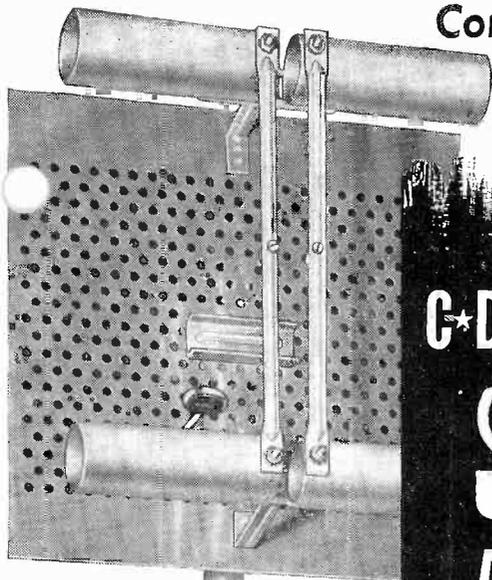
FOR SALE—Parts and tubes for TV projection. H. Bergh, 1583 E. 96th St., Brooklyn 36, N. Y.

WANTED—Instruction operating manual and diagram for McMurdo-Silver 904 capacitor and resistor tester. David C. Mikels, RD 1, Box 163, Short Creek, W. Va.

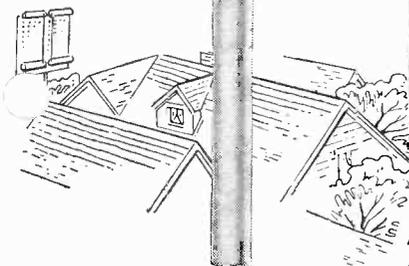
FOR SALE—Supreme manuals 1 to 11 ('26 to '51) \$12.50 p.p., slide rule and case \$3.50. Ellis Radio Service, Vermillion, Ohio.

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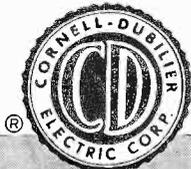
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