Vol. 6 AUGUST, 1942 No. 8

CORNELL-DUBILIER ELECTRIC CORP.
HAMILTON BOULEVARD
SOUTH PLAINFIELD, N. J.

Sec. 562, P. L.&R.
U. S. POSTAGE
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RADIO SERVICE HINTS

Practical Suggestions on Solution of Radio Servicing Problems Encountered in Actual Experience by Servicemen Everywhere

This section, conducted by our servicemen readers, will be a regular feature of the C-D Capacitor, and is intended to provide other servicemen with helpful notes on testing, locating troubles in specific models of sets, repairing them, or any other suggestions to simplify service work.

Cornell-Dubilier will pay $2.00 for each hint published in this section. Notes must be limited to 75 words, or less Any number of hints may be submitted at one time. Unpublished items will not be returned. Be sure to give your name and mailing address. Send hints to: Editor, C-D Capacitor, Cornell-Dubilier Electric Corp., So. Plainfield, N. J.

Generator Interference in Sentinel Set

Sentinel model 189 I.T, 32-volt d.c. sets may be found affected by interference from wincharger or generator.

To correct this condition disconnect the plate resistor to the 6SQ7 tube at the B plus side and connect a quarter meg. resistor in series with it and by-pass the latter to ground with a .1 mfd. tubular type capacitor.

This will not only eliminate the interference problem but improve the tone. — *John Mednansky, Kadoka, S. Dak.*

Speaker Repair

Many types of speakers such as RCA and Philco models have the cone fastened to the outer rim by means of a flexible, serrated strip. This strip becomes hard and prevents free movement of the cone with consequent distortion.

Instead of replacing the cone in such cases, they can be repaired easily and economically as follows. Cut a piece of ordinary shelf oilcloth, such as available at any dime store, to the corresponding shape of the hardened strip. Then carefully remove the old strip one-third around at a time replacing it with one-third of the new strip. By this method the cone will retain its alignment perfectly.—*Vincent J. Lewis, Jr., Yonkers, N. Y.*

RCA-80, GE-H 31 and Westinghouse WR-5

Distortion in these sets when on low volume is commonly due to a defective resistor in the experience of the writer. If this condition occurs, check the 110 ohm resistor connected from the cathode of the second detector to the B plus circuit. This resistor may be found to have changed in value. Replace it with a new 100 ohm unit.—*M. Bobring, St. Louis, Mo.*

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Grid Leads in Cylindrical Type Tube Shields

Sets employing the older type cylindrical tube shield can become somewhat erratic in operation when the top grid lead is misplaced on the inside of the shield. This very often happens when repairing or inspecting a set. Proper operation can be restored by removing the top grid clip and shield and place the lead on outside of shield. This may be the cause of trouble which many servicemen will probably spend much time in locating in other parts of a set.—*Wm. Pinske, Red Wing, Minn.*

Intermittents in Converter Tubes

We have found much radio trouble, such as intermittent playing caused by 6A8 and 1A7 tubes opening in oscillator section of tubes, then for the minute going back to normal. It is a good idea to try another tube before you decide to look for trouble elsewhere. In sets which act this way, the writer finds it saved many hours of hard work.—*D. W. Griffin, Ithaca, N. Y.*

RCA Victor - 46 X 11

After considerable patience in locating weak reception on this set, and checking all possible sources of trouble, a long antenna connected to the loop seemed the only solution to the problem. However, it was finally discovered that the resistance of the first I.F. transformer had increased many times that of its original value. The solution was therefore to replace this unit with a complete new I.F. transformer.—*G. T. Conant, Chelsea, Mass.*

Zenith Model 6 D - 311

If a model of this type set comes into the shop with a bad hum that is not helped by adding capacity or changing tubes, check the resistance of the speaker field winding. If it is near zero, carefully remove the tape around this winding and examine the junction of the two leads with the winding. It may be found that these leads are shorting together. Separate them, and the hum will disappear.—*John T. Frye, Logansport, Ind.*

Aligning of A. C. - D. C. Sets

On many A.C.-D.C. sets, difficulty is experienced in alignment procedure due to A.C. hum when the signal is applied to the grid of the converter tube. Although this can be overcome on some sets by the use of a .00001 mfd. condenser, such is not always the case. The writer employs a 36-inch length of lamp cord with clips, hooking one lead to the signal generator and the other to the grid which works very nicely on all A.C.-D.C. sets.—*Gillespie Radio Service, O'Neill, Neb.*

U. S. SIGNAL CORPS NEEDS ENGINEERS

THE War Department, Aircraft Radio Laboratory at Wright Field, Dayton, Ohio, has a shortage of qualified civilian engineering and inspection personnel. Wright Field is the home of the Materiel Division of the Army Air Corps and there are concentrated all the experimental laboratories which are making such tremendous advances in the development of aircraft and aircraft accessories. The Aircraft Radio Laboratory is responsible for research, development, engineering, and inspection required in the radio field, incident to design, supply, and installation of radio equipment on aircraft.

The basic duties of a radio engineer are to perform or supervise the performance of professional engineering work in design, construction, research, and investigation. Responsibilities and duties are commensurate with the grade.

The Civil Service standards for Junior Radio Engineer, which pays $2,000 per year, are a degree in electrical engineering from an accredited college. The next higher rating, Assistant Radio Engineer, $2,600, has requirements of two years of progressive professional experience, plus substituted experiences vear for year for college education that is lacking. A college degree, while very desirable, is not essential. A well qualified engineer without a degree is eligible for consideration.

Inspectors of Signal Corps Equipment are required to make inspections and tests of aircraft radio equipment to determine compliance with specifications, etc. This duty is usually performed at the plants of the contracting manu facturers. The salary range is from $1,620 to $2,000 per year.

The above salary rates are of course initial rates and promotions for higher rates of pay are made commensurate with responsibility and experience.

Engineers and service men who are interested in these positions are invited to submit a letter outlining their education and experience directly to:

DIRECTOR, AIRCRAFT RADIO LABORATORY
Wright Field Dayton, Ohio

A Free Market-Place for Buyers, Sellers, and Swappers.

These advertisements are listed FREE of charge to C-D readers so if there is anything you would like to buy or sell; if you wish to obtain a position or if you have a position to offer to C-D readers, just send in your ad.

These columns are open only to those who have a legitimate, WANTED, SELL or SWAP proposition to offer. The Cornell-Dubilier Electric Corp. reserves the right to edit advertisements submitted, and to refuse to run any which may be considered unsuitable. We shall endeavor to restrict the ads to legitimate offers but cannot assume any responsibility for the transactions involved.

Please limit your ad to a maximum of 40 words, including name and address. Advertisements will be run as promptly as space limitations permit.

WANTED — Will pay cash for any good service equipment such as Supreme 560A Vedolyzer, 561 audolyzer, 562 signal generator, 571 oscillator, 504, 592 or Precision 920, 954, 844, 854P E-200, Ev10, 856 or Averox 75 condenser checker. Kennedy's Radio, 3407 14th St., N.W., Washington, D. C.

WANTED — A 3-inch Cathode Ray Oscillograph for cash. Please state make, model, condition and price. Donald B. Berry, 196 Adams St., Waltham, Mass.

FOR SALE — Radio laboratory apparatus such as General Radio, panel type and portable meters of all types. Send stamp for list. L. Tulauskas, 104 N. Eaton Ave., Indianapolis, Ind.

FOR SALE OR TRADE — Transformer 110 v. primary; secondary 6,000 v, 20 ma. Was used for luminous gas sign. Best offer takes it. J. W. Shortell, 2333 Washington Ave., Bronx, New York.

WILL PAY about $5 for a 1220 Superior pocket laboratory. Also want diagram, instruction, and full data on Superior All meter AMR. Oscar's Radio Service, Merrill, Iowa.

FOR SALE OR TRADE — Hundreds of used radio parts, tubes, speakers, magazines, electrical books, tube checkers, meters, tools, etc. Describe your goods, list for stamp. Roby's Swapmart, 3569 Cottage Grove, Chicago, Ill.

WANTED — Two telephone operator's headsets, with breastplate, transmitters, and single ear receivers. Advise price, make and impedance. Jack Adler, 431 Champlost Ave., Philadelphia, Pa.

WANTED — Rider's Manuals Nos. 7, 8, 9, 10, 11, 12. State condition and lowest cash price. Will also trade .25 cal. Colt automatic for a 22 cal. target pistol or some other useful article. Frank G. Rector, R. R. 1, Kalamazoo, Mich.

WANTED — Dynamic Mutual Conductance Tube Tester. Full details in first letter. Will pay cash. Leo Kolehmainen, 1426½ Midvale Ave., West Los Angeles, Calif.

WANTED — Rider's Manuals volumes 4 through 13, good condition, cash. Advise what you have. Karl Wagner, C. C. Bk. Bldg., Des Moines, Iowa.

WANTED — A handicapped person is looking for a big hearted radio service man who has no more use for the extra signal generator, parts and radio diagrams which are lying around the shop. Peter J. Jarvis, 4817 S. Elizabeth St., Chicago, Ill.

FOR SALE — 1 Jackson 660 Signal Analyzer practically new; 1 E200 Precision Oscillator practically new; 1 860 Precision multi range volt-ohm-millimeter; 1 cutting and welding outfit; 1 Briggs and Stratton engine, and many other articles. If interested write for list. R. A. Bookman, Rt. 2, Casey, Ill.

FOR TRADE — Have a Triplett 1213 model tube tester which would like to trade for a communications receiver, such as FB7, SW45, Hallicrafters Sky Buddy, or Echophone Portable, or what have you. Manuel A. Perry, 39 Winter St., Wakefield, R. I.

WANTED—Candler advanced code course and Candler typewriter course. Please state price and condition. Corporal Anthony Vernucci, 31st Fighter Control Sq., Army Air Base, Orlando, Fla.

SELL OR SWAP — Auto control leads for almost any car including panel kits and knobs. Guaranteed discounts of not less than 50% on Stewart, Philco and United Motors Leads or kits. Let me know what you have or need. Samuel Blotnick, 103 Cambridge St., Boston, Mass.

WANTED — Any equipment for recording or playback of sound on film except the speech amplifier. Must be in working order. Cash or trade. Have two University PH trumpets and two SAH drivers. Eugene Klinedinst, 126 North Queen St., York, Pa.

WANTED — Good panel meter suitable for making volt-ohm-ammeter. Willing to pay reasonable cash price for meter in good shape. Harold L. Kilgore, College Station, Lafayette, La.

NEON SIGN — Reading in red on both sides Radio. 4 ft. long and 12 inches high with brackets and chains all perfect, $35. Kubicek, 20 Warburton Ave., Yonkers, N. Y.

CASH — For LCR bridge, CBD-3 or 5 condenser decade box, resistance boxes, Wattmeter, Galvanometer, and meters of all kinds. T. Lipani, 157 Leverett St., Boston, Mass.

WANTED — Automatic Record Changing Player Unit, Garrard or Webster, with record cutting head. Please state type and model. Will pay cash. Aladdin Camera & Radio Exchange, 4 East 32nd St., New York.

FOR SALE — Portable "Presto" Recorder, Type E, Ser. No. 1324. Also one Bogen Playback. Will sell one or both. Earl W. Hall, 1427½ Quarrier St., Charleston, W. Va.

FOR SALE — Magazines, Radio Craft, Feb., 1932 to 1941, Service 1932 to 34, some Radio News 1930 to 34. Make an offer. John Staron, 2909 Julian St., Youngstown, Ohio.

WANTED — Rider's Manuals 1 through 12 in good condition complete with supplements and indexes. Quick cash sale if price is right. If you haven't all 12, what have you. Carl E. Mead, 833 Chicopee St., Willimansett, Mass.

BUY, SELL and EXCHANGE — All makes of foreign radio tubes. Want foreign radio tube tester. Aladdin Camera & Radio Exchange, 4 East 32nd St., New York.

FOR SALE — 3-inch oscilloscope built by service engineer to RCA circuit. Neat appearance, tube not burned, no hum. $65. Model 150 RCA Oscillator excellent condition, $60. One new 913 Cathode Ray tube $3. Paul Wilson, 323 S. Phillips Ave., Sioux Falls, S. D.

WANTED — Position as a radio serviceman for young man. Ineligible for draft. Recent graduate of the Y.M.C.A. School, but with no experience. Willing to learn. Will accept nominal salary. Charles J. Neff, 67 Highview Ter., Yonkers, N. Y.

FOR SALE — Breting 12 Recr. $50. Set Rider's Manuals new includes 1 to 5 abridged, 6 through 13, $85. Used Manual set 1 through 12, $85, C.O.D., F.O.B., Los Angeles. Fine condition guaranteed. Send check for prepaid shipment. Your check returned if mdse. previously sold. Also Precision E 200 OSC $40, Triplett 1601, $35. Earl K. Moore, 11537 Pope Ave., Lynwood, Calif.

WILL SWAP — A-1, 22 cal. bolt action, 7 shot clip, Western Field rifle for short wave receiver, transmitter, test equipment, books, or what have you. Also have a 210 lb. set of Bar-bells with 3 courses on weight lifting. Trade for any of above items. Fred C. Schiebler, 909 Adams St., Neenah, Wis.

WANTED — Sky Buddy, Sky Champion or similar communications receiver in good condition. Write stating lowest cash price and condition. A. C. Peed, Jr., 264 East Maxwell St., Lexington, Ky.

WANTED — Standard make signal generator, and a 3-inch oscillograph. Have a photo-electric cell unit and a recorder for trade. Also a few other items, will answer all letters. Eugene Cheney, Box 88, Rudd, Iowa.

BUSINESS FOR SALE — Well stocked radio and electric store, good income, established 25 years. Forced to sell due to enlistment. Remling Bros., Inc., 185 Valley St., N. Tarrytown, N. Y.

WANTED — Rider's Manuals vols. 7 up. Must be in good condition, will pay cash. Rudolphs' Electric Service, 33-35 E. Jackson St., Wilkes-Barrie, Pa.

WANTED — A complete set of Rider's Manuals. Will pay cash for books in good condition with indexes and supplements. Please state condition and lowest price asked for the set. Max Person, 4316 Corliss Ave., Seattle, Wash.

WANTED — A good 3-inch oscilloscope. Must be in perfect condition. Please state make, full particulars and lowest price wanted. James Lawless, 27 Sassafras St., Providence, R. I.

(Continued on page 15)

ELECTRONIC VOLTMETERS*

Design and Application

WITHIN the past few years the electronic voltmeter has become widely accepted as one of the most simple, accurate and convenient instruments for measuring d.c. voltages in high-impedance circuits. Because of their wide use in the war effort, it is felt that a discussion of their design and applications will be of particular interest at this time.

Essentially, the electronic voltmeter differs from other vacuum-tube voltmeters in that it is designed to measure d.c. voltages only, rather than a.c., or both a.c. and d.c. By limiting its application to d.c. measurements, greater stability, accuracy and simplicity are readily obtained. These advantages are extended to a.c. measurements when the electronic voltmeter is employed in conjunction with a suitable rectifier. In addition, such instruments may be designed to serve as ohmmeters, as well as voltmeters, and in such applications enable measurement of extremely high resistances.

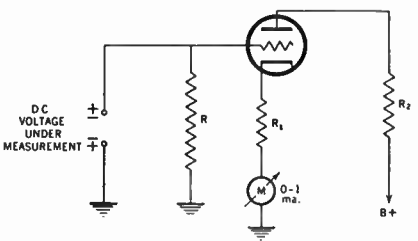

Fig. 1. Fundamental circuit of electronic voltmeter. Meter in cathode circuit indicates cathode current.

Fundamental Circuit

The fundamental circuit of one of the simplest types of electronic voltmeters is shown in Fig. 1. The meter in the cathode circuit of the triode indicates the cathode current. When a negative d.c. voltage is applied to the grid, the current decreases; when the grid terminal connects to the positive pole of the voltage source, the cathode current increases. Thus the meter may be calibrated to indicate both the polarity and the magnitude of the d.c. voltage under measurement.

Now let us see what design considerations are involved in this simple circuit. First, to complete the grid circuit when the voltmeter is disconnected from the circuit under test, the resistor R must be used. A high resistance of the order of 10 megohms, is desirable, since the amount of circuit loading and the ohms-per-volt rating depend upon the value of resistance chosen. Thus, if R is 10 megohms and the meter is calibrated to read up to 5 volts, negative or positive, the sensitivity is equal to 2,000,000 ohms-per-volt. To duplicate this sensitivity using a microammeter and series multiplier, without the vacuum tube, would require a center-zero meter designed to deflect to full scale in either direction for a current of 2.5 microamperes. While such meters are available, they are costly and require considerable care in handling. By using the electronic voltmeter circuit, a relatively insensitive meter—full scale deflection for 1 ma.—may be employed to provide equal sensitivity.

Damage due to accidental overload of the meter may be guarded against in the design. R2 serves as a limiting resistor which prevents the plate current—and cathode current—from rising to extreme values should the applied positive grid voltage exceed the range of the meter. When the

* *By John H. Potts in "Radio."*

applied grid voltage is negative, the cathode current decreases, so the only effect of excessive voltage of negative polarity is to reduce the meter current to zero, so no damage can possibly result.

The use of the cathode resistor R1 provides degeneration so that greater

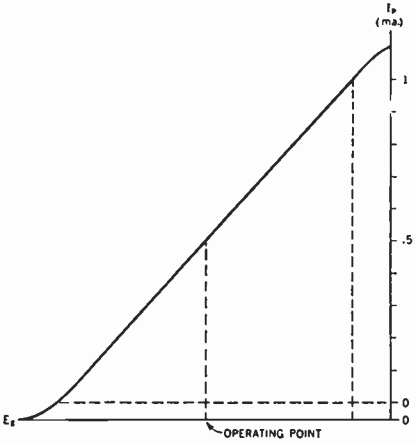

Fig. 2. Grid-voltage, plate-current characteristic of typical triode. Point is chosen which produces a plate current of 0.5 ma.

stability is secured. Minor variations in tube characteristics then have negligible effect upon the calibration of the meter. However, R1 must not be too high in value, otherwise the tube will function as a detector and alternating voltages in the circuit under test will produce a rectified voltage which will register on the meter. To avoid this, the cathode resistor is so chosen that the bias applied enables the tube to operate as a Class A amplifier; and the plate voltage is selected to meet the range of the meter chosen.

Operating Point

A grid-voltage, plate-current characteristic of a typical triode is shown in Fig. 2. Note that the operating point is chosen at a grid bias which produces a plate current of 0.5 ma. The voltages and resistances in the circuit are so chosen that this value of plate current occurs in approximately the middle of the straight portion of the Eg-Ip curve. Thus a 1-ma. meter will read half scale when the electronic voltmeter is operating, but with no test voltage applied. If this point on the voltmeter scale is calibrated as zero, then a 5-volt change in a positive direction will cause the meter pointer to deflect full scale to the right, while a 5-volt change in a negative direction will cause a similar deflection in the opposite direction. Since operation is chosen over a straight portion of the curve, the scale is substantially linear. Further, it should be noted that, though changes in tube-operating voltages will cause an increase or decrease in the meter current, they will not affect the calibration, provided means are employed to readjust the plate current to 0.5 ma.

Preventing Rectification

Since the operating point chosen is such that the deflection in a positive direction is substantially the same as that in a negative direction for equal applied voltages of opposite polarity, it follows that a.c. voltages within the operating range of the voltmeter will not be rectified provided they are of pure waveform. If, however, the alternating voltage applied is unsymmetrical in form, or of sufficient mag-

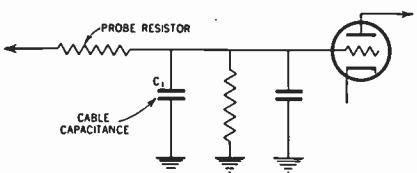

Fig. 3. Grid-circuit resistance-capacitance filter used to prevent rectification of a.c. voltages.

nitude to drive the bias beyond cutoff, rectification will result unless special precautions are taken. This is done by employing a simple resistance-capacity filter in the grid circuit, as shown in Fig. 3. In some commercial

instruments, the resistance is placed in the probe end of a shielded cable which plugs into the input terminals of the electronic voltmeter, as shown in Fig. 4. A small capacitance, of the order of .001 μfd. is placed across the input circuit. The grounded shield forms the balance of the capacitive section of the filter circuit. Sufficient attenuation is thus secured to render negligible the effect of a strong a.c. component in the d.c. reading of

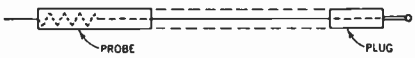

Fig. 4. In some designs the filter resistor is placed in the probe end of the shielded cable.

the circuit under test. It is, of course, not entirely essential that the cable be shielded, but this is an advantage in guarding against stray pickup, due to the high impedance of the input circuit. By placing the resistor R1 in the probe, the shielded cable capacitance is effectively isolated from the circuit under test and it becomes possible to measure d.c. voltages in tuned circuits without introducing any more loading than would result if the isolating resistor alone were shunted across the circuit under test. Since it is possible to make R1 1 megohm or more, measurements of d.c. in radio-frequency circuits are thus made possible without appreciable detuning effect.

Commercial Design

The complete circuit of a typical commercial design of electronic voltmeter, as employed in signal-tracing instruments of various types, is shown in Fig. 5. This circuit represents the design originally used in the RCA Rider Chanalyst. When used with the special cable and probe shown in Fig. 4, the ranges covered are as shown on the diagram. The filter condenser C1 is limited to a capacity of .001 $\mu\mu$fd. While a larger capacitance would provide greater attenuation of a.c. voltages arriving at the grid, it would also increase the time constant of the input circuit to the extent that the interval required for the charge accumulated on the condenser to leak off would become appreciable. During the period over which this charge is held, the voltage applied to the grid remains effective, so the meter pointer does not return to zero until this charge is dissipated. This results in sluggish action which interferes with the utility of the device. There is no appreciable time lag of this sort when the values shown in the diagram are maintained.

The 5,000-ohm rheostat shown in the cathode circuit is adjusted to give the required sensitivity for the particular tube chosen. When properly adjusted, the meter pointer will rise to half-scale deflection as soon as the tube has reached operating temperature, and will deflect to full scale for an input voltage of 5 volts (applied through the 1-megohm probe) in either a positive or negative direction. In the latter direction, the deflection is not quite full scale, since the tube bias does not reach cutoff. Once adjusted, this rheostat seldom requires change when replacement tubes are substituted, except when the replacement differs widely in characteristics from that for which the original calibration

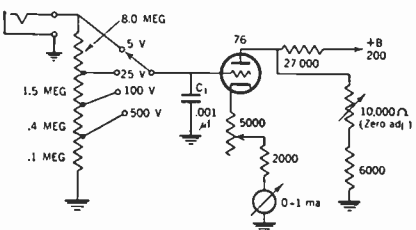

Fig. 5. Circuit of typical commercial design of electronic voltmeter, as used in signal tracing.

was made. Changes in power-supply voltage will affect the zero setting; compensation for these changes is made by readjusting the 10,000-ohm zero adjustment. The normal applied

plate voltage (at the tube plate) is 70 volts.

This design of electronic voltmeter has outstanding advantages in that it permits measurements of either positive or negative voltages without regard to the polarity of connection of the voltmeter. The ground connection of the electronic voltmeter is simply connected to the corresponding ground connection of the apparatus under test and the probe may be moved from circuit to circuit, without the operator needing to know the polarity of the voltage under test. Further, the magnitude of the voltage is likewise of small concern. For, if the voltmeter is switched to the 5-volt scale and the voltage across the circuit under test is as much as 500, no damage to the meter will result. The maximum current which will be produced in the cathode circuit of the tube, and which passes through the meter, is approximately 8 ma., which does not overload a 1-mil. meter enough to bend the pointer. And, when overvoltage of any magnitude in a negative direction is applied, the result is simply to reduce the meter current to zero.

Laboratory Design

These advantages are obtained at a sacrifice of the accuracy and readability which would result were the full scale of the meter to be used, and means were employed for reversing the polarity. While the advantages greatly outweigh the disadvantages when an electronic voltmeter of this design is employed for trouble-shooting in maintenance work, for laboratory applications a design utilizing the full range of the meter is undoubtedly preferable. Although the polarity of the voltage must be known, a reversing switch enables such adjustment with minimum effort.

A fundamental circuit of a laboratory type electronic voltmeter is shown in Fig. 6. This is a bridge arrangement in which V1 and V2 form two arms of a bridge and the sections of the potentiometer R3 supply the other two arms. When R3 is properly adjusted, the current flowing in the plate circuit of V1 is balanced out by that flowing in the plate circuit of V2. Thus no current flows through the meter circuit and the meter reads zero. If the plate voltage increases due to a change in line voltage, the plate current of each tube should increase in like degree (provided their characteristics are identical) and therefore the bridge remains balanced and the meter indication is unaffected. For the same reason, changes in heater voltage should likewise produce no

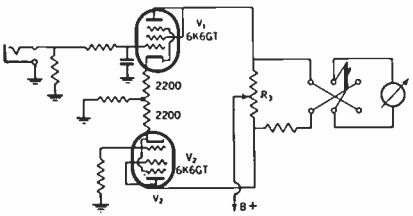

Fig. 6. Fundamental circuit of laboratory type electronic voltmeter of the bridge type, with V1 and V2 the two arms.

unbalance in the circuit. Practically, however, it is impossible to obtain conveniently tubes which match precisely, so some slight degree of unbalance due to changes in operating voltages must be expected. It is customary, in the more elaborate designs, to use some form of voltage regulator in the power-supply circuit, such as an Amperite or a special voltage-regulating transformer. An exceptional degree of stability is then secured.

It will be noted that V2 serves solely as a means of balancing out the normal quiescent plate current in the measuring tube, V1, when no external voltage is applied to the grid of V1. However, when the test probe of V1 is connected to a d.c. voltage source and a positive voltage is applied to its grid, the current in the plate circuit of V1 is increased and consequently the cathode voltage is likewise increased. The increase in plate current upsets the balanced state due to the bridge arrangement, causing a

meter indication. This reading is further increased because the unbalance due to the increase in the plate current of V1 is further augmented by a decrease in the plate current of V2 (due to an increase in cathode voltage). Thus the action is somewhat regenerative and greater sensitivity is thus obtained.

It might be pointed out that the need for the reversing switch to change the meter polarity might be avoided by interchanging the input leads and readjusting the meter to read full scale and deflect in reverse direction for negative voltages. While this could be done, it would be necessary to isolate all circuits from grounds, otherwise in measuring high negative potentials the case of the instrument would be "up in the air" and a severe shock might be thus obtained. Such contingencies are avoided when the case is grounded and the reversing switch is employed in the manner shown.

Resistance Measurement

The application of this device to the measurement of resistances is obtained in the manner illustrated in Fig. 7. A voltage E, sufficient to produce full-scale deflection of the electronic voltmeter, is applied through the calibrating resistor R to the input circuit of the electronic voltmeter. Since the input circuit resistance is extremely high in comparison with that of the calibrating resistor R, no appreciable voltage drop occurs. But when an unknown resistor, Rx, is shunted across the input circuit, as shown, the voltage applied to the electronic voltmeter input is reduced so that the input voltage Ei, resulting, is determined by the formula

$$Ei = E\left(\frac{Rx}{Rx+R}\right)$$

whence the value of unknown resistance producing any measured input voltage may be readily calculated.

It has been stated that the input resistance of the electronic voltmeter is extremely high in comparison with the calibrating resistor R of Fig. 7. In order to obtain such a condition, it is necessary to operate V1 and V2 far below their rated voltages. When the heater voltage is reduced to approximately 5 volts and the plate voltage is limited to 60 volts, and is further reduced by the cathode bias, lowering of input resistance due to ionization of gas particles is reduced to such degree that an input resistance of the order of thousands of megohms is readily realized. Thus it becomes possible to measure resistances of the order of hundreds of megohms in the manner shown in Fig. 7.

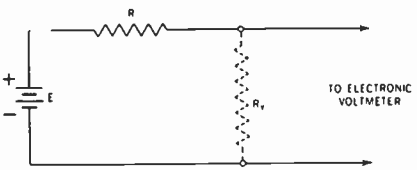

Fig. 7. Additional circuit employed with electronic voltmeter for making resistance measurements.

In multi-range ohmmeters, one annoying characteristic of most conventional designs has been the need to readjust the zero setting when switching from a high range to a low range, and vice versa. This is due to the change in current drain on the test battery, causing a varying voltage drop across the internal resistance of the battery. By using an electronic voltmeter in the resistance-measuring circuit diagrammed in Fig. 7, the zero setting does not require readjustment when switching from range to range. This is due to the fact that the drain on the battery is practically nil, except when the unknown resistor is under test, because the input circuit of the voltmeter presents a constant high impedance termination to the measuring circuit. However, it must be pointed out that some inaccuracy will result if a run-down battery is used in the circuit. Though the open-circuit volt-

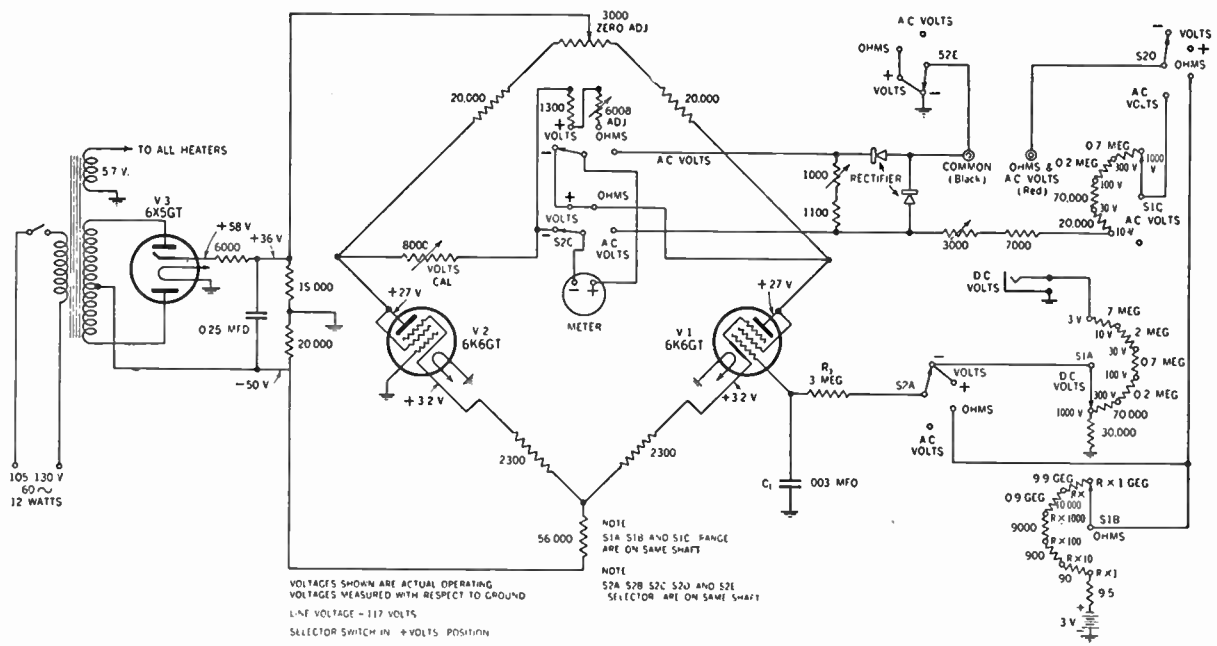

Fig. 8. Schematic of the RCA VoltOhmyst Jr. electronic volt-ohmmeter. It measures d.c. voltages in six ranges, a.c. volts in five ranges, and ohms in six ranges, as indicated in the diagram. Its effective range as an ohmmeter is from 0.1 to 1,000 megohms. Note that the cathodes of V1 and V2 are up in the air to the extent of 30 volts.

age remains substantially unaffected by the increase in the internal resistance of the battery, this resistance is added to that of the resistor under test and may cause serious errors when very low values of resistance are measured. For higher resistance ranges, of course, no trouble results. It is convenient to avoid this trouble by checking the condition of the battery by noting the reading obtained from a low value resistor of known resistance, say 10 ohms or less, and to replace the battery when the reading obtained deviates appreciably from the known value.

VoltOhmyst Jr.

One of the most widely known types of electronic volt-ohmmeters, incorporating most of the features described above, is the RCA VoltOhmyst Jr., the schematic of which is given in Fig. 8. This instrument measures d.c. voltages in six ranges, from 3 to 1,000 volts, full scale, with a constant input resistance of 10 megohms (this becomes 11 megohms when the 1-megohm resistance in the probe is added); a.c. volts (at 1,000 ohms-per-volt) in 5 ranges from 10 to 1,000 volts, full scale; and ohms in 6 ranges, from 10 ohms to 10 megohms, center scale. This means that the effective range as an ohmmeter covers from 0.1 to 1,000 megohms.

The meter used has a 200-microampere movement. This sensitivity is required because of the low operating voltages employed. Note that the heater voltage for the 6K6GT's is only 5.7 volts and the total output voltage of the high-voltage section of the power supply is only 60 volts. The effective plate voltage is less than this value, since the cathodes are "up in the air" 30 volts. These low operating potentials make for the high input resistance required in the ohmmeter circuit.

A polarity reversing switch, S2B and S2C, enables the input circuit to remain grounded regardless of the polarity of the voltage in the circuit under test. Note the additional filtration of alternating voltages present in the circuit under test is furnished by the resistance-capacity network composed of the 3-megohm resistor R3 and the .003 $\mu\mu$fd. bypass condenser C1. This network, in effect, forms the second section of a two-section filter, of which the first section is formed by the shielded cable capacity and the 1-megohm resistance in the test probe, which is used for all d.c. measurements. For a.c. measurements, the copper-oxide rectifier is employed in a conventional design. Since the tubes are not required for a.c. measurements, the instrument need not be plugged into the power line when testing a.c. circuits.

Radio-Frequency Measurements

While the copper-oxide rectifier is convenient for low-frequency measurements, the utility of the instrument is increased if some means for making r-f. measurements is made available. A simple vacuum-tube rectifier which will serve the purpose is diagrammed in Fig. 9. A unit such as this may be built up in a shielded can, which may be made quite small if the tube chosen is of the acorn variety, such as the 955. The leads to the electronic voltmeter from the rectifier carry only d.c. and may therefore be quite long

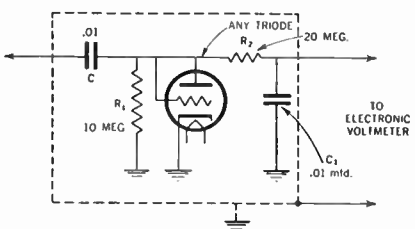

Fig. 9. Simple vacuum-tube rectifier circuit which may be added for the purpose of making r.f. measurements.

without causing difficulties. The a.c. component is filtered out by the resistance-capacity network, R2-C1.

It should be particularly emphasized that the input resistor of the

electronic voltmeter must be open-circuited when this rectifier is employed, otherwise the sensitivity of the instrument will be appreciably reduced. The "contact" potential of the rectifier will produce a reading on the electronic voltmeter, even when no a.c. voltage is being measured, but this may be taken into account when calibrating the instrument for a.c., which must be done in any event. The scale will be fairly linear and the readings will be proportional to the positive peak of the voltage being tested. This will cause no error in measuring sine waves, but inaccuracies will result if complex waves are being measured. For higher voltage ranges, where the sensitivity must be reduced, the input circuit of the electronic voltmeter may be used in the normal manner, using the range switch and voltage divider resistors just as for measuring d.c. voltages. For the higher voltages, the increase in output voltage of the rectifier will be essentially proportional to the magnitude of the voltage being measured, so the readings will follow a linear scale.

THE RADIO TRADING POST

(*Continued from p. 6*)

FOR SALE — New Reading chain hoists. Spur gear, ball bearing. 3 ½-ton, 8' lift, $70 ea.; 3 1-ton, 8' lift, $90 ea.; 2 2-ton, 9' lift, $140 ea.; 3 3-ton, 10' lift, $180 ea.; 2 5-ton, 12' lift, $280 ea. 20% off. R. Bertolette, 505 Astor St., Norristown, Pa.

WANTED — Small 2 or 3 tube AC-DC radio (headphones or speaker). Give full description. L. LeClere, 312 W. Wabash, Carthage, Ill.

TRADE OR SALE — K&E polyphase duplex Trig slide rule, like new, perfect condition. Also have a Bell 16mm. movie camera. Want 12-inch P.M. speakers of 15 watt continuous rating. What have you. Melvin Cohen, 1025 East 2nd St., Duluth, Minn.

FOR SALE — Triplett master analyzer oscillator and tube tester series 1200 to 1230. Will not sell separately. Sidney Goldhor, 833 49th St., Brooklyn, N. Y.

TRADE — QST 1926-1930, good 5 inch slide rule, Micrometer, 8 Bliss electrical engineering books, Vibroplex with case, code oscillator in case, condenser checker. Want good 10" slide rule, Reflex camera or what. Percy Ott, 507 Juniper St., Quakertown, Pa.

WANTED — Superior 1130, or Superior 1230 or Readrite Triplett, or any other cheap all wave signal generator. Willing to pay $10 down for one. Oscar's Radio Service, Merrill, Iowa.

SELL OR SWAP — Supreme 89 Series Tube Tester; Precision Electronometer, Series 500 Tube and Condenser Tester both factory modernized. Test latest tubes. Want good short wave receiver. Will also pay cash for one. Oliver F. Klein, 2235 N. 39th St., Milwaukee, Wis.

WANTED — Rider's Manuals 1 to 12. Must be in good condition and with index and supplements. Will pay cash. Gillespie Radio Service, O'Neill, Neb.

FOR SALE OR TRADE — 2 high fidelity Lincoln De luxe 12 tube all-wave receivers, range 15 to 550 meters, complete with heavy Jensen type M-20 12 inch speakers, separate power packs and consoles, 5 double tuned I.F. transformers, nickel plated show chassis and all new tubes plus spare tubes, everything in perfect operating condition. Original cost $300 net, sell for $45 and $60 for sets and $10 and $15 for cabinets. Want Chanalyst, Signalyst, Volt Ohmist, Jr., 12 Rider's Manuals. Henry Bal, 20 South 13th St., Newark, N. J.

WANTED — Cheap all wave signal generator for $5 or $6. Superior 1130-S or the like. Also want data, diagram, and directions, etc., on Superior Allmeter AMR. Will pay cash for signal generator. Oscar's Radio Service, Merrill, Ia.

SELL OR SWAP — Supreme 89 series counter type tube checker; Precision 500 series tube tester. Both recently factory rewired to tubes. Double-barrel shotgun. Will sell or trade for National NC 100X, HRO senior, Super-Pro SX28, or Hallicrafter set. Oliver F. Klein, 2235 N. 39th St., Milwaukee, Wis.

TRADE OR SELL — Weston 590 battery operated R.F. and 400 cycle A.F. oscillator. Nat'l SW3, tubes, 8 coils continuous from 1.7 mc to 23 mc, has HRO dials, excellent condition. With or less pack—2.5 or 6.3 volt tubes. May be used on batteries. Make offer or trade list. Bob Eubank, 1227 Windsor Ave., Richmond, Va.

WANTED — Clough-Brengle; Graphoscope No. 127 C-B No. 130 A-C Bridge; C-B No. 131 Universal Speaker; C-B No. OMA C-B No. 88-A V.T. Voltmeter; C-B No. 185 Unimeter Will pay cash. Must be in good condition. Hall's Radio Service, Cor. Eighth and Pine St., Camden, N. J.

WANTED — Hanoria Ultra Short Wave generator, Model U.S.D. 2711. Must be very reasonable. Supreme Model De Luxe Tester, No. 585, in good condition. Voltmeter, 300 volts, millimeter 0-100. Have—Majestic 90's. What am I offered. Goldstone Radio, 1279 Sheridan Ave. Bronx, N. Y.

WANTED — Volt-ohmmeter Precision 830 or equal in working or easily repairable condition. State cash price and condition, type. Globe Radio, 106-10 New York Blvd., Jamaica, N. Y.

SELL OR TRADE — Bogen Model WR Wireless Remote Control, Controller, tubes, brand new. Interested in high fidelity transformers (audio) like Thordarson T15A74, 90A04 or equivalent. Best offer takes remote control or what have you. Kensington Sound Service, 517 E Wildey St., Philadelphia, Pa.

SELL OR SWAP — One Jewell 3 inch bakelite cased A.C. voltmeter; scale reads 0-4-8-16-160-800 v. Only 4 and 160 v. have multipliers built in. A1 condition. One model 24E Audak Microdyne pickup, Hi-impedance, brown and gold finish. A1 condition. Best offer takes them or what have you in high fidelity audio transformers. Thomas Slack, 517 E. Wildey St., Phila., Pa.

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