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No. 4

CORNELL-DUBILIER ELECTRIC CORP.
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THERMIONIC RECTIFIER CIRCUITS*

(Continued from last issue)

Eight-Tube Bridge Rectifier

An eight-tube bridge rectifier using receiving-type tubes is shown in Fig. 7. The output data for this circuit, when type 80 tubes are employed, are given in Fig. 8. A maximum output

different voltages, a Variac supplies the plate transformer.



High-voltage bridge rectifier capable of delivering 0.25 amp at 2500 v with eight type 80 tubes. The Variac being adjusted here is connected across the primary of the plate transformer.

of 0.450 amp instead of 0.250 amp is possible if 5Z3 tubes are used instead of type 80 tubes. Both filament and plate transformers are needed for this circuit, and for experimental use at

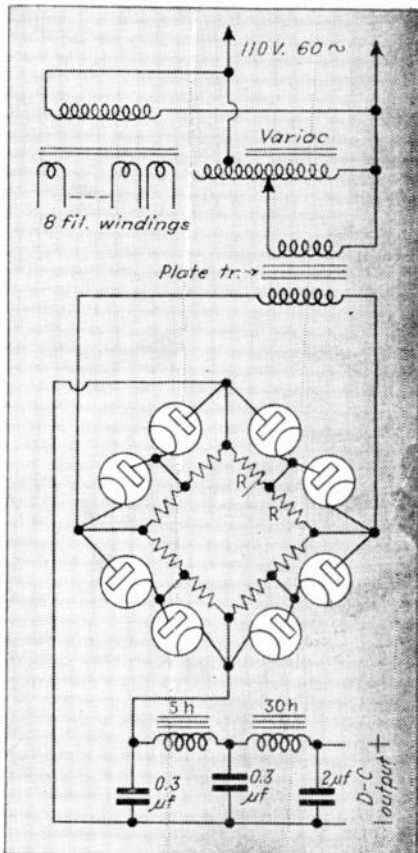


Fig. 7. — High-voltage bridge rectifier circuit, using eight receiver-type tubes (type 80 or 5Z3) to provide maximum direct voltage of 2500 v with ample current for cathode-ray tube applications and experimental laboratory use.

* By *Lieut. Richard C. Hutchcock, U.S.N.R.*, in "Electronics." The assertions herein are the private ones of the writer, and are not to be construed as official or reflecting the views of the Navy Department or of the Naval service at large.

The filament transformer must be insulated for 5,000 volts both to ground and between the various filaments. If type 80 tubes are used, the rating of each of the eight windings is 2 amp at 5 v. Usually such windings can be overloaded, however, for the 5-v, 3-amp filaments of 5Z3 tubes. Tubes 4 and 5 may be connected in parallel to a single secondary of a filament transformer having a double current rating.

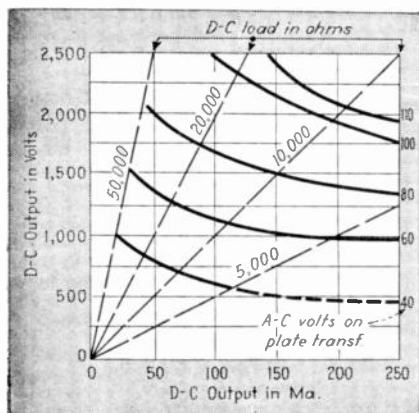


Fig. 8.—Operating characteristics of high-voltage bridge rectifier circuit of Fig. 7.

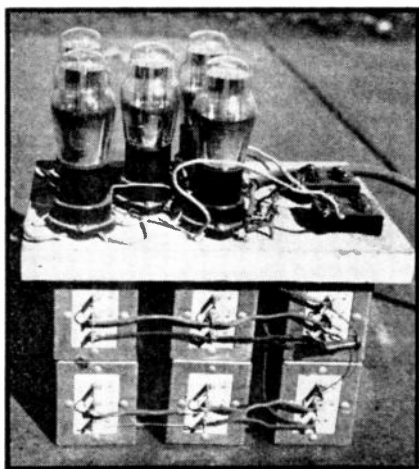
While it is normally quite safe to apply plate and filament potentials simultaneously to vacuum tubes, it is perhaps better for this high-voltage device to light the filaments with the Variac set at 0 volts for the plate transformer primary. The primary voltage can then be increased until the desired output is reached. A radio-type transformer is used, the secondary being a 2,000-v winding with a center tap which is not needed for this circuit.

An essential part of the circuit of Fig. 7 is the use of eight resistors, R, which parallel each rectifier tube. These are 0.5-meg, 2-w carbon units. They serve the important function of dividing the back emf evenly among the tubes. In the forward direction those resistors are largely shunted out by the conductance of the tubes.

Output characteristics are shown in Fig. 8. The dashed lines indicate load resistances of 5,000 to 50,000 ohms. The curved lines are the a-c voltages which are impressed on the primary of the plate transformer as indicated. For instance, with 80 v a-c impressed on the primary, this curve shows that an output of 150 ma at 1,500 v is available with a 10,000-ohm load.

The weight of the eight-tube bridge rectifier assembled as shown in the photograph is 98 lb. All capacitors are oil-impregnated paper units rated at 3,000 v.

The eight tube sockets may be mounted on an insulating ring in the center of which is the filament transformer, allowing convenient, short leads. To be safe at the potentials used, auto ignition cable is suggested. Isolantite rods support the insulating ring from the metal panel on which all components are fastened.



Experimental model used in the development of the half-wave, full-wave doubler, and half-wave doubler circuits. Each of the cans underneath the mounting board is a 4- μ f paper capacitor, oil-impregnated with capacitance tolerance of ± 10 percent. Various combinations of these were used during the test runs.

(Continued on page 15)



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WANTED—Pocket type VOM. Describe fully. State price. H. C. Dexter, P.O. Box 262, Princeton, N. J.

FOR SALE—Complete radio engineering library and I.R.E. copies for 1939-43 complete. F. E. Herman, 4820 W. Hutchinson St., Chicago, Illinois.

WANTED—Buy a .303 Savage rifle in good condition. Have many tubes in 1½ v. d.c. and 2½ v. a.c. to sell or trade. Roberts Radio Service, St. Louis, Michigan.

WILL TRADE—New Bosch amplifier, never unpacked, with tubes. Good foundation for phone amplifier. Want direct reading a.c. oscillator, VOM, or what have you. George C. Elwood, 90 Ocean View Ave., Santa Cruz, California.

WANTED—All kinds of radio test equipment, analyzers, etc., tools and magazines. Quote what you have to sell and best cash prices. H. B. Howell, Anna, Texas.

WANTED—Good radio man, with either military exemption or disability discharge, a golden opportunity to right man. Southern Radio Service, 124 E. Jackson St., Thomasville, Ga.

FOR SALE—2 3½ ft. Racon horns, 2 Racon baby units, 2 Y adapters, 1 unit feeds 2 horns; 1 ABC Unameuter tube tester, 1 genemotor, 6 v. input, 300 v. 100 m.a. output. Make an offer. Geo. S. Oakford, 19 Greenwich St., Hempstead, N. Y.

FOR SALE OR EXCHANGE—17 watt P. A. system, two enclosed speakers, 1 floor stand, 1 desk stand Webster mod. 417, almost new. 1 G.E. Tungar double charger for batteries, 1 Flexograph to make your own letters and advertising material. Arlington Radio Service, 158 Jamaica Ave., Brooklyn, N. Y.

TRADE—3 tube ac-dc short wave receiver, 6 plug-in coils, 15-550 meters, for Hallicrafter "Sky Buddy" or Howard 35A. Will pay difference in cash.

WANTED—Triplet 666 or 666H pocket multimeter. State condition, age, and price. Manuel A. Perry, 39 Winter St., Wakefield, R. I.

WILL PAY for instruction book and tube chart or a copy of same for a Confidence special tube tester made by Apparatus Design Co. Fred Wittich, 7202 Juniper Valley Rd., Middle Village, N. Y.

FOR SALE—Rider's Chanalyst, complete, like new, \$100. Rider's Manuals, 1-12 inc., like new, \$90. Cash only. Edgar Dragon, Hotel Osmund, Melrose 76, Mass.

WANTED—50L6 6T16 or any other hard to get types of radio tubes. Will pay cash or swap with other parts. Jack Rudie, 4725 28th Ave. South, Minneapolis 6, Minn.

WANTED—ac dc VOM. Prefer one that also measures mfd. Describe instrument fully. Robert L. Wesson, D-8 1/2 11th St., Trion, Ga.

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TRADE—2 Triplett meters, Model 221, 0-250 mls, 0-100 mls, brand new. Green Flyer turntable, model A, new. 5 each 6SC7, 6SQ7, 6x5, 6K7, 6L6; 3 2A4G, 2 2051, 1 954, 1 955 in original cartons, new. Want—3 or 5 in. oscillograph and RCA Voltohmyst in new condition. Will pay difference. Henry Kadas, 763 Blair Ave., St. Paul, Minn.

FOR SALE—Series 910 Ser. No. 9975 Precision tube checker, A-1 condition, \$26.00. ATR 32 v.d.c. to 110 v.a.c. inverter, 100 w. cap., slightly used \$10.50. C. R. Crever, St. Joseph, Minn.

ROTARY CONVERTER—Janette Type CA-20, 115 v.d.c. 2 amps. 110 v.a.c. 1 amp. Highest cash offer takes it or what have you to swap? Courtney Electric Co., 5104 Germantown Ave., Philadelphia 44, Pa.

FOR SALE—1940 little used SX24 the Hallicrafters famous communication receiver, \$75.00 cash F.O.B. or half cash balance C.O.D. Fred W. Rudolph Service, Stryker, Ohio.

FOR SALE—Tubes, old and new. Send card for numbers and price. 2SA6, 27, 37, 199 and 99, etc. Taubers Radio Shop, 516 S. Cicero Ave., Chicago, Ill.

WANTED—Inexpensive .22 cal. bolt action rifle. Charles Carlton, Jr., 156 Mitchell Court, Rantoul, Illinois.

FOR SALE OR TRADE—Comet Pro beat osc. short wave receiver, Amperite ribbon mike, Underwood Standard portable typewriter, 2 v. 8 tube farm radio, late model, size 9 1/2, child's ice skates. H. B. Losey, 102 Hancock Ave., Jersey City, N. J.

WANTED—All kinds of radio equipment, also Rider's Manuals, tools and tubes. State price and condition. Gilbert Radio Shop, 1296 Sheridan Ave., Bronx 56, New York.

WANTED—Rider's Manuals, vols. 3 thru 12, in good condition. Peter F. Stefaniak, 216 Springfield St., Chicopee, Mass.

FOR SALE—RCA type 955 acorn tube, brand new \$2.50. Also 6A7, 25Z5, 25Z6: 75, 6Q7GT; 6SK7GT/G; 26; 12F5GT; 1C5GT/G; 1R5; 80. Want new 6, 12 or 32 v. vibrator transformer. Robert Freed, 1140 Fifth Avenue, New York 28, N. Y.

FOR SALE—Power level meter, Weston, model 695, 2 in. C.R. oscillograph, RCA, 151-2. Supreme radio analyzer, model 339. August Friel, 35 Humbert Street, Princeton, N. J.

WANTED—1 boom mike stand or boom attachment; P.A. equipment, turntables, receiving tubes, small radios, 33/78 turntable. Ed Monahan, Shawomet, Rhode Island.

FOR SALE—Hallicrafters transmitter, 40, 20, 10 meter bands, band switching, like new, complete with tubes and one xtal covering three bands. \$135.00 includes packing. V. P. Ternullo, 43 Robblee Ave., San Francisco, Calif.

FOR SALE—R.M.E. 69 receiver with D. B. 20 and speaker. Mounted on a gray rack panel, 19"x16", in one unit. \$225 F.O.B. N. Y. C. Write do not call. Sterling Electronic Labs, 521 W. 131 St., New York City.

FOR SALE—32 v.d.c., adjustable speed, G. I. Flyer phono motor, heavy duty, less T.T. Also have standard 6 ft. Par metal relay rack for 19" panels. Make offer. C. W. Schecter, Scenic Drive, R. No. 2, Muskegon, Mich.

WANTED—0-1 milliammeter, 14 in. 25 watt speaker and good carbon mike. **FOR SALE**—1936 model "Sky-Buddy," fair condition. John E. Thiel, 742 No. Denver, Tulsa, Okla.

FOR SALE—1 Wells Gardner recorder and play back unit with pre amplifier built in, suit case type, cash or trade for good test equipment. Recorder new, A-1 condition. Lovett's Radio Shop, P. O. Box 143, Newland, N. C.

WANTED—Reflex camera, as Wirgin, Arcoflex, etc. Must be in good condition. Have brand new Superior tube checker, many tubes, new filters, also cash. Gerald Samkolsky, 527 Bedford Ave., Brooklyn, N. Y.

SWAP—Aerovox 95 L.C. checker for Sprague Telomike standard. Louis Bauernfeind, Box 125, Hortonville, Wis.

(Continued on page 11)

AM DETECTOR OPERATION*

Characteristics of diode detectors as amplitude demodulators Effect of AVC network and other circuits across the diode load

The operation of detection is used in every type of radio receiver. A great deal of the service work done on today's sets is in connection with detector systems. Many alignment problems are handled by observing current or voltage changes in the detector circuit. Much of the audio distortion originates here, and in the majority of sets, the volume control which is a source of many service jobs, is in the second detector circuit. Most receivers develop the AVC voltage in the second detector. From this partial list of the actions of second detectors, it is apparent that a thorough understanding of the types, functions, and tests is of real importance.

Fundamental Job in AM

The number one job of a detector is to separate the music or speech signal from the carrier signal. Thus, it is the reverse of modulation. To understand what is necessary to demodulate two signals, it is important to understand what the transmitter did in combining the RF carrier and the audio signal.

Several methods of amplitude modulation are employed by broadcasters, plate modulation being one of the more common types. The RF carrier voltage developed by other stages of the transmitter is fed to the Class C stage which is to be modulated. The power output of this stage is proportional to the square of the instantaneous plate voltage on the tube. The audio signal which is to modulate the RF carrier is amplified and is introduced in series with the high voltage supply to the RF amplifier. The plate voltage of the RF amplifier will then be the algebraic combination of the direct voltage of the power supply and the audio signal voltage. The modulation is thus a process of varying the amplitude, and consequently

the power, of the RF carrier in accordance with the audio signal.

AM Side Bands

A mathematical analysis of modulation will show, for a single sinusoidal modulating tone, that the RF output wave will have three components, one of which is the RF carrier voltage with its original amplitude, and two other components, with half the carrier amplitude times the modulation factor. One of these two components has a frequency of the carrier plus the frequency of the modulating signal, and the other component has a frequency of the carrier minus the modulating signal frequency. The modulating factor is defined as the ratio of the maximum deviation of the modulated wave envelope from the unmodulated wave, to the unmodulated wave. This statement is explained by referring to Fig. 1. The voltage measurements on the signal and carrier waves are peak values. For sine waves, the RMS value is 0.707 of the peak.

The power in a modulated wave is equal to the power of the carrier plus the power in the side bands. The side band power is proportional to the square of the modulation factor and has a maximum value, for 100 per cent modulation, of one-half of the unmodulated carrier power. Thus, a station delivering 50 kw. at 100 per cent modulation has a carrier strength of $33\frac{1}{3}$ kw., and the other $16\frac{2}{3}$ kw. is in the side bands. Since the side bands contain the only information, it may be seen that a high percentage of modulation is desirable.

Diode Detectors

The simplest and most common detector, or demodulator is the diode rectifier. It performs the job of recovering the information transmitted

* Courtesy "Radio Retailing Today."

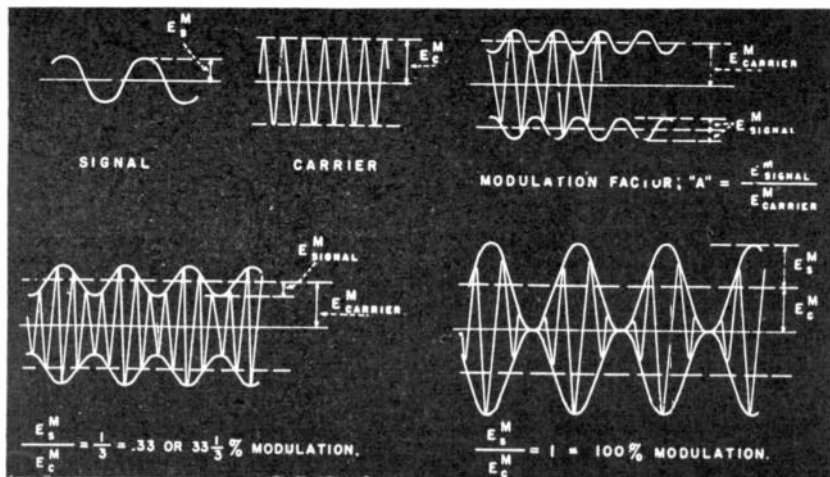


Fig. 1—Components of amplitude modulated carrier with single frequency sine wave. Percentage modulation is ratio of peak of audio voltage to peak of RF carrier voltage. Upper and lower side bands are not represented by any parts of modulated wave.

in the side bands by rectifying the complete signal and developing a current which is proportional to the original modulating signal. The carrier and its side-band components are bypassed across the load resistor by a capacitor small enough to prevent the high frequency audio signals developed across the resistor from being shunted out.

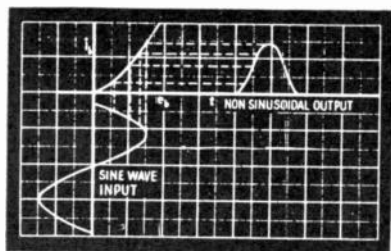


Fig. 2—Square law characteristic of diode for small signals causes distortion. Note flaring of curve near zero axis.

Two fundamental types of operation for diodes depend upon the amplitude of the signal applied to the circuit. Square-law detection takes

place when the signal amplitude is small and the plate current of the diode is confined to the curved portion of the characteristic near the cut-off point. The "square law" refers to the portion of the tube's current-voltage curve through which the current increases as the square of the applied voltage. Thus if three voltage readings were 1, 2, and 3, the corresponding current values would be 1, 4, and 9.

Due to the curved section of the characteristic, distortion results. If the operation is perfectly "square-law," the distortion will be the introduction of a second harmonic which can be as great as 25 per cent of the fundamental audio signal. The effect of the square-law characteristic on a sine wave is shown in Fig. 2.

Linear Detection

Linear operation, which is the desired detection characteristic, is approximated for large input signal amplitudes. The output voltage across the load resistance is practically proportional to the input carrier voltage. This linear operation for ordinary

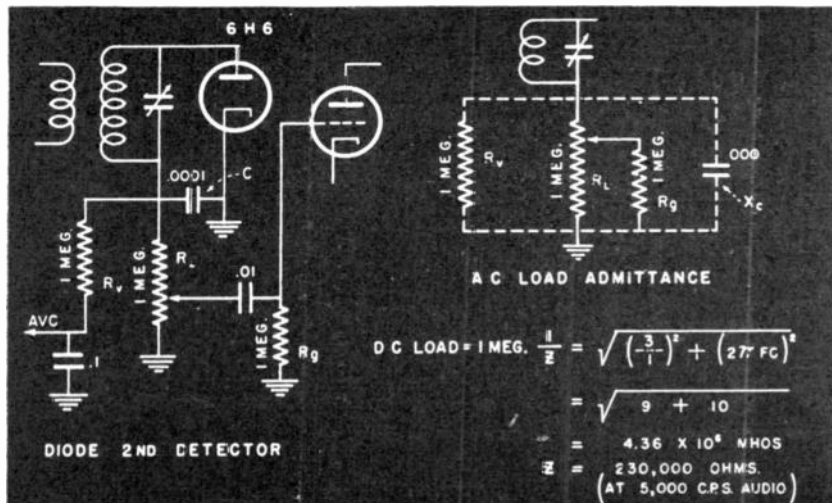


Fig. 3—Single diode half-wave detector with AVC connection and audio volume control. For higher audio frequencies, the AVC resistor and volume control are effectively in parallel with the diode load resistor reducing its value as shown in calculation.

diode detectors takes place on carriers with a 10-volt or higher peak value. Power detection, as this type of operation is called, is usually realized in broadcast sets.

So far we have discussed the diode rectifier under the conditions of a constant carrier voltage. When the carrier is modulated, the instantaneous carrier amplitude is varied at the frequency of the audio signal. It can be seen from Fig. 1 that the greater the percentage of modulation, the lower the instantaneous carrier amplitude falls during portions of the modulating cycle. Thus for 100 per cent modulation, the carrier is actually reduced to zero amplitude once each modulating cycle. It is obvious that the type of diode operation varies from linear on the maximum carrier peaks to "square law" on the very low carrier levels encountered in high percentage modulation. This shifting from one type of operation to the other introduces some distortion at high levels of modulation.

Another serious cause of distortion in diode detectors is the shunting effect

of the (1) audio amplifier grid resistance, (2) the AVC network, (3) "magic eye" circuit, (4) and the RF bypass capacitors across the diode load resistor. These circuit elements do not affect the DC load to the diode circuit, but are in parallel with the load resistor when an audio signal is present.

25 Per Cent of DC Load

Fig. 3 shows the circuit for a typical diode second detector with the various load elements. With a constant carrier input (no modulation) the only load element in the output circuit is the resistance R_L . The capacitor C is not a part of the load even though it is in parallel with R_L because C is infinite to the DC present with constant carrier amplitude.

As soon as the carrier is modulated, an alternating signal will be present across R_L . The other components shown at the right of Fig. 3 are effectively in parallel with R_L for audio currents because of the negligible impedance of the AVC bypass and the audio coupling capacitors. The load on the diode is thus reduced from its

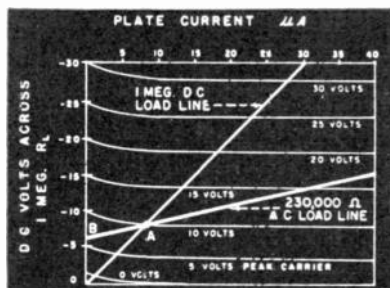


Fig. 4—Rectification characteristic of 6H6 diode with 1 meg. DC load line and 230 M ohm audio load line. Peak carrier voltage is 10 volts.

DC value of $R_L = 1$ meg. to the parallel combination of R_v , R_g , R_L , and X_c . The calculation of a typical circuit is shown in the diagram and applies when the volume control is set at maximum. The shunting effect of

R_g is most serious at the maximum volume level and is negligible if the control is about one-fifth or less than maximum. The shunting due to the capacitor C will increase with the audio frequency.

The AC load at 5,000 cycles for the diode is 230,000 ohms, roughly one-fourth of the original DC load of 1 meg. The effect of this new load impedance might at first be thought to be merely a reduction of useful output delivered by the circuit. The effect is much more serious because the result is high distortion on high levels of modulation. Examination of Fig. 4 will help to show what happens.

Limits Demodulation

Fig. 4 is the dynamic characteristic of a single 6H6 section. Assuming a 10-volt peak carrier and the 1 meg. DC load, the DC developed by the circuit is about -8 volts. This is

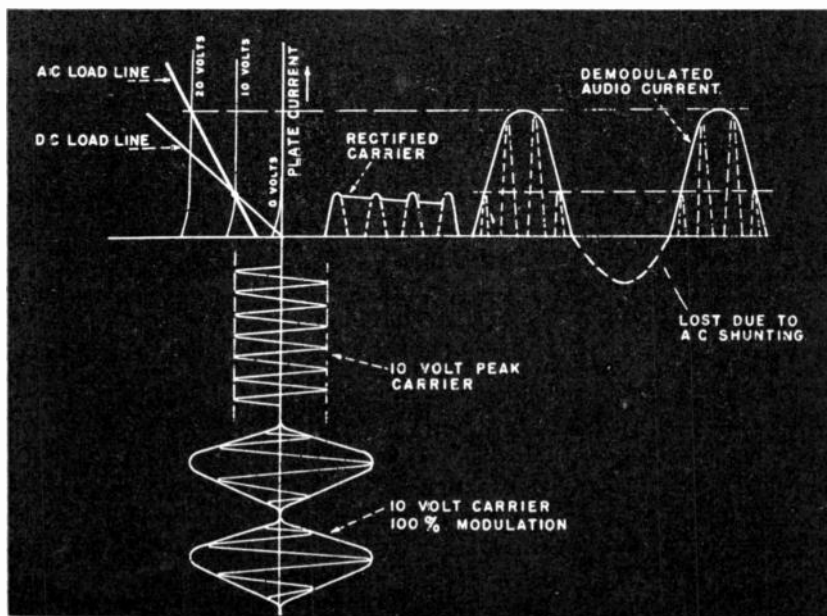


Fig. 5—Lower value of AC load line causes clipping of negative peaks of modulation signal causing distortion. For the example shown, maximum degree of modulation that could be received without distortion is 25 percent.

determined by the intersection of the load line and the 10-volt carrier line at A. If the carrier is now modulated at say 100 per cent, point A would shift up along the 1 meg. load line to the 20-volt peak carrier line and down to the 0-volt line, if the load to the diode circuit remained at 1 meg. during modulation. However, the load does change, and a new load line must be constructed. In the case being discussed, the AC load at 5,000 cps is 230,000 ohms. This load line is constructed so as to pass through A since the same 10-volt peak carrier is assumed. The new AC load line does not pass through zero as does the DC 1 meg. line, because tube conditions must return to point A when modulation stops.

It is obvious from the slope of the AC load line that cut-off plate current occurs at approximately —7 volts. This means that modulation over 30 per cent will produce distortion.

In other words, the carrier amplitude can only be modulated from 7 volts to 13 volts, or 30 per cent before the minimum carrier peaks would be cut-off. The percentage modulation which the diode can handle without distortion is approximately $R_{ac}/R_{dc} \times 100$. This is usually the most serious distortion in detection. In the particular case cited, the worst conditions were used. At frequencies less than 5,000 cycles, and volume control setting less than maximum, much less distortion of high percentage modulation would result.

Some compensated diode circuits employ a positive bias on the detector plate to shift the point A up or down the DC load line in relation to the strength of the carrier. By proper adjustment, the AC shunting effect may be made almost negligible.

Fig. 5 shows graphically how the two load lines act on an unmodulated carrier and on a modulated carrier.

THE RADIO TRADING POST

(Continued on page 6)

FOR SALE OR TRADE—One new ac-dc wireless, phono-oscillator. Uses one 37 and one 6-A7 tube. Want construction kits, meters, and test equipment. Geo. Heard, 26 N. Bellevue, Memphis 4, Tenn.

FOR SALE — New Independent lathe chucks. 4 jaw. Cash. 5 18", \$73.60 ea. 5 16" \$55.60 ea., 4 14", \$43.45 ea., 5 12", \$38.30 ea., 3 10" \$33.45 ea. R. Bertolotto, 628 Astor St., Norristown, Pa.

SELL OR TRADE—1 RCA phono oscillator, new, unused; 1 15", 20 w. dynamic speaker, with power pack and 500 ohm output trans. Want tubes or small ohm meter. What have you, what do you want? John Arnold, Bluffs, Ill.

FOR SALE—9 tube Hallcrafters Super-Skyrider in good shape, complete with crystal filter, tubes and built in spkr. Set is about 1937 model. What am I offered? A. Ignal, 850 E. 156th St., New York 55, N. Y.

FOR SALE OR TRADE—Triplett free point tester, Model 1220-B and Jewell 199 Analyzer. Want fishing and photographic equipment, or radio parts. Joe's Radio, 2224 W. Belden Ave., Chicago 47, Ill.

FOR SALE OR TRADE—One Howard No. 437-1 Amperite mike with acoustic compensator, one Amperite contact mike. 5" and 12" P.M. speakers. Lots of Jewell, Weston and Hickok meters. Interested in South Bend, or similar metal bench lathe or 5 h.p. garden tractor. George Foster, Rt. 1, Burghill, Ohio.

FOR SALE—Keuffel & Esser 7 instrument drawing set; square type instruments; catalog number, Anvil N 999. Dexter Kurs, 4525 45 St., Long Island City 4, N. Y.

FOR SALE—Kolster console radio K-45, almost new, push button and remote cable, list \$600, give offer. Halson and Philco table models, 5 and 6 tube. Want Riders Manuals, 1 to 8. Louis A. Goldstone, 1279 Sheridan Ave., Bronx 56, New York City.

FOR SALE—1 Garrard magnetic pick-up \$7.50, 1 Racine Webster mag. \$4.50, 1 Amertran D-11 audio \$8.00, W.E. 4-A pickup, arm, scratch filter and all wiring diagrams, curves, equalizer \$10.00. Lots of used tubes, metals and glass for sale. Write for list. Herman Mc-Masters, 1800 S. 26th St., Terre Haute, Ind.

FOR SALE—Mallory 4 amp. dry charger, new rectifier \$12; RCA station allocator, new \$20; G.M. Delco auto radio for 1937 Oldsmobile \$20. Paul Capito, 637 W. 21 St., Erie, Pa.

FOR SALE—Howard 450A communications receiver, 13 tubes, 550 kc to 68 mc. (including 5 meter band using separate di-pole) matching enclosed P.M. speaker, has crystal filter, signal "R" meter, B.F.O., etc. Excellent condition and performance. Best offer takes it C.O.D. L. F. Carini, 246 Wolcott Hill Rd., Wethersfield 9, Conn.

FOR SALE—Ghirardi's Radio Physics \$4; Triplett 1210A tube tester, panel worn, \$13.50; used and new chokes, radio parts and magazines. T. Wojciechowski, 2837 Fulton St., Brooklyn 7, N. Y.

FOR SALE — Set signal tracing probes, Sterling 0-10 ma. 2 filter chokes, 350 ma, 3 tube wireless mike, Detrola radio, auto radio, combination, etc. Want Keystone projector 82 or 75. Harry Kay, Rt. 2, Box 255, Imlay City, Mich.

FOR SALE—Selenium rectifiers new 2½ amp. 50 v. maximum load, easily rebuilt for other current or voltage requirements, bargain. M. C. Bursma, 105 Avondale, Jackson, Mich.

WANTED FOR CASH—Riders Manuals 1 to 13, Superior utility tester, also any good condenser analyzer. State price. Must be in A-1 condition. All inquiries answered. H. Ilderton, 945 Madison St., Albany 6, California.

FOR SALE OR TRADE — Tube testers, Weston 676, Superior 1280; Superior signal generator, 1230, Triplett free point tester 1220, 199 Jewell portable analyzer, has 2 3" meters, also tubes, and radio parts, speakers. **WANT**—outboard motor, 1.5 to 5 h.p., or fishing equipment. Joe Sventek, 2224 W. Belden Ave., Chicago 47, Ill.

WANTED—Will pay from \$2 to \$3 for crystal or magnetic pickup, with or without needle. Elton Wolff, R. 2, Box 45 A, Wishek, N. Dak.

FOR SALE — Pr. 8 power binoculars (French), Model 91 Supreme analyzer, Model 85 Supreme tube tester with all adapters, Supreme pocket meter Model T MV-97-A RCA signal generator, Vols. 1, 2, 3, Riders Manuals. F. R. Magee, R. F. D. 2, Greenwich, N. Y.

WANTED—Will pay cash for a good tube tester, signal generator or condenser tester. George Pidherny, 3415 31 Ave., Astoria, N. Y.

WANTED—One Hickok 510X tube and set tester or one of the following: Precision 920C, Radio City 802, Supreme 599. High price paid. Chester C. Manho, 20413 Marx, Detroit 3, Mich.

WANTED TO BUY—Used recorder cutting head with mounting, state make and price. Need tubes and good tube tester, state price and make. John M. Moore, 80 N. Cleveland St., Memphis, Tenn.

FOR SALE—Used radio equipment including Weston meters, test equipment, books. Send for list. Want Riders Manuals, vols. 8 to 13. C. F. McCracken, Hughes Park, Bridgeport, Pa.

WANTED — Electrical and radio books and magazines. Must be cheap and in good condition. State title, author, edition. John A. Seaman, Gentry, Ark.

FOR SALE—One model 400-B Supreme Diagonometer, complete, with carrying case, \$45; one batt. operated oscillator, aluminum case, built up with Natl. vernier cond. and dial, \$10; Riders Manuals, vols. 2, 3. T. C. Raynes, Box 239, Oxford, Kansas.

WANTED—Recording equipment with extra turntable, complete or in part. Good signal generator and any type modern shop equipment. State make, model, lowest cash price first letter. Logan Radio Shop, 1759 Logan Ave., San Diego, Calif.

WANTED — Latest model tube tester, meters and tubes: 12SK7, 12SA7, 12SQ7, 12SR7, 80, 35S5, 45S5, 12K7, etc. Homer Mays, 507 Shady St., Fort Worth, Tex.

TRADE—DM-36 converter gray, like new, made by RME, works with any receiver that tunes to 10,000 kc. Scale has 28 to 30 and 56 to 60 megacycles. Want Meissner deluxe signal shifter. Elmer Shafer, 2889 E. 116th, Cleveland, Ohio.

WANTED—20 new or good used 50L6GT radio tubes. Can use 35L6GT type also. Send me your price. Clyde W. Wimer, Ellwood City, Pa., R. D. No. 2.

WANTED—Riders Manuals, 7 to 12 incl. with index. State price and condition. Clyde W. Wimer, Ellwood City, Pa., R. D. No. 2.

FOR SALE OR TRADE—QST more or less complete from Oct. 1919, some issues missing, "R9" Dec. 1933-Dec. 1935, "Radio" Dec. 33-May 1940, some 1941. Radio News, Pop. Science, etc. Chas. F. Lohner, 157 Logan St., Bedford, O.

SELL OR SWAP—Merriam-Webster 3000 page complete Dictionary, with reference history of the world; also J. H. Morecroft's "Elements of Radio Communication." Cash or swap for 8mm movie projector, late model. Ted Gasiarowski, 209 Giffin Ave., Mt. Oliver 10, Pa.

WANTED—Wattmeter or appliance tester. State range, make, and price. Brook's Electric Shop, Twin Bridges, Montana.

WANTED—Used Instructograph or Teleplex with tapes and instructions. State condition and price wanted. Have 17 Wabash No. 0 photoflash bulbs, cash or what have you. Jos. R. Kukura, P. O. Box 91, Genoa, Ill.

WANTED—One late model tube tester, one voltohmmeter, no special make, list price first letter. Burkitt's Service Station, Inc., 112 Meacham Avenue, Park Ridge, Ill.

WANTED—Will pay cash for copy of revised instruction booklet on Simpson Model 220 Rotoranger, this tube and set serviced modernized to check ban-tam and 117 V tubes. P. P. Miglin, 846 West Drive Woodruff Place, Indianapolis 1, Ind.

WANT—Condenser and filter block, part no. 3887 for Majestic radio, model 20, either new or used, must be in good condition, state price. Albert Beilfuss Radio Service, Route 1, Box 404, Harms Road, Glenview, Ill.

WANTED — Dynamic condenser tester, Solar model QCA or CE or Aerovox 95, also beat frequency oscillator. Phone Crawford 3571, address 1546 S. Christiana Ave., Chicago, Ill. Philip D. Padva.

WANTED—Dynamotor input 6 v., output 400 v. at 200 ma. State make, condition and price. T. Clarke, 603 Birch St., Fall River, Mass.

WANTED—We are in urgent need of a Hallcraft "Sky Champion" S-20R. Will pay immediate cash. Please contact Paul Kuzmak, 67 Buckland Road, Wethersfield 9, Conn.

WANTED—Garrard BBC turntable; plate transformer 500 v. or more, 200 ma; filter chokes 200 ma or more; permanent point pick-ups or heads only. A. H. Taylor, Sound Div., Naval Research Lab., Washington, D. C.

SWAP—A complete DeForrest Radio and Electrical Course and Television Course for a late NRI Course, or what have you. Must be complete. Have 0-5 Triplet m.a. meter in new condition. Want 35Z5 and 35L6 tubes. John R. Naples, 87 Tod Lane, Youngstown, Ohio.

FOR SALE — 100 Dumore fractional h.p. motors with gear reduction 60/1 ratio. Originally made for aircraft equipment, 24 volts dc type. Will sell in any quantity. N. K. Stover, 1357 Hill St., York, Pennsylvania.

FOR SALE—1 Webster 78 rpm recorder and playback chassis in aeroplane-luggage type case, crystal cutter, featherweight crystal pickup, all new \$40.00. 1 Radex loop for use on signal generator, new \$3.50, 1 American D7T mike \$12.50. Myron E. Kluge, 1913 Montrose St., Los Angeles 26, Calif.

FOR SALE—One OCA Clough Brengle signal generator, one Superior 1230 signal generator, Meissner Analyst 10-1154. All these instruments are in perfect condition, perfect calibration. J. F. Martin, 142 Ralph Avenue, Brooklyn 33, N. Y.

CASH WAITING—For a 110 v Victrola playing arm. James Wilson, 437 Ar-leth St., Terre Haute, Ind.

FOR SALE OR TRADE — Modern Radio Servicing, 2nd edit. Radio Trouble Shooters Handbook, 1st edit. M-Y Encyclopedia, all for \$5, or trade for set of short wave coils, 4 prong, 140 mmfd cond., or other short wave parts. H. R. Lauffer, R. D. No. 1, Export, Pa.

WANTED—Audax microdyne relayed flux type magnetic pickup head. Advise output impedance, description and price. R. L. Brackett, P. O. Box 733, Opa Locka, Fla.

WANT — Tube checker, tube tester, new Imperial tube tester, model 200; model 310 tube tester series 3 and 4. Sound and test equipment, radio parts, Triplett model 1213 1612 and Superior model 1240 tube tester, Philco tube tester. Burkitt's Service Station, Inc., 112 Meacham Ave., Park Ridge, Ill.

NEED TUBES—Use available tubes thru adapters. Build your own in 15 mins. for 10c each. Send for instructions on substitution for practically any tube. Hundreds listed. Post paid for \$1.00. C. E. Ranniger, Gowrie, Iowa.

WANTED—One Aerovox, Model No. 95, L/C checker. Wire price and condition. Standard Piezo Company, Carlisle, Pa.

WANTED—Superior utility tester. Will trade complete new phono motor turntable, pickup, also table model radio in playing condition minus cabinet. Write list small parts. Geo. H. Hague, 6 Carver St., Fall River, Mass.

WILL SWAP—One pair homing pigeons for one 1A7GT, 1H5GT or 12SA7 or any 12 volt series tube. You pay special low express charge on birds. Chas. L. Culley, Melville, Louisiana.

WILL SWAP — Copies of ARRL, defense edition "Amateur Handbook," "Learning the Radiotelegraph Code," "Course in Radio Fundamentals" and "License Manuals." Have big stock, what have you? Chas. L. Culley, Melville, La.

WILL SWAP—Vibroplex original "bug" for a small candid camera using 35mm or roll film. Irvin A. Weinman, 25 South Mills St., Madison, Wis.

WANTED—Signal generator, must be in good condition, send full particulars. Also want Precision 845 VOM. S. G. Hernandez, 120 S. Alazan St., San Antonio, Texas.

WILL BUY—Good signal generator, ac operated, or a MRI (mfg. by Readrite) battery operated s.g. and multimeter combination. T. H. Clark, 1821 N. Caroline St., Baltimore 13, Md.

WANTED—All purpose set tester and analyzer, 920C, 920PM or Precision model 844L. Will trade for movie camera 16mm Kodak, or a 16mm Kodak projector, all automatic threader, like new. If swap not desired, give cash price. M. J. Difini, Executive Division, General Post Office, Brooklyn 1, N. Y.

SALE OR SWAP—Speedwriting, speed-typing, Dearborn system, complete course, nine beautiful books, self-instruction, fine dictionary. Best offer cash, books or gear. Arpad A. Fazakas, 1 Cathedral Ave., Nutley 10, New Jersey.

CRYSTAL RADIO EXPERIMENTERS — Write for the latest information on new electronic uses for the crystal which operates loudspeaker. Amazing modern hook-ups. Leslie Hulet, 29 East 39th St., New York City.

FOR SALE —Brand new Turner mikes, U9S dynamic, CX crystal, CD dynamic, mostly with 20 ft. cord, 3 mike stands, 2 floor, 1 banquet style, 1 2 speed portable phono-turntable, in portable case, 1 78 rpm Green flyer motor, phono turntable, in case, 3 Utah 12" PM speakers, brand new. John J. Spankowitz, 239 N. 9th St., Allentown, Pa.

WANTED—Converter from 110 ac 60 cycle to 110 ac 25 cycle, rotor type. Arizona Radio Service, 1007 Grand Ave., Phoenix, Arizona.

TRADE—12SQ7, 12SK7, 35L6 tubes for 45Z5, 14Q7 or 7A8 radio tubes. Will sell Model 333 Simpson tube checker, never used, will check all tubes to date, \$30. Carl Oing, 213 W. Emerson, Princeton, Indiana.

WANTED TO BUY—30-70 watt public address system complete or will buy 30-70 watt amplifier. Carl L. Oing, 213 W. Emerson, Princeton, Indiana.

WANT — Most Anything in radio test equipment, Riders 11, 12, and 13. Have car hot water heater and clock, professional type barber's hair clippers, shears, razors and strop, marcelle irons and heater, or cash. Glenn Watt, Chanute, Kans.

WANTED — 510X dynamic mutual conductance tube and set tester, or any up-to-date tube tester. Send make, model, price cash. Bert Buckner, 280 W. Central 3, St. Paul, Minn.

WANTED TO BUY—Supreme audiolizer, Model 562. Must be in good working order. Write Home Radio Service, Plymouth, Wis.

FOR SALE—Jewell No. 198 set analyzer (no case) ac and dc milli. meter \$11; Jewell 135 v. dc meter, Thordarson No. 70R21 power transformer (new). Books all new, The Meter at Work, Rider, Radio Physics Course, Ghirardi, Modern Radio Servicing, Ghirardi, Audel's Radioman's Guide, Corona Typewriter No. 3, case, \$3.50. William Rasmussen, 91-37 184th St., Jamaica 3, New York.

FOR SALE — New Shure 70H mike and cord \$15.50 post paid or will trade for hand printing press. Campbell Radio Service, Ann Arbor 6, Mich.

SELL OR SWAP—Teleplex code practice set, variable speed, ac motor, Cutting Head, phones, key, 30 rolls, some uncut in leatherette case, \$40.00. Want ac generator, gas driven 250 w. or over, must be A-1. J. Starr's Electric Radio Shop, 16 Grove St., White Plains, N. Y.

FOR SALE OR TRADE — Oscilloscope, model airplane engines, radio tubes and other parts also 1 new 10" motor scooter wheel and tire. Franks Radio Lab., New London, Iowa.

WANTED — Timing condenser gang complete for both Majestic models 70-61 please state condition and price. Art. Comstock, 108 Main St., Winsted, Conn.

WILL PAY CASH—For Gernsback Radio Circuit Manuals before 1941, prefer Vol. 7 especially. Also want Riders Manuals 7, 8, 9, 10, 11, give prices, and must be in good condition, write at once. W. S. Crooks, P.O. Box 94, Kent, Ohio.

FOR SALE OR SWAP—Have new Model 666-H Triplett ac-dc VOM and Silver-tone tube tester, will sell for best offer, or will swap for good communications receiver or 8 mm. projector. Paul B. Kuzmak, 67 Buckland Road, Wethersfield 9, Conn.

SWAP — Royal portable typewriter, in brand-new condition. Trade for good radio test instrument. Only good instrument wanted. Superior Film Service, 126 Fourth Ave., Paterson 4, N. J.

WANTED—A multimeter or volt-ohmmeter in good condition, popular make. Also NRI course late issue. Will swap for or cash. Have sports equipment and one 0-10 dc milliammeter, radio parts, tubes 26, 27, 45, 80, 1A7GT. Charles Lentz, 2300 Bronx Park E., Bronx 67, New York.

FIRST CLASS Licensed Radio Engineer desires position in B.C. station in New England, age 31, draft 4F. Commercial operator since 1930, ham since 1928. Desire post with responsibilities. \$50 week minimum. Bernard Seamon, Wiscasset, Maine.

FOR SALE—Teleplex, ac-dc, built in audio oscillator, leatherette carrying case, special tapes. Excellent condition, \$35.00 cash. L. F. B. Carini, 246 Wolcott Hl. Road, Wethersfield 9, Conn.

WANTED—Riders Manuals, 6 to 13 inclusive. State condition and price. Albert Rosen, 247 S. 58 St., Philadelphia, Pa.

FOR SALE—RME 69 receiver, excellent condition, 550 kc to 32 mc, BFO, AVC, crystal filter, band spread, and 8 in. PM speaker to match. Best offer over \$100 takes it. P. J. Freed, 1226 Broad St., Newark, N. J.

WANTED—Silent moving-picture projector, 500 watts or more, (for large size picture.) Must be perfect and cash price right. Similar to Universal P 500 projector. Give complete details. H. Brown, 520 Pen Argyll St., Pen Argyll, Pennsylvania.

FOR SALE—25 w. P.A. amplifier, good condition, w/2 mike and 1 phone input. Have Amperite PGH chrome dynamic mike w/ new type unit, chrome floor stand. Low price. C. W. Schechter, Scenic Drive, Rt. 2, Muskegon, Mich.

FOR SALE OR SWAP—1936 Dodge or Plymouth custom radio, like new. Univex 8mm. camera in original packing. Want radio tubes, record players, pickups, or cash. Leo Stein, 7 Monroe St., Mount Vernon, N. Y.

WANTED—Phono motors, crystal pickups, midjet radios, tubes (all 5 v. rectifiers, all tubes 12 v. or over). Give full details and prices. Leading Radio Service, 114 East 3 St., Mount Vernon, N. Y.

FOR SALE—Triplett 1671 vibrator tester, Oxford universal test speaker, tubes, used all tested are: 26, 27, 36, 56, 58, 38, 79, 71A, 45, etc., radio correspondence course. Royce Saxton's Radio Shop, Rt. 1, Pontiac, Illinois.

WANTED—Superior Model 1280 combination tester with cover. State condition and lowest price. Delbert Shaffner, Deepwater, Missouri.

WANTED—G. E. JFM-90 FM converter; Hallcrafters S-29 communications receiver, radio test equipment. George G. Chandler, Assoc. Eng. U.S.N., P.O. Box 73, Back Bay Sta., Boston 17, Mass.

URGENTLY NEEDED for WERS use—National one-ten receiver. State condition and price in first letter. C. W. Schechter, Scenic Drive, Rt. 2, Muskegon, Mich.

FOR SALE—Western Electric motor KS 5161 1/5 h.p., 1200 r.p.m., 110 v., 60 cycle, type Y 33B. One motor generator: set, 110 v., 200 m.a. d.c. by Electric Specialty Co. One a.c.-d.c. 110 v. turn table motor. Levines Radio Shop, 625 Main St., Worcester, Mass.

FOR SALE—R.C.P. Model 663 electronic multimeter in original carton, used once. Best offer takes it. 36 watt amplifier, astatic microphone, model T-3 with stand and cable. Norman Jacobson, 1697 Andrews Ave., Bronx, New York City.

WANTED—Used record recorder in good condition with blanks, a.c. voltage meter for cash or trade books, stamps, magazines, radio parts, etc. Joseph Mayer, 556 Vineyard St., Bethlehem, Pa.

WANTED—Radio receiving tubes, all types, advise best discount off list. Can use P.A. and sound equipment. Radion Co., 148-29 Jamaica Ave., Jamaica 2, N. Y.

WANTED—Portable typewriter, camera and camera equipment (still and motion), record player, binoculars.

SWAP—New, hard to get tubes, for other new, hard to get tubes. Also have new RCA Jr. recorder. Al's Radio Service, 14 N. Milton Ave., Baltimore 24, Md.

Thermionic Rectifier Circuits

(Continued from page 4)

A miniature switchboard-type voltmeter and ammeter may be connected in the d-c output. A 5-ma (full scale) meter calibrated in volts is used in series with an external multiplier of eight 2-watt, 75,000-ohm units. This voltmeter and series resistor also serve to discharge the stored energy in the filter capacitor when the circuit is OFF.

References

- (1) Waidelich, D. L., The Full-Wave Doubling Rectifier Circuit, Proc. I R E, 554-558, Oct., 1941.
- (2) Waidelich and Gleason, The Half-Wave Voltage-Doubling Rectifier Circuit, Proc. I R E, 535-541, Dec., 1942.
- (3) Waidelich, D. L., Voltage Multiplier Circuits, Electronics, p. 28-29, May, 1941.
- (4) Gage, S. H., and Gage, H. P., Optic Projection, p. 68, Comstock, Ithaca, N. Y., 1914.
- (5) RC14 Receiving Tube Manual, p. 26, P. 169, RCA Mfg. Co., Harrison, N. J. 1940.
- (6) Ref. (5), p. 254.
- (7) Ref. (5), p. 26, Fig. 33.
- (8) K. Henny (Editor) "Radio Engineering Handbook," p. 501, McGraw-Hill Book Co., 3rd Ed. 1941.

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