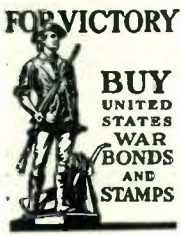
Vol. 10 JANUARY, 1945 No. 1

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

Sec. 562, P. L.&R.
U. S. POSTAGE
PAID
So. Plainfield, N. J.
Permit No. 1



Mr. George M. Beale
130 25th Ave.
San Francisco, Calif.

Cornell-Dubilier Appoints New Sales Manager

K. C. Burcaw has been appointed sales manager of the Cornell-Dubilier Electric Corporation, Jobber Division. Mr. Burcaw brings to his new position a wealth of sales experience.

As a young man, he gained his first knowledge of salesmanship with the P. Lorillard Tobacco Company in Cleveland. L. K. Wildberg, of that city, interested him in the electrical appliance field. Mr. Wildberg, now president of Radiart, soon had Burcaw calling on appliance dealers and after eight months he was Sales Manager for the New York District.

In 1924, Mr. Burcaw together with Mr. Wildberg, incorporated the Radiart Company. After that he represented them in the Michigan, Indiana, Kentucky, Chicago territory. In 1934, he returned to Cleveland to create a Radio Jobber Division for the Radiart Corporation. And as Sales Manager he not only sent sales volume to new highs, but was also instrumental in making the Radiart line an important factor in the jobber field.

Mr. Burcaw is now rounding out plans which will bring to his work at C-D the same intensive selling and aggressive merchandising that marked his successful years at Radiart. Between jobber calls he intends to continue his aviation and "ham" hobbies. He holds the rank of flight officer in the Civil Air Patrol and is the communications officer of his squadron. He has taken part in numerous plane-to-ground two way radio experiments.

CATHODE FOLLOWER CIRCUIT*

Basic Relationship of Cathode Loaded Amplifiers Including Mathematical and Graphical Calculations for Voltage.

The use of a vacuum tube as an impedance transformer is well known. The basic circuit for this type of operation is the same or similar to that of Fig. 1. The output voltage E_o of the vacuum tube stage appears across the parallel combination of a load impedance and cathode circuit impedance. These impedances may, of course, be simple or complex. The plate circuit of the vacuum tube is at ground potential as far as the signal current is concerned. This is accomplished by the low reactance capacitor C. One hundred per cent negative feedback is employed since the entire output voltage E_o is series opposing with the applied signal E_s. The available grid voltage E_o is, therefore, $E_s - E_o$.

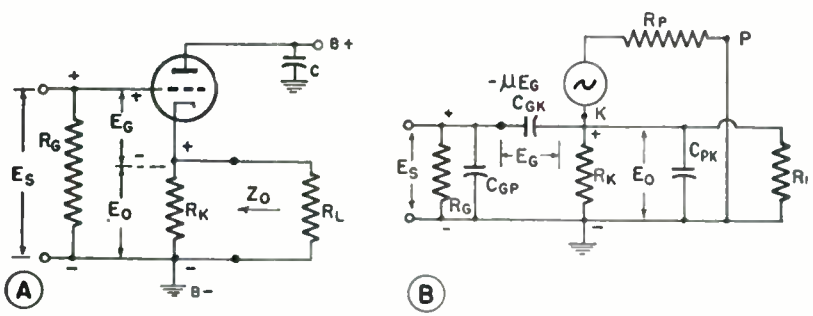


Fig. 1. Simplified circuit of cathode follower used as low output impedance voltage amplifier. Capacitor C grounds plate for all signals. Equivalent circuit at B.

The equivalent AC circuit for the conventional cathode follower stage is shown in Fig. 1B. The inter-electrode tube capacitances are shown connected across the various sections of the circuit. The grid to plate capacitance C_{GP} is shunted directly across the input terminals, along with the series combination of the grid to cathode capacitance, C_{GK}, and the plate to cathode capacitance, C_{PK}. The input circuit loading is due primarily to C_{GP} and would, therefore, be less severe when a pentode or other screen grid tube is used. In the output circuit the plate to cathode capacitance is across the load but since this is usually a low impedance circuit the effects on frequency response would be small.

In the following formulas given in Fig. 2 and Fig 4, the load impedances are considered to be simple, that is, pure resistance and the effects of the inter-electrode capacitances are ignored. Where the frequencies involved are such as to make the inter-electrode capacitances as well as other straight L and C combinations important, the complex impedance combinations can be employed in the equation in place of the resistance components given.

The amplication or voltage gain of

* *By William Moulic in "Electronic Industries."*

CATHODE FOLLOWER VOLTAGE AMPLIFIER EQUATIONS

OUTPUT

$$E_O = E_S \cdot \frac{\mu' Z}{R_P' + Z} \quad (1)$$

$$E_O = E_S \cdot \frac{G_M Z}{1 + G_M Z} \quad (1A)$$

(FOR PENTODE)

WHERE

$$\mu' = \frac{\mu}{1 + \mu}$$

$$R_P' = \frac{R_P}{1 + \mu}$$

$$Z = \frac{R_K \cdot R_L}{R_K + R_L}$$

GAIN

$$\alpha = \frac{E_O}{E_S} = \frac{\mu' Z}{R_P' + Z} \quad (2)$$

OUTPUT IMPEDANCE

$$Z_O = \frac{R_P' \cdot R_K}{R_P' + R_K} = \frac{R_P \cdot R_K}{R_P + (1+\mu) R_K} \quad (3)$$

LOAD CURRENT

$$I_L = \frac{E_O}{R_L} = E_S \cdot \frac{\mu' R_K}{R_P' (R_L + R_K) + R_L R_K} \quad (4)$$

TRANSFER ADMITTANCE

$$Y_T = \frac{I_L}{E_S} = \frac{\mu' R_K}{R_P' (R_K + R_L) + R_K R_L} \quad (5)$$

MATCHED IMPEDANCE

WHERE

$$R_L = Z_O = \frac{R_P \cdot R_K}{R_P + (1+\mu) R_K}$$

$$I_L = \frac{G_M \cdot E_S}{2} \quad (6)$$

$$E_O = E_S \cdot \frac{G_M \cdot R_L}{2} \quad (7)$$

$$\alpha = \frac{G_M \cdot R_L}{2} \quad (8)$$

G_M = TRANSCONDUCTANCE IN MHOS

R_P = AC PLATE RESISTANCE OHMS

μ = AMPLIFICATION FACTOR

Fig. 2. Gain, output impedance, current, and voltage relationships for linear operation of Fig. 1.

the cathode follower circuit, as given in Fig. 1, is always slightly less than 1. This is obvious from examination of the circuit wherein the voltage E_s must always be greater than E_o by the grid voltage E_G. As a voltage amplifier, the cathode follower will produce the same gain as a hypothetical tube having an amplification factor $\mu' = \mu/(1 + \mu)$ and a plate resistance $R_p' = R_p/(1 + \mu)$. The output voltage E_o is given by equation 1 in Fig. 2. Where the plate resistance R_p is large in comparison with the parallel combination of R_K and R_L the voltage output is given by equation 1A. The effect of the 100 per cent feedback used in cathode followers is to reduce the apparent amplification factor to approximately 1 and to divide the AC plate resistance of the tube by a factor $1 + \mu$.

The output impedance of a cathode follower stage is that impedance looking back toward the tube from the load R_L. This value is given by equation 3 in Fig. 2. The general expressions for the load current I_L flowing through the load R_L and the transfer admittance Y_T are given by equations 4 and 5. In the case of a matched impedance where R_L is equal to the output impedance Z_o, the load current, output voltage and the stage gain are given by equations 6, 7, and 8 in Fig. 2.

The cathode follower is also useful as an output stage or power amplifier particularly since the load impedance normally used in output stages is low. When the cathode follower is used as a power amplifier to drive a dynamic loudspeaker, the law impedance which the speaker voice-coil sees

(Continued on page 7)

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.

URGENTLY NEEDED—Rider's Manuals 8 through 13; new, used, or any condition as long as no pages missing. prices must be reasonable. Buford Brown, Box 307, Trion, Ga.

WANTED—12SA7, 6A8. 25Z5, 12A8, 14Q7, 2 of each. T. B. White, Rt 7, Box 209, Jacksonville, 5, Fla.

WANTED—Philco, model 1841 auto radio for 1941 Ford, also FM tuner or parts, and Ford - McCullough Supercharger. Bill Matchett, P.O. Box 1563, Santa Ana, Calif.

FOR SALE—All types of electronic tubes, such as: cathode ray, acorn, transmitter, receiver, etc., supply limited. Send self-addressed stamped envelope together with your order for tubes. New list out late January. V. Kozma, 3104 Wilkinson Ave., New York 61, New York.

FOR SALE — Solar condenser checker, A1 condition, $15.00. Measures capacity and resistances. Dundee Radio Shop, Dundee, Mich.

FOR SALE—3 superhet 9 tube Brunswick radio chassis; Mod. 370 Majestic radio and spkr., Baltfeit Gillifian and Fada radio chassis, numerous other standard radios, RCA, Philco, Crosley, Colonial, Zenith. Louis A. Goldstone, 1279 Sheridan Ave., Bronx 56, New York, N. Y.

WANTED — Automatic record changer. Langstons Radio Shop, 703 Main St., Watertown, Conn.

FOR SALE—Early model GE tube tester in exchange for NRI or Sprayberry Radio Course. Can offer latest AC tubes in addition or cash. State age, condition and price. Albert Spector, 178 Cornell St., Roslindale 31, Mass.

FOR SALE OR TRADE—DC generator, 6 or 12 v. to 350 and 750 v.d.c. Just overhauled, new bearings & brushes. Interested in photographic or fishing equipment. Make offer. S. Wiseman, 114 N. Elmwood Ave., Buffalo 1, N. Y.

WANTED — Late N. R. I. radio course. Send information as to year and price. L. T. Hussin, 63 Miriam St., Valley Stream, N. Y.

SALE OR TRADE—Astatic X26 crystal recording head $12; Kwick Feed, No. 2, S. & R. mimeograph; Vensen 20w PM spkr., late model $15. Need analyzer oscillator a.c. or batt., pocket multimeter, 2" oscillograph. Describe. Stamp brings list. Robert Bargdill, Westboro, Ohio.

WANTED—One RCA Universal a-c bridge, type TMV-132-A. State condition, price. George E. Beggs, Jr., School Lane, Warrington, Pa.

FOR SALE—12 headless boys' figures, each with new shoes and socks. Especially made for infants' wear store (ages 6-8). Best offer takes all. Want C-D B-F 50, Solar BQC, Sprague Tel-Omike capacitor analyzers. Price and condition. Milton Maultasch, 535 Grand St., Brooklyn 11, New York.

SELL OR TRADE—Argoflex reflex F4.5 camera, case and color adapter. Will sell or trade, prefer test equipment. E. Schmitka, Apt. 4E, 1481 Shakespeare Ave., Bronx 52, New York.

FOR SALE—Two Philco auto radios $30 each; ¼ hp a.c. motor $12; portable auto generator tester, amps. and volts $12; new Stancor A jack de luxe $50. Paul Capito, 637 W. 21 St., Erie, Pa.

FOR SALE—4 tube regenerative set, 15-2000 m., ac-dc, complete with tubes, spkr., coils, etc. Metal cabinet, perfect condition, ideal for any use, can be adapted to batt. or 6v use. First check for $15 takes it. G. Samkofsky, 527 Bedford Ave., Brooklyn, N. Y.

FOR SALE — Solar condenser tester in excellent condition. Cap. range .0001 to 800 mfd. Res. range 50 ohm to 2 megohm. Price $35. Ted Hamilton, What Cheer, Iowa.

FOR SALE—Tubes 2 35, 2 57, 2 41, 2 56, 2 2A7, 1 4S, 1 53, 2 59, 6 58, 2 6B7, 3 6Z5, 5 12A5, 1 6D7, 1 27. List price over $48, Sell lot for $25. These have been in storage. Or will trade for good late tube tester, signal generator or volt ohmmeter. Mac Green, 5047 Washington Blvd., Chicago 44, Illinois.

WANTED — Rider's 10, 11, 12. Triplett 1175B or meter for same. Will sell new vibrators, 2 v., for GE model LB-530, $3.75 postpaid. OPA list for new Philco tubes 7A4, 7A7, 7B5, 7B6, 7H7, 7Y4. Dennis White, Stephenville, Texas.

WANTED—Cash for the following tubes: 35Z5, 25Z6, 117Z6, 25Z5, 80, 50L6, 35L6, 12SQ7, 12SA7, 12SK7, 1A7, 1N5, 25L6, 12K7, 3Q5, 6A8, 12A8 and other receiver tubes. Send list and prices. Joseph Conino, 103 Wentworth, Charleston 6, S. C.

FOR SALE — Webster 8" arm tangent crystal phono pick-up, GE induction disc phono motor, 10" TT, 50-60 cy, 110 v.a.c. Miller pre-selector 3-tube a.c. operated, 8-200 meter range; Howard commercial recv., mod. 430, 6 tubes, a.c., 5.5-42 megacycles. Pistol grip electric drill ¼" cap. Ask for prices. F. U. Dillion, 1200 N. Olive Drive, Hollywood 46, Calif.

FOR SALE—Weston 547 analyzer, ac and dc, 750 v. Will consider all offers. J. Hauswirt, 16 Jones St., Worcester, Mass.

FOR SALE—Webster type HB 59 P.A. system. Has 3 stage class B amp. with 20 w. output. 12" dynamic speaker, carrying case. Price $75. . Burcher's Elec. Store, 513 Main St., Honesdale, Pennsylvania.

SWAP—Rolleicord II camera with Zeiss 3.5, ER case, shade, 4 filters, speed gun, and electric exposure meter, for a good tube checker, VOM and signal generator. Prefer Precision make, consider all offers. M. York, 35 Charles St., Houlton, Maine.

WANTED—Will pay cash for Supreme Vedolyzer 560A; Supreme Oscillator 561; Jackson condenser tester 650A; Hickok zero current meter 210S. Any or all at reasonable prices in good condition. Give details and phone number. Olympic Appliances Co., 10745 Interlake Ave., Seattle 33, Wash.

WANTED—Two United Motors radio test panels, mod. 652. State price and condition. Urgently needed for war work. Erie Radio, 1401 State St., Erie, Pa.

URGENTLY NEEDED—Battery tester, prefer National Union counter type battery merchandiser. Will pay cash. Describe fully and price in first letter. David B. Bevier, 1400 Belleview Blvd., Steubenville, Ohio.

WILL TRADE—One new 12SJ7 tube for a May, 1944 issue of the C-D Capacitor. Also, will pay cash for issues of The Electrical Experimenter and Modern Electrics previous to 1918. J. T. Lipani, 157 Leverett St., Boston 14, Mass.

SELL OR TRADE — 35-mm sound films, features and comedies, will sell reasonably or swap for your sound prints. Want 35-mm portable sound projector. H. J. Barkholz, 13573 Northlawn, Detroit, Michigan.

SELL OR TRADE—New Knight code practice, oscillator, speaker, phone jack, ac-dc. G.H.Q. gas model engine, complete; RCA phono oscillator; Solar cond. analyzer, like new; 1 tube ac-dc amplifier, electric tatoo set. A. Penquite, Jr., 513 S. Fifth St., Marshalltown, Iowa.

WANTED — 2" F2.8 Tessar for a Contax camera, also 135 mm. F4 sonnar for same. 0-1 Mil. Weston 3" meter. Murray J. Douglas, Concord, Calif.

WANTED — Home recorder, semi-professional recording equipment, or recording motor. Preferably less amplifier. D. R. Marsh, 7 Cardinal Court, Audubon Village, N. J.

WANTED—Small type communications receiver by service man. Any make. Fair condition or otherwise. State reasonable price and description. Also tube checker. What have you? Harold M. Kirts, SAD3c, U.S.N.A.T.B., Solomons Br., Gunnery School Office, Washington, D. C.

(Continued on page 9)

Cathode Follower Circuit

(Continued from page 4)

looking back toward the stage provides a high degree of damping which improves overall performance.*

Fig. 3 is the cathode follower used as an output stage in which the output transformer T reflects the load resistance R back to the cathode circuit, this reflected load being shown as R_L. In the equivalent AC circuit of Fig. 3B, only the AC reflected load R_L is considered, losses in the transformer and so forth being neglected.

The power output from such a stage in terms of the signal voltage E_s, is given by equation 1, Fig. 4. The power output in terms of the voltage between grid and cathode E_g, is given by equation 2 and this is identical with the power output that

*Cathode Follower Output Stage, C. J. Mitchell—Wireless World, April 1944.

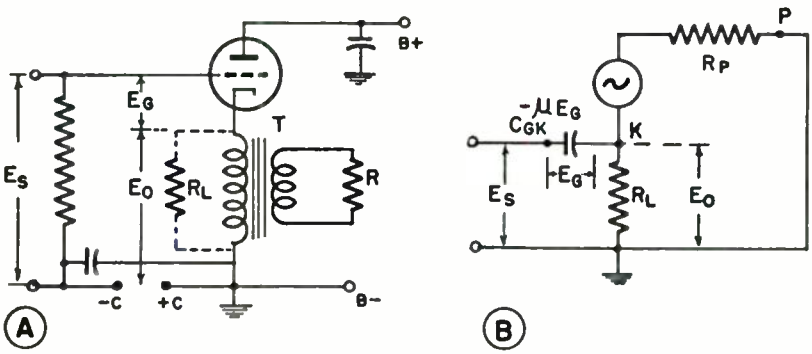


Fig. 3. The cathode follower as an output stage and equivalent circuit at B. Ideal components and linear operation are assumed.

CATHODE FOLLOWER POWER AMPLIFIER EQUATIONS

$$P_O = \frac{E_s^2 \mu^2 R_L}{[R_P + R_L (1+\mu)]^2} \quad (1)$$

$$P_O = \frac{E_G^2 \mu^2 R_L}{(R_P + R_L)^2} \quad (2)$$

$$P_O = \frac{E_s^2 \mu^2}{R_P (2+\mu)^2} \quad (3)$$

WHERE $R_L = R_P$

$$P_{O\,(MAX)} = \frac{E_s^2 \mu^2}{4 R_P (1+\mu)} \quad (4)$$

WHERE $R_L = R_P' = \frac{R_P}{1+\mu}$

$$\%\ \text{REMAINING DISTORTION} = \frac{(R_P + R_L) D}{R_P + R_L (1+\mu)} \times 100 \quad (5)$$

$$\%\ \text{REMAINING DISTORTION} = \frac{D}{2} \times 100 \quad (6)$$

WHERE $R_L = \frac{R_P}{1+\mu}$

D = ORIGINAL DISTORTION

Fig. 4. Power output equations for linear operation of cathode follower.

would be delivered by a tube operating in a conventional manner, that is, with the load impedance in the plate circuit and no feedback. This is apparent since the tube does not know what type of circuit it is operating in and, therefore, for the same voltage E_G, it will deliver the same output in any circuit other things remaining the same. As a cathode follower the load resistance R_L can be made equal to R_p in which case the power output is given by equation 3 in Fig. 4. If equation 1 of Fig. 4 is differentiated with respect to R_L, and equated to zero, it is found that the maximum power is delivered, for a given signal voltage E_s, when $R_L = R_p/(1 + \mu)$. This is in keeping with the general idea that a load resistance is equal to the internal resistance of the generator for maximum power when it is recalled that as far as the input signal E_s is concerned the tube has an internal plate resistance of $R_p/(1 + \mu)$.

The conventional plate characteristic curves given in tube data books can be used to predict performance of the tube as a cathode follower. If the plate voltage scale of the particular characteristic in question is divided by a factor of $1 + \mu$, the resultant curves are those of a hypothetical tube whose amplification factor $\mu' = \mu/$

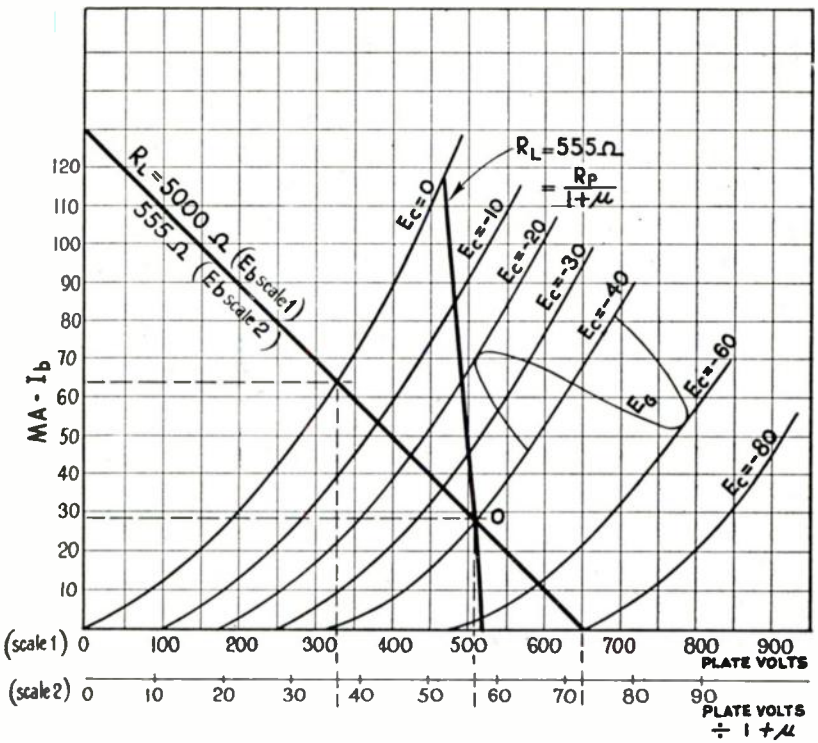


Fig. 5. Plate characteristic of type 801 showing method of dividing plat voltage scale by $1 + \mu$ to give dynamic operation characteristics of cathode follower. Static value must be taken from normal scale.

$(1 + \mu)$ and plate resistance $R_p' = R_p/(1 + \mu)$.

The average plate characteristics for the type 801 are given in Fig. 5. The μ for the 801 is 8. A second plate voltage scale divided by $1 + \mu$ is also drawn. Two load lines are drawn through the operating point O. One is for a load of $R_L = R_p = 5000$ ohms. The other is $R_L = R_p/(1 + \mu) = 555$ ohms.

Assuming a peak AC grid voltage of 20 volts, the power output calculated from the curves in the case of $R_L = 5000$ ohms is:

$$\frac{(0.044 - 0.012)\ (590 - 430)}{8}$$

$= 0.64$ watts

The second harmonic distortion in this condition is about 1.5 per cent. For $R_L = 555$ ohms, the power output:

$$\frac{(.063 - .003)\ (524 - 495)}{8}$$

$= .218$ watts

The distortion in the last case is about 8.5 per cent.

The power output and distortion figures for the two values of load resistance are based on using the tube as a conventional amplifier, and not as a cathode follower.

The 5000-ohm loadline is also a 555-ohm loadline when the lower plate voltage scale is considered. This is because the 555 ohm line and the voltage scale are changed by the same factor, $1 + \mu$.

The power output from the 801 as a cathode follower and with a load resistance of 555 ohms can be calculated using the original 5000 ohm line.

The power in this case is:

$$\frac{(65.5 - 47.8)\ (0.044 - 0.012)}{8}$$

$= 0.071$ watts

The power calculated by equation (4) in Fig. 4 also gives 0.071 watts. The value of E_s used in this equation is 14.1 rms. v. The peak value of this is 20 v., the same as used for the graphical power calculation. The reason for this value is that the graphical power calculation treats the cathode follower circuit as a special tube of low μ and R_p but in a standard circuit in which $E_G = E_s$, that is, no feedback.

The required E_s for a given output can be found by equation 1 of Fig. 2. Where μ is large (10 or more) E_s is approximately $2E_o$.

As a summary, the cathode follower circuit provides up to 50 per cent reduction in distortion when used for a low impedance output stage. (Equation 6, Fig. 4.) Greater distortion reduction results when higher load impedances are used.

THE RADIO TRADING POST

(Continued from page 6)

WANTED—Television receiver or receiver kit and C.R.O. tube for same. W. L. Thiel, 96 Westbury Blvd., Hempstead, New York.

WANTED—Record player, plug-in model to attach to radio. State condition and price. John Compel, Jr., 1165 Oak St., S.W., Warren, Ohio.

WANTED—Good Supreme No. 582 signal generator, must be in good condition. Also want 1 RCA 905 or any 5" tube. Write Leslie Bigelow, 123 1/2 S. Dubuque St., Iowa City, Iowa.

FOR SALE—New Motorola auto radios for 1941-42 Buicks, 1942 Chevrolets, 1942 Ford. Write for prices. Paul Capito, 637 W. 21 St., Erie, Pa.

WANTED—Signal generator, either ac or battery operated, Supreme or Philco preferred, all wave. Must be in good condition. Cash waiting. A. J. Firestone, R. D. 1, Hunkers, Pa.

WANTED—Keystone projector mod 82 or 75. Also sound head for 16mm films. Will buy Dodge 12v generator. Harry Kay, Rt. 2, Box 255, Imlay City, Mich.

WANTED—Will pay highest cash price immediately for good tube checker and signal generator. Have model OC Clough-Brengle signal generator and Weston 677 tube tester for sale, also new 35Z5 and 50L6 tubes. Henry Perka, 18 Warner St., Groton, Conn.

WANTED—SW-3-4-5 with power pack or coils for above. Have Triplett 1200 meter and RCP tube tester, using 6H6. Pvt. Fred Bachand, 32578079, Heavy Bomb Dept., Flight Test Sect., 610th A.A.F., Bn. H, Eglin Field, Florida.

WANTED—Table model radios, will pay fair price, advise condition and tubes used in each. Need tubes 12SK7GT, 12SA7GT, 12SQ7GT, 35Z5GT, or substitutes. Howard Wolfson, 831 E. 46th St., Chicago 15, Ill.

TUBES FOR SALE—6C5, 6SA7, 6SK7, 12 SK7, 12SQ7, 50L6, 80, etc. Also instruments and supplies. Send stamped envelope for reply and my list. John Trowbridge, 7936 Parnell, Chicago 20, Illinois.

WANTED — 1936 Superseven or Ward's Professional, or 1937 Sky Chief or Sky Buddy communications receiver in fair condition. Also copy July 1926 issue Radio. W8FX, 14860 Cedargrove, Detroit 5, Mich.

TRADE—Gernsbach Manuals 1 to 7 used, Radcraft 1941 and 1942, both new, Jewell 409 analyzer, good. Want camera with fast lens and compur, view camera, good typewriter, or deer rifle. Best offer. Include stamped envelope for reply. W. S. Crooks, Box 94, Kent, Ohio.

FOR SALE—Good, used, hard to get and obsolete parts for home and auto radios. State needs, all answered. Also 10 and 15 ohm, 5 and 6 amp. Cutler-Hammer shunt field rheostats, new, never used. R. J. Fogg, P. O. Box No. 275, Grand Rapids 1, Mich.

WANTED—913 1" cathode ray tube. Will pay cash or trade any of following tubes which are equal in list price: 6SA7, 5Y3, 5Y4, 6SQ7, 12SQ7 and others. Robert DeGrasse, 1407 W. Chestnut, Yakima, Wash.

SALE OR SWAP—Triplett No. 1210A tube checker, Weston Model 770 tube checker. Want signal generator or oscilloscope. Loewey's, 48 Palisade Ave., Yonkers 2, N. Y.

SELL OR TRADE—For good reflex camera only. value $35 to $40. Four Jewell meters, Stamped addressed envelope for details. W. S. Crooks, Box 94, Kent, Ohio.

FOR SALE—U. S. Claritone table model 26P pentode receiver, 1 Echophone superhet; console chassis RCA complete, good condition; 2 midgets; Philco console chassis; 2 sets ear phones; 100 burned out tubes 4c each. The radios need some repairs, several speakers. All for $25.00. Conrad Schmidt, Jr., 1663 N. Francisco Ave., rear bldg., Chicago, Illinois.

WANTED—All types of slide rules, notably Crooke's radio slide rule, and RC A 10" DB and harmonic scale slide rule. Have all types of radio servicing equipment for trade or will pay cash. Sgt. Tony Owsiany, Det. 103rd Army Airways Comm. Sqdn., 232 E. Main St., Logan, Ohio.

SELL OR TRADE—Portable radio, 100 new radio tubes, electric time switch, electric fencer, AC 6 watt P.A., electric clock, phono amplifier, 2 sets headphones, 2 tubeless vibrapacks, AC-DC condenser tester, dry disc 2 amps battery charger, 400 ft. 16mm (new) glamour newsreel film. Radio Technician, 2748 Meade St., Detroit 12, Mich.

FOR SALE—Highest offer takes Jewell, no. 54, 0-100 ma dc; No. 190 0-10 v. center ac. Weston 301, 0-15 vdc. Will sell individually. Herbert Levinson, 2422 N. Natrona St., Philadelphia 32, Pa.

CASH—We want amplifiers from 8 watts up, also test equipment. State make and model no. and tube line up. National Sound Equipment Co., 625 Main St., Worcester, Mass.

FOR SALE—Radio Lab. contents: 2, 3 and 5 in. cathode ray tubes, metal, VHF acorns and midget tubes, 0-1 ma. 0-200 micro amp. and 0-50 micro amp. meters. Precision 100 kc Xtals; resistors and condensers; C-D hi-voltage condensers. Send stamped addressed envelope for parts list. Rufus Lee, 1128 Wagner Av., Philadelphia 41, Pa.

WANTED—Tubes like 3Q5GT, 35Z5GT, 50-L6GT, 12SQ7, 12SA7, 1A7GT, 1A5GT, 12SK7, 12SJ7, and 6SS7, also tube tester to handle all tubes. Howard Wolfson, 831 East 46th St., Chicago 15, Illinois.

FOR SALE—HY114B 9002 tubes. Components for 112 Mc receivers and transmitters. Want two Sylvania Stock Boy cabinets in good condition. Fox Radio Service, 435 S. 5th St., Richmond, Ind.

WANTED—12, 35, 50 and 70 v. tubes, also condenser analyzer, sig. generator, tube tester and VTVM, and Rider's Manuals. Roy Saxton's Radio Shop, R. 1, Pontiac, Illinois.

POSTWAR OPPORTUNITY FOR SERVICEMEN AND TECHNICIANS*

There is hardly a radio or electronic enterprise able to undertake all the things it would like or do them as well as it would like to do. The reason is the lack of sufficient development and engineering personnel. Because their number is limited by the prewar size of the industry they cannot be found quickly or developed from unskilled personnel. Even the termination of war contracts and the return to civilian life of many persons now in the Armed Forces or in defense plants will not be able to produce a surplus of capable engineering personnel.

It is not a question of finding jobs for displaced personnel postwar. It is a question of finding personnel for jobs that did not exist prewar. Many of those in the service will be suitable for this work, particularly those who have had experience before they entered the service. It must be recognized that in addition to the prewar radio industry employing approximately 300,000 persons, who will start up after the war with a tremendous backlog of business to fill for civilian needs, there are the many needs of electronics. It will require perhaps a 500% increase in employment postwar to handle new developments in electronics, television, railroad radio, radio-frequency heating, industrial applications, electron microscopy, medicine, microwave communication facilities and the conversion and extension of frequency modulation. Not a single one of these developments is stabilized nor has its zenith in sight.

In Table I, 100 developments or opportunities for engineering personnel are enumerated. Any one of these developments can be made important enough to completely occupy hundreds and in some cases, many thousands of qualified radio people. This would be in connection with development, design, manufacture, installation, maintenance, training, or sales.

Prewar radio and electronic equipment were of relatively few types and contained little in the way of tubes or parts. A radio receiver usually had less than ten tubes in it. Radio technicians and servicemen could maintain such equipment. Postwar we must definitely expect equipment that will contain over 25 tubes and in many cases up to 100 tubes. The maximum number can be expected in the case of television, particularly if it includes color and sound. It will also hold true for other apparatus such as the electron microscope, radio medicine, industrial electronics and aids to land, air, and water transportation.

Let us analyze what 100 tubes in a piece of radio or electronic equipment really means when it comes to design or maintenance of such apparatus. Although future tubes may contain additional elements, let us think of it on the simpler prewar basis. Assume it had an average of 5 elements per tube (filament, cathode, control grid, screen grid, and anode). In a 100-tube apparatus there might be 1000 resistor, condenser, inductance, and terminal connections. Then the number of details and possible sources of trouble becomes not 5 elements $\times$ 100 tubes $\times$ 1000 connections or a total of 500,000. Actually the tube angle is not 100 times 5 but 100 to the fifth power. Therefore in reality it is 100 $\times$ 100 $\times$ 100 $\times$ 100 $\times$ 100 $\times$ 1000 or a total of 10,000,000,000,000 or ten trillion.

* *By Samuel Freedman in "Radio News."*

Table I. Postwar Fields of Opportunity

Frequency Modulation. Replacement of Amplitude Modulation.
Facsimile systems.
Television.
Television in color with accompanying sound.
Diathermy equipment.
Radio alarm transmitters.
Radio alarm receivers.
Microwave automatic relay stations.
Transducers.
Sound detectors.
Magnetic detection.
Radio detection.
Navigational aids.
Aeronautical aids.
Vibration analyzers.
Electron optics.
Induction transmission.
Carrier channels of transmission on metallic circuits.
Carrier and sub-carrier channels on radio circuits.
Panoramic receivers.
Cathode-ray oscilloscopes.
Electron microscope.
Supersonic communication.
Electrical recording and transcription.
Magnetic recording and transcription.
Light recording and transcription.
X-ray techniques in medicine and industry.
Microphone equipment.
Loudspeakers.
Velocity modulation.
Phototube applications.
Talking movies.
Radio beacons.
Acoustics.
Radio plastics.
Public address systems.
Inter-office communication systems.
Wired Wireless systems.
Centralized radio receivers.
Automatic remote controls.
Component parts manufacturing.
Broadcast receiver manufacturing.
Vacuum tube manufacturing.
Cyclotron and atom smashing equipment.
Fluorescent lighting and adaptations.
Convulsion or shock machines to cure mental conditions.
Radio hardware.
Radio tools.
Radio transformers, chokes and inductances.
Resistor parts—fixed and variable.
Capacitors—fixed and variable.
High-frequency insulation materials.
Low-impedance components at microwave frequencies.
Police radio.
Railroad radio.
Radio nails.
Radio-frequency heating.
Public utility radio systems.
Taxicab radio.
Radio communication for trucks and buses.
2-way radio in automobiles.
Analysis of motional conditions too fast for the eye to see or body to feel.
Stroboscopic applications.
Radio altimeters.
Pressure indicators.
Humidity indicators.
Wind indicators.
Speed indicators.
Magnetic prospecting and metal locators.
Phasing equipment.
Electro-surgery equipment.
High-frequency baking, heating and roasting.
Medical research.
Crime detection.
Tissue growth, destruction and removal.
Traffic control aids.
Electronic clocks and timing devices.
Synchronizing equipment.
Color control and color matching.
Quality control and matching.
Density control and matching.
Electronic counting equipment.
Automatic warning and signalling.
Automatic control of lights depending on visibility.
Fire warning and fire control.
Geophysical exploration below earth's surface.
Atomic molecular and even electronic control.
General microwave development.
Miscellaneous medical research and development.
Multivibrators and electronic switches functioning as fast as millionths of a second or as slow as hours in their action.
Power supply equipment using vacuum tubes for rectification.
Radio test equipment.
Antenna and transmission line techniques.
Radiosonde and meteorology.
Hearing aids.
Interference elimination.
Schools, textbooks and publications.
Amplidyne and selsyn systems.
Recording meters actuated by electronic circuits.
Measuring mass, motion, quality, flaws, quantity, rate of change and their control.

Each of these can furnish employment in research, design, manufacture, sales and distribution, installation, maintenance, training and utilization.

Even if there are not ten trillion points that might cause inoperation, there could conceivably be situations comparable with that number to be responsible for sub-standard performance. That is why postwar there will be a need for engineers rather than ordinary technicians and servicemen. Men and women with extensive education in physics and mathematics will be required as physicists and development engineers where they will specialize to a great degree.

Outside the laboratory, personnel will be required that can work with the equipment as a complete system. To keep this equipment functioning and in the hands of the consumer will require large numbers of sales and maintenance engineers. These engineers will be unsuitable if their training has been entirely academic. The field engineer must have an over-all knowledge of equipment from the highest practical standpoint . . . namely selling it and keeping it sold by having the equipment continue to function satisfactorily in the customer's hands. This article is largely directed towards such men—both actual and potential engineers.

There must be a shortage of such men now and postwar regardless of the displacement and changeover after the termination of hostilities and resumption of peace. The engineers required must have a good practical experience extending over a period of a few years. In addition, they should have specific theoretical understanding of vacuum tubes, use and application of the cathode-ray oscilloscope, time-base circuits, very-high-frequency techniques, phasing phenomena and a knowledge of mathematics sufficient to appreciate the algebraic and vectorial analyses of radio-electrical circuits.

It is not necessary that this theoretical training be obtained in residence school or at college with complete separation from one's trade or earning power during that time. It is feasible and perhaps desirable that men continue at their present radio tasks while acquiring the additional knowledge required by university extension, correspondence school course or simple self-study. Their normal radio work is a splendid substitute for laboratory experience. If opportunity affords, some resident instruction or visits to laboratories or factories are desirable, but not absolutely necessary. What is really necessary and very important is that the individual have an innate aptitude and desire for the work as well as an appreciation of what the future in radio and electronics holds forth. That cannot be better demonstrated than by one who has been employed in the field several years and who, by his own efforts, undertakes theoretical spare-time study to further improve himself. For such men minor disqualifications of age, physical disability, or lack of a full formal education will not be a handicap towards making good.

While the equipment development may be the combined efforts of many minds, the job of making it a working system narrows down to the individual engineer. The fact that there are many engineers is due to the fact that there are many types of equipment since it is tied in with production and sales. The best engineer will be the one who came up the hard way from a junior category but obtained sufficient education formally or informally. If he started the intellectual or academic way, then it is important that he start at the bottom and acquire seasoning, maturity and a great deal of practical experience under a variety of conditions. He should come in contact with many people, a good portion of whom should be practical men.

To such readers who have these engineering requisites or desires, the writer wishes to convey this message. There are youngsters reaching maturity who will need jobs and opportunities. In most cases they will be too

immature and inexperienced to commence in any but a junior capacity. It is up to you men to recognize your duty and perform it. That duty is to yourself and to everyone else . . . and it is to qualify as an engineer and to cease remaining in the status of a technician or serviceman. Any indifference or disinclination you may have to get ahead or to disturb any snug situation now enjoyed is holding up the line for everybody behind you. Do not force less capable men to pass you up because of your failure to move. You should be the engineer because you have much of the know-how already and can acquire the remainder needed without much additional preparation. The fact that you lack a sheepskin, or that you have only a layman's knowledge and appreciation of history, literature, ancient civilization and polished manners is unimportant. That is not the issue. It is desirable only that you be honest with yourself as to what your real limitations are and make a sincere effort to correct them. These may perhaps be unpleasant speech, poor habits, envying of the successful people in your field (although you do nothing yourself to acquire similar success), inferiority complex, poor spelling, poor at arithmetic or mathematics, or carelessness in heeding technical information and modern developments in the field.

The real truth is that radio and electronics are not complicated. People can be made to think it is but that still does not make it so. The fact is that radio troubles can be great in numbers, but are very few in type. Radio and electronics have never been, are not now and probably never will be more than an inductance, a resistor, a condenser and a vacuum tube. It is only their size, number and manner of connection that make up a thousand different kinds of useful apparatus. Understand inductance, resistance, capacitance and vacuum tubes and add them to your backlog of practical experience.

In Table I are enumerated 100 opportunities, each of which can in turn be subdivided as many as 100 times or more. Some of them may become greater than all radio itself. Magnetism and magnetic phenomena can in time overshadow the rest of radio and electronics. It may break suddenly without warning. Already the existence of a magnetic current has been discovered and disclosed. The cyclotron is another basic development which can be compared with Edison's first electrical discovery.

If prospective engineers follow the advice contained in this article and find it difficult to know how to apply their qualifications, it is suggested that:

If you cannot develop or design equipment,

then build it,

or sell it,

or repair it,

or use it,

or show some one else how to do any of these things.

If no one wants to hire you at it, then do better and develop your own enterprise. Anyone approached for placement who will not furnish same, must run the risk of creating a competitor. If you do not recognize at least one thing in the list that you have sufficient confidence in yourself to successfully put across, then you are indeed an unfortunate person with questionable qualifications for a radio or electronic career.

Radio and electronics will always need men with creative ability, vision, courage, initiative, willingness to be both teacher and pupil as occasion may dictate, unselfishness and confidence.

KEEP ON BACKING THE ATTACK BUY WAR BONDS

WANTED!

Case Histories of

Cornell-Dubilier Capacitors

◆

HUNDREDS of Dubilier mica and paper capacitors made over a decade ago and more, are still giving efficient and reliable service in radio and electronic equipment. These capacitors are as good today as the day they were made. We are collecting case histories of such units.

If you know of a Dubilier capacitor ten years old or more, in use today, please tell us all about it and in what type of equipment it is used. A post card will do. Thank you.

◆

Address:

EDITOR, THE C-D CAPACITOR

Cornell-Dubilier Electric Corporation,

South Plainfield, N. J.

"Never a failure"

— writes W. B. GILLESPIE, Prop.
Gillespie Radio Service
O'Neill, Nebraska

"I use C-D Condensers and have for several years," continues Mr. Gillespie. "Am still waiting for the first failure!" Hundreds of the nation's leading servicemen have used virtually the same words when writing us. Outstanding performance pays off — in added profits, customer good-will and valued repeat business. You can standardize on Cornell-Dubilier Capacitors with confidence!

WRITE FOR CATALOG

MICA • PAPER • DYKANOL • WET AND DRY ELECTROLYTIC CAPACITORS

Cornell Dubilier

ELECTRIC CORPORATION

1049 HAMILTON BLVD. • SO. PLAINFIELD, N. J.

MORE IN USE TODAY THAN ANY OTHER MAKE

PRINTED IN U.S.A.