NEW AUDIO CIRCUIT

(See page 3)

OCT. 10
1931

RADIO WORLD

REG. U.S. PAT. OFF.

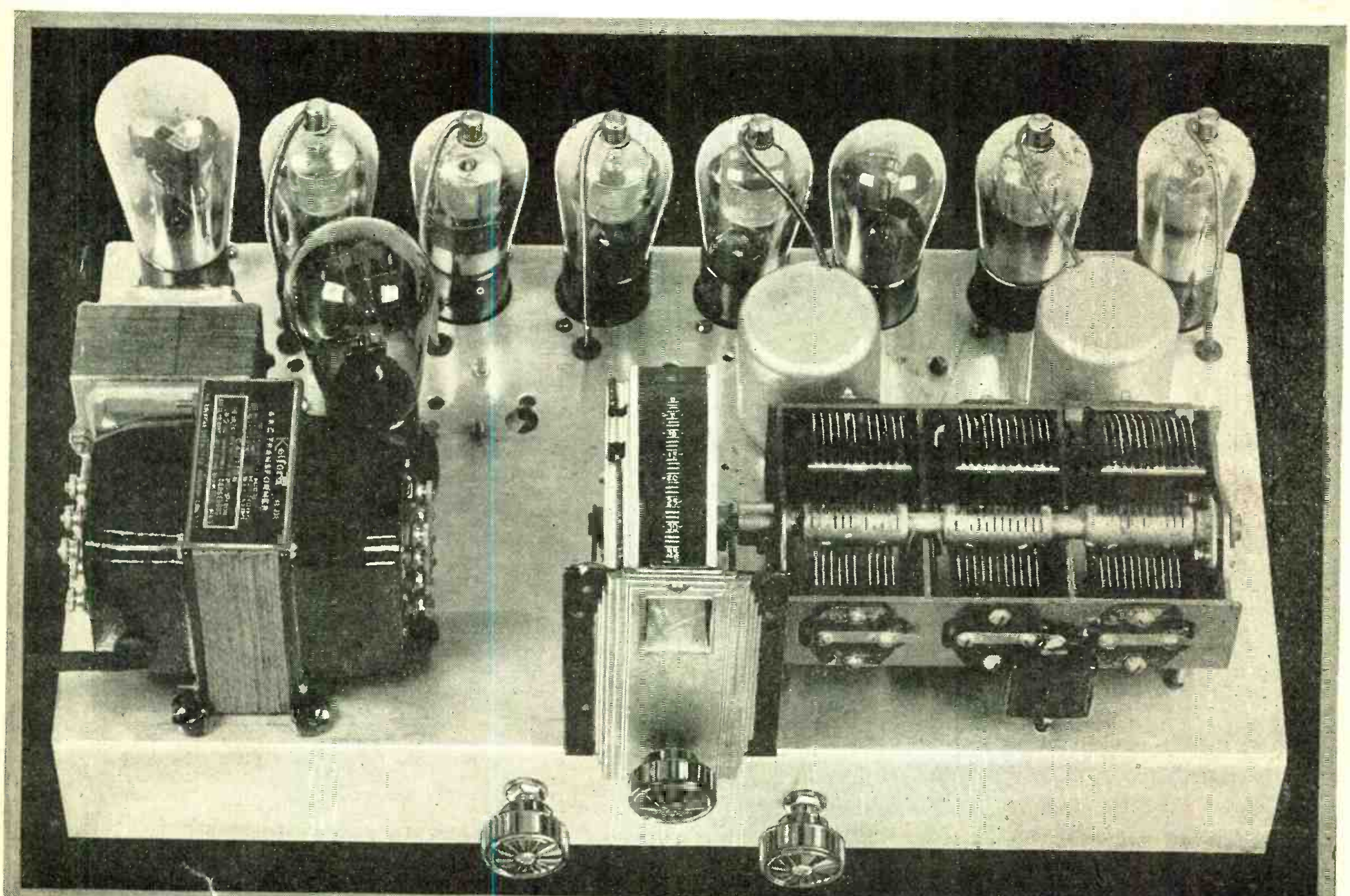
The First and Only National Radio Weekly

498th Consecutive Issue—TENTH YEAR

PRICE
15¢
PER COPY

9 TUBE SUPERHETERODYNE

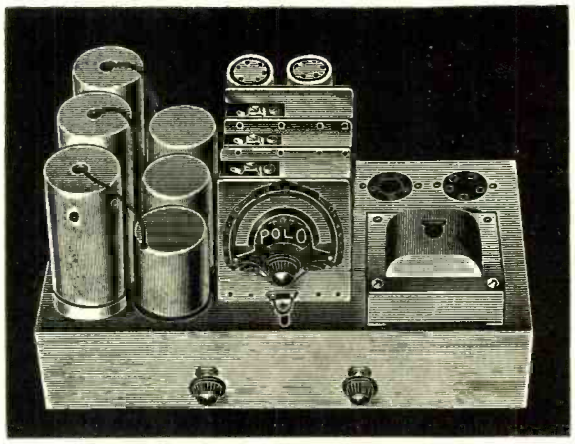
(See page 12)



Top view of the nine-tube superheterodyne described in this issue, showing the layout of the principal parts. Four variable mu tubes and one power pentode are used in the circuit.

Police Calls on the POLO MIDGET!

Not Only Does the Polo Midget Tune in the Full Broadcast Band But It Gets Police Calls as Well. Range, 179 to 557 meters. No Switching



Three-gang, stator-shielded condenser with trimmers; full-vision, illuminated projection dial; volume control; tube shields for radio frequency and detector; 16 mfd. filter capacity; phonograph jack. For 105-120 v, 50-60 cycles.

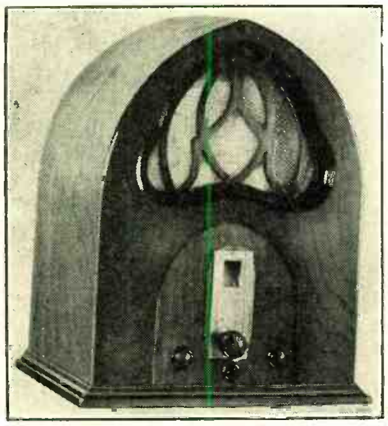
An Average of 55 Broadcast Stations Tuned in Nightly by Users of the Polo Midget, the Sensational 5-tube Set!

New Circuit Develops Amazing Sensitivity!

The Polo Midget Does With Five Tubes What Most Seven Tube Receivers Can Not Do —It Separates Stations Crisply and Reaches Out For REAL DX Despite Locals! This Set is Just Full of Pep—An Astounding Performer!

Our new wired chassis, 13" wide, 9½" front to back, flap 3" high, overall height 8", @ $14.95 net to trade, including Rola dynamic speaker, 1932 model, is Polo's newest big bargain. Coils, two radio frequency tubes and detector tube shielded. Tubes used: two 235, one 224 (detector), one 247 and one 280. Cat. MCH @ $14.95. Midget walnut cabinet (Cat. MWC) to house chassis and speaker, $4.05 extra, or install in a console. Wired chassis installed in walnut finish, midget cabinet (Cat. PM), @ $19.00. Kit of tubes, Cat. KTPM, $4.03 extra.

ALL-WAVE MIDGET



Our 5 tube All-Wave Receiver, the AW-5 15 to 545 meters, is a sensitive and selective five tube product, with knob for band shifting.

Order Cat. AW-5 (wired model) complete with tubes, 235, 224, 227, 245, 280. @ $55.00

Kit supplied (including picture diagram, cabinet, all parts, less tubes), order Cat. AW-5K @ $35.00

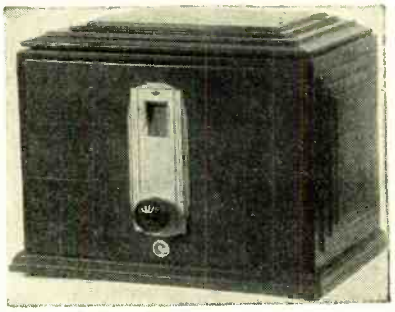
The DX-4 is a Short-Wave Converter (at right) to be connected to your broadcast set to enable you to bring in short waves on the loudspeaker. The wavelength range is 15 to 200 meters, with the additional facility of broadcast waves through the converter (200 to 600 meters), so that you can convert any set into a superhetrodyne, both for short-wave and broadcast-band reception. The tubes used are two 235 (variable mu), one 224 and one 227. Single tuning control. Precision air-wound plug-in coils are used. AC operated. Built in power supply.

Wired model, with complete set of coils (less tubes, less cabinet), order Cat. DX-4-W @.......... $30.00

Kit of parts, complete with coils and picture diagram (less tubes, less cabinet), order Cat. DX-4-K @.. $25.00

Walnut finish modernistic wood cabinet, order Cat. CBT @.................................... $5.00

SHORT WAVE CONVERTER



Mr. Lippe, of 215 Baldwin Ave., Jersey City, N. J., is one of the many reporting great DX results. His list includes: VDP, Suva, Fiji Islands; HRB, Honduras; FL, Toulouse, France; WZXAL, Salt Lake City; W1XAV, Boston; W9XR, Chicago; W7XAB, Los Angeles; W2XBA, Long Island; W9XAA, Chicago; W9XG, West Lafayette; W7XAV, Portland, Oregon; W2XAP, Jersey City; EAR25, Barcelona, Spain; YORK, England; VE3AP, Drummondville, Canada; W8BN, S. S. Leviathan; CJKA, Winnipeg, Canada; Australia.

POLO ENGINEERING LABORATORIES

125 WEST 45TH STREET NEW YORK, N. Y.

Our Entire Line on Exhibition at Our Office ***Tel. BRyant 9-6516***

Vol. XX No. 4 Whole No. 498
October 10, 1931
[Entered as second-class matter, March, 1922, at the Post Office, at New York, N. Y., under act of March, 1879]
15c per Copy. $6 per Year.

TENTH YEAR
Technical Accuracy Second to None
Latest Circuits and News

A Weekly Paper Published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y.
(Just East of Broadway)
Telephone, BRyant 9-0558 and 9-0559

RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.; Roland Burke Hennessy, editor. Herman Bernard, managing editor; J. E. Anderson, technical editor; L. C. Tobin, Advertising Manager

A New Audio Circuit Using Regeneration for Tone

Power Amplifier Omits Large Bypass Condensers

By Herman Bernard

COMPLETE stability in a three stage resistance coupled audio amplifier is attained by the method diagrammed in Fig. 1, which also makes it unnecessary to use large bypass capacities.

The safeguarding of stability is the solution of a long standing problem. The omission of the bypass condensers is simply an incidental economy that the system permits, indeed requires. If you use large bypass capacities the circuit will not work at all well, for it would be just the same as omitting them from ordinary amplifiers.

The solution of the stability problem lies in the use of audio regeneration. Here we have three stages of audio, the most convenient form, permitting the feedback of audio current from a subsequent to an antecedent stage. Thus, if the biasing resistors for the two stages are 5,000 ohms each, the cathodes of both tubes may be joined by another 5,000 ohm resistor. Then the effect is regenerative.

Electric Shield Needed

There will be a strong electric field about the first audio tube, which requires that a tube shield be used, and makes it necessary also to put the two resistors and the condenser following this tube inside a shield. A small aluminum can will do. The requirement is not for audio frequency magnetic fields, which would mean thick iron, but for a field of steady electricity.

While the practical representation of the solution of an old problem is simply the introduction of a single resistor—the 5,000 ohm unit from cathode to cathode—the electrical change wrought is very extensive. Moreover, the stability is most welcome to those who insist on the finest tone quality, and to those interested in television, who have been weighted with the necessity of having pure amplification, without any means of insuring enough gain consistent with stability, or of insuring adequateness of tone quality, because of low value plate and grid loads required to attain stability. Also large bypass capacities would be required—hundreds of microfarads for results scaled to television.

Here, however, we have for the first time the conscious and intentional use of positive feedback, not only to correct for the negative feedback through biasing resistors, voltage dividers, chokes, etc., but also to build up the gain at the same time to the maximum allowable limit. What that limit is will depend on varoius factors, but in brief it concerns the type of instability that is present.

Shift of Instability, Then Removal

When this type is of the low frequency order the remedies sacrifice volume and usually quality. But the instability always can be shifted to a higher frequency, one of the principal contributions involved in the invention herein described. The instability is shifted from motorboat frequencies to a howl around 2,000 cycles in this instance, although any one of various frequencies may be used, and of course the solution is easily afforded by a relatively small capacity. For instance, 0.1 mfd. from cathode of the first audio amplifier to ground always will remove this howl.

The considerations may be summarized as follows:

1—A method of attaining complete stability in multistage resistance coupled audio amplifiers by introducing regeneration.

2—The omission of bypass capacities from the biasing resistors entirely, excepting a relatively small condenser to remove a howl representing the purposeful shift of instability.

The two considerations are tantamount to the same thing, since the purpose of bypass capacities in ordinary amplifiers is to remove the devastating effect of negative feedback, through biasing impedances, and here we use regeneration for this purpose, for the first time ever. Naturally, if the amount of positive feedback is made just enough to cancel the negative feedback, then there is no signal through the biasing adjunct. And if a bypass condenser is put across the biasing resistor of any tube, or across the regeneration resistance, then positive feedback is bypassed, and the system is upset, the negative feedback predominating. That is why not only are large bypass capacities unnecessary, but no such bypass capacity is even tolerable. The circuit's tone is of the same high order of quality as it would be if 100 mfd. of capacity were across each of the three biasing resistors in an ordinary circuit. So a 5,000 ohm ½ watt resistor takes the place of 300 mfd. of capacity.

A question that naturally will be asked is: "Even though you feed back from one stage to another, you confine feedback to one stage only, so how will that cancel out negative feedback in the biasing resistor of a subsequent stage?"

The Amplifier Is a Unit

The reason is that the audio amplifier—any amplifier—is a unit, and may be considered as the electrical unit Z—a single impedance. Therefore the feedback effect introduced anywhere is effective on the unit system, or, all effects are present in the speaker output, is another way of expressing the same idea. The slow progress in developing the resistance coupled amplifier is due to the very mistake of regarding stages individually, instead of the amplifier as a unit.

The fact that regeneration is used opens the way to tuning the audio system. As is well known, small output transformers are generally used. Nice consideration of requirements, such as large core, high inductance, matched impedances and the like, are ignored in such output transformers. Yet the quality may be put on the highest level with the smaller devices, including small sized cones on dynamics, and small baffle areas. The regeneration can be brought up to such a point that the feedback overcomes the shortcomings that otherwise would be present. The effect of these undersized items may be treated in the same light as negative feedback effect.

The tuning expedient is more readily effected with screen grid tubes in the audio amplifier, as the screen voltage can be varied until the resultant feedback is positive to the desired degree and the bass drum may be made to sound even louder than the saxophone. However, the result in such a case is an over-accentuation of the bass. The frequencies are not so evenly handled in other regions, therefore better tone results from the hookup as diagrammed.

Practical Also With Screen Grid

The screen grid case is cited only to prove that the slurring of the bass can be readily overcome, and the remedy can be readily

(Continued on next page)

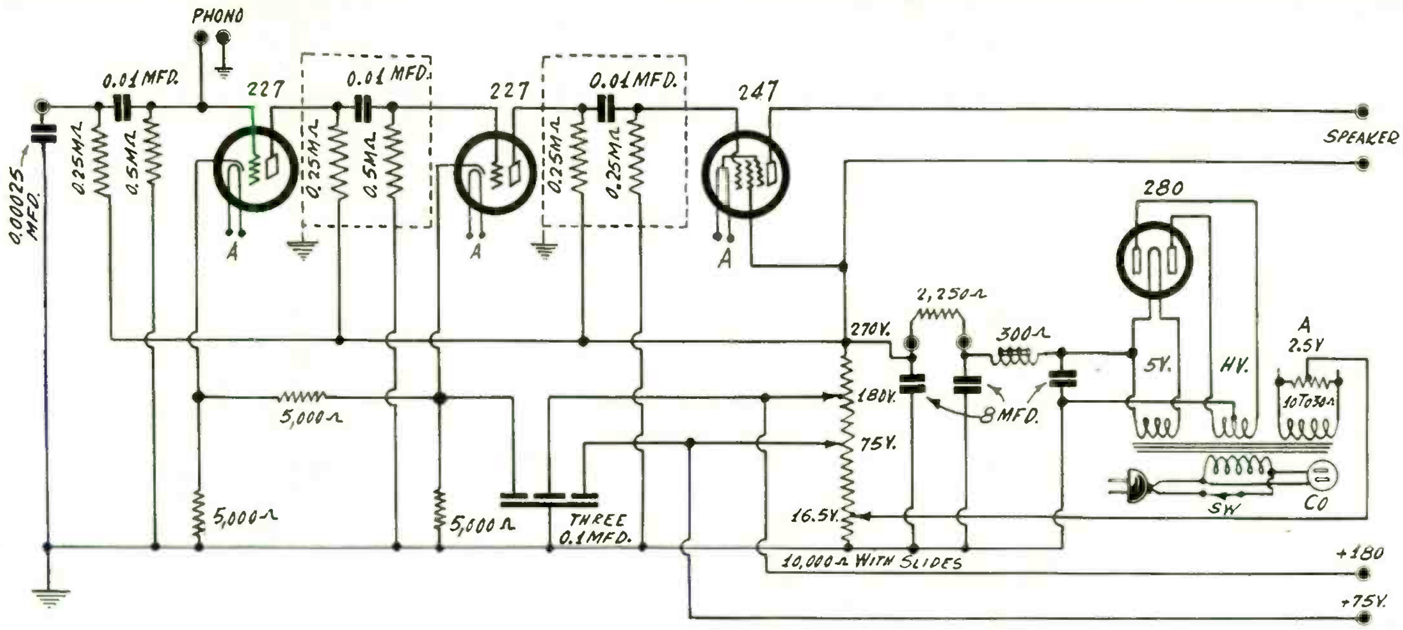


FIG. 1

First presentation of the Bernard Audio Amplifier, applied to a three-stage, resistance-coupled channel, with pentode output. A regeneration resistor, 5,000 ohms, 1/2 watt, does the work of 300 mfd. capacity in other circuits.

overdone and perhaps be worse than the ailment. Screen grid amplifiers with flat characteristic can be attained, and will be shown subsequently.

Many persons now have three stage resistance coupled amplifiers to which the remedy may be applied according to Fig. 1, by omitting the bypass condensers across biasing resistors, introducing 227 tubes if others are used, and a single bypass condenser of 0.1 mfd. or less used from first audio cathode to grounded B minus.

The value of 0.1 mfd. is cited because it proved an infallible remedy, but it is well to try smaller capacities, as there is no point in using a larger capacity than absolutely necessary. In fact, the feedback might be so proportioned, as was done actually, to omit the necessity of any bypass condensers, but this required general reduction of feedback, so that the decrease was more than was considered desirable. Here we can, by using a relatively small condenser, enjoy intense feedback, with the oscillation thereby removed but with a strong resultant electric field that requires shielding.

Therefore a tube shield is required for the first audio, or regenerated stage, and the resistors and condenser in the following coupling circuit must likewise be shielded. If these precautions are not taken, if you use the amplifier in a receiver, and you have a metal escutcheon on your dial, a sound will be registered when you touch the metal, as the grounding alone is not effective on the electric field. That is because of the static charge on the plate (here the escutcheon). The charge is not there if the shielding precautions are taken.

Moreover, it is advisable, although not imperative, to use a tube shield on the second audio tube, and also to shield the two resistors and the isolating condenser that are used in the coupling to the pentode.

Full Bias Applicable

The bias on the pentode is not critical, but if it is around 16.5 volts, the recommended standard in other circuits, the low note response will not be quite as great as if the bias were lowered. Yet lowering the bias increases the hum. Here the bias may be even 20 volts negative, regeneration supplying the corrective. But the filtration must be extra good, as the same hum threshold appears when the low note reproduction is rendered keener by lowering the 5.000 ohm coupling resistor (between cathodes). So the better the filtration the better the bass response possible without running into hum.

Three 8 mfd. condensers are used, and may be electrolytics. One is next to the rectifier. Then comes a 300 ohm choke, which, however, may be almost any choke of commercial rating of 15 henries or more, for the direct current resistance will be from 150 to 400 ohms, usually, and the resultant difference in output voltage available is not large enough to require particular safeguards.

Next comes a 2,250 ohm resistor, but if you have one of from 1,200 to 2,500 ohms, 25 watts, use that. However, if you have a dynamic speaker with a direct current field coil, 1,200 to 2,500 ohm resistance, that may replace the resistor. In fact, the resistor is there simply to hold the line for the dynamic field. Then the field coil becomes also a B supply choke coil, a common practice.

Of course there will be a considerable difference in the voltage from the end of the choke chain to ground, depending on the value of the resistance (marked 2,250 ohms but for which substitution may be made), or on the d-c resistance of the field winding of the dynamic. There will be a difference of about 5 volts for every 100 ohms difference in d-c resistance. Normal voltages are stated on the diagram, but most of the instances cited will afford 250 volts maximum with popular transformers, 270 volts with transformers intended for 245 tubes but used here on the pentode.

A popular type of dynamic speaker is one having a 1,800 ohm field coil, tapped at 300 ohms, in which case it is all right to use the 300 ohms as diagrammed, and the 1,500 ohms to replace the resistor marked 2,250 ohms. Remove the resistor and connect the 1,500 ohm section of the field coil instead.

The voltages are adjustable, except the maximum voltage, but even that is subject to reduction by introducing more series resistance than specified, or to increase, by using less series resistance than diagrammed. The 300 ohms and 2,250 ohms in the diagram are referred to.

Avoids Cumulative Voltages

From what has been stated it should be apparent that the tone quality is of the same high order as that obtainable from the non-reactive audio amplifier. This type, popularly known as the Loftin-White amplifier, is resistance coupled, without stopping condensers, and therefore the voltages applied to the audio channel are cumulative. High voltage rating filter condensers, 281 rectifier or rectifiers, and a high voltage secondary on the transformer would be necessary for a three-stage system, as well as bypass capacities. But the present system attains the same tonal goal without cumulative voltages and without large bypass condensers.

The reason why the system works out extremely well as diagrammed is that there are three audio tubes to deal with, and two of them are loaded with resistors virtually exclusively, as the effect of the stopping condenser may be neglected as reactively small, and also as being overcome by regeneration also. The phase difference between the first and second audio stages is 180 degrees, so it becomes simple to proportion the feedback. Where feedback is to be established from the power tube it would require special precautions and treatment because the phase difference is less than 180 degrees, on account of the effect of the inductive plate load.

Though this difference would be small it would be ratable in establishing a solution, hence Fig. 1 is shown as a definitive solution for one particular case.

Uses Discussed

The power amplifier will supply B voltage to a tuner, but not filament or heater voltage, so a filament transformer of 2.5 volt secondary would have to be included for a tuner using 235, 224 or 227 tubes.

The detector plate return is taken care of in the power amplifier, the connection being to maximum voltage, which is all right if you use negative bias detection, or if you use grid leak detection with the 224 tube in the detector socket, screen and plate tied together, the result being a three-element high mu tube. In case the 224 is used in that way the grid condenser may remain what it is, presumably 0.00025 mfd., but the grid leak would be 5 meg., and also the plate load resistor, marked 0.25 meg., may be raised to a value of from 0.5 meg. to 2 meg.

If it is desired to use the amplifier with a phonograph pickup, then the pickup is connected in the grid circuit of the first audio tube. In that case there would be no tuner to serve, so it would not be necessary to use the voltage divider at all, but simply return the plates of the audio tubes to maximum B plus.

If the voltage divider is to be omitted when a tuner is used, never-

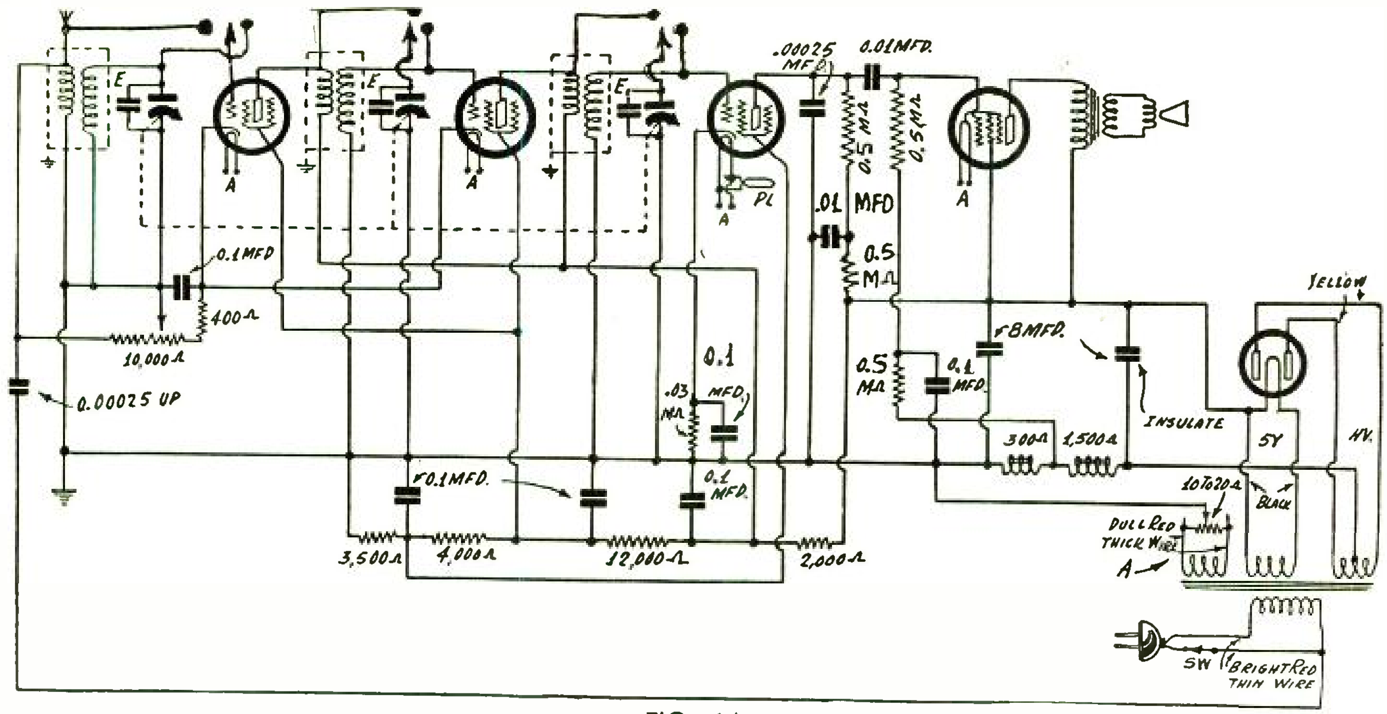


FIG. 1A

Regeneration is present even in this audio circuit, due to the choke being in the negative rectifier leg, and the method of pentode bias. The tuner covers 60-560 meters with two settings—broadcast and short waves.

theless, a series resistance of 0.005 meg. (5,000 ohms) may be used to drop the maximum voltage to around 180 volts, with a 0.0015 mfd. or higher capacity condenser connected from B plus to ground in the set. Then if lower voltages for screens are to prevail, these would have to be provided in the set also, resistors of 0.1 meg., between screen and maximum B plus, being satisfactory, but should be bypassed for radio frequencies, with 0.0015 mfd. or higher capacity, from screen to grounded B minus.

[See the article on next page and following for more data]

Here is a list of new members of the Short Wave Club:

Raphael R. Quiñones, 47 Luna St., San Juan, Porto Rico.
Pedro F. Ferrer, 32 Riera Palmer St., Mayaguez, Porto Rico.
William Haine, La Plume, Pa.
George F.DuBois,368ChurchSt., Poughkeepsie, N. Y.
John V anCoonis, 932 Ballenger Ave., Flint, Mich.
S. Letkauskas, 18 Watkins Terr., Rochester, N. Y.
W. S. Dobrowski, 747 N. May St., Chicago, Ill.
Thomas Liguori, 213 Mill St., Poughkeepsie, N. Y.
T. A. Bedford, 1221 15th St., Sacramento, Calif.
Jim Richeson, Box 724, Lefors, Tex.
Marshall Rankin, Rankin's Radio Service, 324 Brooklyn Ave., Dayton, Ohio.
E. Herbert Ottoson, 19 Euclid Ave., Worcester, Mass.
Frank V. Felter, 2 So. Franklin St., Nyack, N. Y.
H. Bowman, 635 4th Ave., East, Prince Albert, Sask., Canada.
F. R. Schulze, 521 22nd St., Union City, N. J.
Frank Stilling, 350 East 67th St., New York, N. Y.
Roy Lingenfelter, 413 3rd Ave., Altoona, Pa.
Carl T. Olsen, 423 Elizabeth Ave., Elizabeth, N. J.
J. M. Stafford, Box 336, Stuttgart, Ark.
Carl Jacobson, 862 Jennings St., Bronx, New York City.
Russel J. Ramsey, Alpine Blvd., Wi kinsburg, Pa.
Gordon Peterson, 24 Holman St., Fitchburg, Mass.
George Conroy, 189 Union Avenue, Clifton, N. J.
W. A. Behm, 710 Ashland Ave., Niagara Falls, N. Y.
Harry B. Cox, 1416 Clark St., Racine, Wis.
Dagoberto Valdés, Lagunas 52 bajôs, Habana, Cuba.
M. A. Clift, 1417 S. Chandler Ave., Denison, Tex.
Willard Phillips, R. 1, Box 113, Kannapolis, N. Car.
Max Olesker, 608 Prospect Ave., Bronx, N. Y. City
Hubert Stolle, 805 No. Travis St., Sherman, Tex.
Paul N. Wright, Box 323, Greencastle, Ind.
Robert H. Leonard, Jr., P. O. Box 222, Caldwell, Idaho
Garrett S. Wall, Worthington, Ohio
Norman L. Harper, 603 E. Comm. St., Charleston, Mo.
Oei Kimtoen, Boulevard Menteng 23, Batavia-Centum, Java, D.E.I.
E. H. Overbey, P. O. Box 12, San Antonio, Texas.
Clarence Uchimura, 1710 Fort St., Honolulu, Hawaii
Gordon Depew, Pullman, Wash.
George H. Snyder, Jr., P. O. Box 202, Ridgewood, N. J.
James Kendall, 2819 Draper St., Warren, Ohio
W. H. Denio, 191 Cedarwood Terrace, Rochester, N. Y.
Truman Martin, Perryololis, Pa.
Wade P. Hamilton, Box 43, Pullman, Wash.
Louis V. Babcock, 171 South Market St., San Jose, Calif.
Frank Perez, 751 Belden St., Monterey, Calif.
M. C. Burnaugh, 1443 Hudson Ave., Apt. 4E, Chicago, Ill.
O. Clayton Smith, 2316—4th Ave., Los Angeles, Calif.
Egbert J. McKay, 5 King Street, Kingston, Jamaica, B.W.I.
August Scheidt, 261 E St., Fresno, Calif.
Pedro R. Hernandez, P. O. Box 1129, San Juan, P. R.
Joel B. Hoberman, 115 Salem St., Malden, Mass.
Harry Z. Matthews, 1838 Vyse Ave., New York, N. Y.
Sherman E. Carr, 28 Leslie St., Lawrence, Mass.
Chas. L. Zinkan, 6012 Prentice St., Cincinnati, Ohio
Joseph D. Nalitz, 236 So. Pacific Ave., Pittsburgh, Pa.
Vinson Casey, Sidney, Mont.
A. D. Golden, 6528—20th, N.E., Seattle, Wash.
L. D. Wolfe, 1635 So. Sutter St., Stockton, Calif.
A. L. Crim, 1321 E. Elm St., New Albany, Ind.
J. Andrew Smith, 603 N. Iola, Pueblo, Colo
Raleigh H. Padgett, 421 No. 15th St., Terre Haute, Ind.
Hugo Castelli, 744 So. Ottowa St., Joliet, Ill.
Orval McClellam, 206 Rockwell St., Jackson, Mich.
Joseph Romallo 2nd, Montefiore Hospital, Gun Hill Road, Bronx, New York, N. Y.
Paul J. Shaffer, Shaffer's Radio Shop, Terra Alta, W. Va.
Jean A. Cotri, 718 Atwells Ave., Providence, R. I.
Howard Bowron, 809 So. Oak St., Graham, Texas.
Frank P. Brennan, Operator, VE1CS, 15 College St., Halifax, N. S., Can.
Ernest F. Matchulat, 942 Prescoth Ave., Scranton, Pa.
Freelan Shafer, Eyers Grove, Pa.
Edward C. Lake, 58 West 91st St., New York, N. Y.
Harold R. Hensen, 595 Sycamore St., Buffalo, N. Y.
Ralph J. Holbrook, 708 E. Airline Ave., Gastonia, N. C.
Francisco Lopez, Radio Technician, Bureau of Post Radio, Pasay, Rizal, Philippines.
A. D. Sheneman, 527 Mary St., Marion, Ohio.
J. A. Wetzel, Brisbane, Calif.
Chas. McComb, 127 Liberty St., Battle Creek, Mich.
Joseph E. Pincar, 6-O'Briens Court, Bayonne, N. J.
K. A. Neise, 33 Ashland Ave., River Forest, Ill.
Glyndon Lynde, Hartington, Nebr.
James L. Estell, 211 N. Eureka Ave., Columbus, Ohio.
Fred B. York, 30 Hancock St., Newburyport, Mass.
Ralph Wright, 1102 Longfellow Ave., Bronx, N. Y.
Nathan Sirot, 1421 Clinton Ave., Bronx, N. Y.
Abe Ginsberg, 2307 E. 37th St., Kansas City, Mo.
Frederick Eisenberg Selig, 482 Cherry St., New York, N. Y.
Geo. Stoffregen, Jr., Cornelia, Ga.
R. C. Jones, 1732 Bluff St., Des Moines, Iowa.
Irvin J. Archey, 558 E. 50th St., Chicago, Ill.
Thos. Thompson, c/o Radio Station WHBG, Memphis, Tenn.
Charles Myers, 11 N. Ann St., Baltimore, Md.
Francis Weidler, McKean, Erie Co., Pa.
David A. Mennie, 1162 Granville St., Vancouver, B. C. Can.
Hugh Gordon, Soldier's Hospital, Sulphur, Okla.
Dwight Hill, 667 California, Huron, S. D.

Short-Wave Club

Short-Wave Editor, Radio World, 145 West 45th Street, New York, N. Y.

Please enroll me as a member of Radio World's Short-Wave Club. This does not commit me to any obligation whatever.

Name ....

Address ....

City .... **State** ....

☐ **I am a subscriber for Radio World.**

☐ **I am not a subscriber, but buy copies at news-stands.**

Seven Tube Chassis Uses Re

By Herma

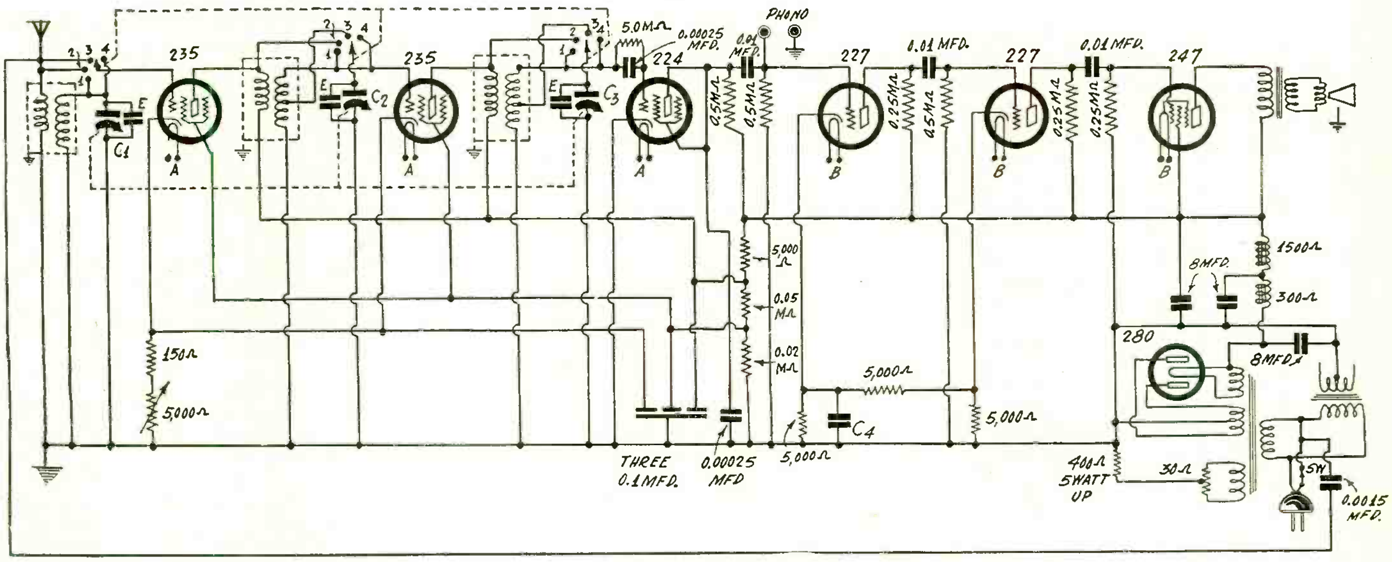


FIG. 2
The regenerative audio circuit discussed in the preceding pages is included in this 7-tube all-wave tuned radio frequency receiver. C4 may be 0.1 mfd., but if smaller capacity removes the high pitched howl, use that. The circuit is utterly stable when bypassed as recommended.

IN the construction of a tuned radio frequency receiver, some data will call for husky primaries, other data for skinny primaries, while it is well known that the limit on the number of primary turns connected in plate circuits is the oscillation point. So a set that has 30 turns on the primaries may not oscillate at any setting of the volume control, on any frequency, whereas one with a few turns, say 10, would oscillate. Just that condition was experienced in working on the circuit shown in Fig. 2, where skinny primaries are used, and wherein also the regenerative audio frequency channel is used.

The reason for the difference in the number of primary turns is the sensitivity of the detector. As the detector becomes more sensitive, the heightened amplitude is reflected to the preceding stages, and the tendency toward oscillation rises. It is the same with a radio frequency amplifier and with an audio channel: the system constitutes a unit, and what is done at any particular point affects all points in that channel. Receivers therefore may be regarded as two-unit system, one being radio frequency, the other audio frequency, while the detector is truly a link between the two, comprising something of each, common to both.

Why 8 Turn Primaries Sufficed

It may surprise many to learn that the set was built of shielded coils, the shield diameter being about 2⅛ inches, and yet with 10 turns on the primary there was oscillation, and the number of turns had to be reduced to 8 before oscillation stopped. Also, despite the choke primary which builds up the low radio frequencies in the antenna circuit, the oscillation showed up on the high frequencies. Of course, the volume control could check it, but the inflexible goal is to avoid regeneration at radio frequencies on the broadcast band.

There is a great latitude left to designers of tuned radio frequency circuits as to sensitivity and selectivity. Naturally, the more turns on the plate circuit primaries, the greater the sensitivity, the less the selectivity. Also sensitivity shows up most apparently as greater volume on local stations, with some difficulty in obtaining distant stations when the locals are on in any three-tuned-circuit system.

The effect of increasing the number of turns is to increase the coupling. I doubt very much whether the larger number of turns increases the impedance of the plate load, because the plate coil is fed with a resonant frequency, and where the input to a transformer is at resonance, and the secondary output is likewise, the impedance is the same for both, I believe, despite dissimilar number of primary turns, within practical limits, say 5 and 50 turns primary. This should hold true in the working realm, that is, affecting the degrees of coupling normally used, and is to be distinguished from the impedance changes in the primary and secondary due to the coupling itself. The point is that whatever it is for one it is for both,

LIST OF PARTS

Coils

One shielded antenna coupler, two shielded interstage couplers, as described
One power transformer, to handle five heater tubes, one 247 and one 280.
One B supply choke coil and one output transformer (both built into speaker)

Condensers

Two 8 mfd. wet electrolytic condensers with brackets and one dry 8 mfd. (next to rectifier)
Three 0.1 mfd. condensers in one case
Three 0.01 mfd. fixed condensers
One three-gang tuning condenser, C1, C2, C3
Three equalizers (E) for tuning condenser
One 0.00025 mfd. grid condenser with clips, on insulating disc
One 0.00025 mfd. fixed condenser
One 0.0015 mfd. fixed condenser
One 0.05 mfd. or 0.1 mfd. (C4)

Resistors

One 150 ohm flexible biasing resistor
One 5,000-ohm potentiometer or rheostat, with a-c switch attached
One 5 meg. tubular grid leak
Three 0.25 meg. pigtail resistors (250,000 ohms)
Two 0.5 meg. pigtail resistors (500,000 ohms)
Four 0.005 meg. pigtail resistors (5,000 ohms)
One potentiometer, maximum 10 to 30 ohms
One 0.05 meg. pigtail (50,000 ohms)
One 0.02 meg. pigtail (20,000 ohms)

Remaining Parts

Antenna and ground connectors
One four-point, triple throw rotary selector switch, shaft insulated from everything.
One dynamic speaker, with pentode output transformer and field coil of 1,800 ohms d-c resistance built in
One chassis, 13½ inches wide, 9½ inches front to back, with front and rear elevating flaps 3 inches high; drilled for sockets, inductance switch, volume control, etc.
Two UY sockets, marked 235, one UY marked 224, two UY sockets marked 227, one marked 247, and one UX socket marked 280
One a-c cable and plug
One full-vision illuminated vernier projection dial, travelling light type; scale; escutcheon; 2.5 volt pilot lamp
One roll of hook-up wire
One bakelite strip for holding audio resistors and audio isolating condensers
One phonograph twin jack assembly
One cabinet (may be of midget Gothic arch type)

generative Audio System

Bernard

being the impedance at resonance, which does not depend on number of turns.

The situation, of course, is different where the voltage fed to the primary is not of the frequency of the secondary, for then the primary and the secondary have independent impedances.

Hum Reduction

Of course, in any set the fact must be realized that some one is to purchase it, and has to be satisfied. So he makes his own test in a demonstration. He may know nothing about radio, still he is strong for the demonstration, as well he should be. Two important facts interest him in an alternating current design. He does not want the set to hum, but he does want plenty of pep. A third factor also of interest to him is the price, but we need not go into that.

Elimination of hum is entirely practical, and since not much of the hum experienced will be due to radio frequency modulation, because the filter will suppress the ripple voltage sufficiently to protect the r-f tubes, so the detector may be analyzed first for hum elimination.

There are only two types of detectors generally used—grid leak and negative bias. The grid leak type is in several styles, depending on leak and condenser values, but the hookup is the same. More sensitivity by far results when the condenser is somewhere near the usual value of 0.00025 mfd. and the leak value high. Also, the higher the leak value, usually the less the hum, until the value gets to be well beyond 5 meg., when the detector may show signs of becoming erratic. Also the low-note reproduction is improved when high leak value is used.

Work on the Detector

In line with the recommendation of increased resistance is the plate load. Nowadays this is usually a pigtail resistor, and while 0.25 meg. is normally recommended for a screen grid tube, for any type detector, it is a fact that the higher the plate load resistance, the lower the feedback through the detector. This feedback has to do with audio frequencies. So if the audio amplifier is a good one, it will tend to amplify the 120 cycle hum (second harmonic in a full wave rectifier) rather strongly, and means must be adopted for remedying the feedback that augments hum.

Even with the filtration not changed, the hum level will be found easily low enough, with remedies applied as described, though at first blush it seemed the rectifier filtration was sadly and irretrievably at fault.

Fig. 2 shows a circuit with 0.5 meg. as the plate load resistance, for then the voltage output from the detector was considerably greater than with 0.25 meg. Of course this is a special type of detector, using a 224 tube with screen and plate tied together, constituting a high mu three element tube, but the same principle applies to increased plate load resistance to decrease feedback no matter what the type of detector. Also, 0.75 meg. and 1 meg. were tried, with greater output, but then the low notes were too strongly favored, and the hum began to reappear.

The recommendation therefore is that the detector plate load be at least doubled, and that still higher values be tried for their effect, as an experiment, for in some circuits 1 meg. will be all right.

Low Leak Values

In any audio amplifier the amount of amplification in the low frequency region is limited by oscillation at a motorboat frequency, just as oscillation is the limit to all systems, radio or audio. So if a circuit can motorboat it is a good sign, for the low notes, usually slighted, are being given more than a fair shake and a square deal. If a circuit motorboats, the leak value may be decreased in any audio grid circuit until the trouble disappears, and no hesitancy need be felt on this score, for, as pointed out in last week's discussion of audio circuits, the theoretical considerations regarding leak values and stopping condenser values do not apply. When the trouble is there, regeneration is palpable, the full sign and proof of the energetic handling of low notes. And a circuit can not be worked to amplify in any region unless it is stable. Therefore you will get fine results even if a leak value in the audio channel has to be only .05 meg., for, as repeatedly stated, we are dealing with a unit, and what is done at one place is done all over. What affects one stage affects all stages. If you connect three resistors in parallel, or series parallel, you can not change the resistance value of one of the resistors without changing the net resistance value of the combination. Tubes and their loads are as resistors, or better, as impedances, and the three audio tubes are in series, with plate and grid loads in parallel with the tubes they couple.

A device popularly used is to have a negative bias or power detector with the usual value of biasing resistors, say, 0.02 to .05 meg. (20,000 to 50,000 ohms), and to put a relatively small condenser across it. Normally you would expect 8 mfd., and you can get a better low note response by using it, but you may get too much activity in the low note region due to stray feedback, so the need of a small condenser where a large one is expected is overcome by the feedback conditions. As an auxiliary to the method of using a small bypass condenser a filter circuit usually is incorporated, consisting of a high resistance and a small capacity, say, 0.5 meg. and 0.25 meg. mfd. That capacity is small to audio frequencies. That circuit has all the earmarks of a low pass filter, but in actual practice it works out as a high pass filter. If the comparison is made between the full load without the capacity (plate load resistor and the 0.5 meg. in series), next with the condenser included from the juncture t of the resistors to ground or cathode, then the fact that upper frequencies are passed becomes obvious.

The effect of such a filter also is to reduce the applied plate voltage. When the condenser is omitted the effect of applied voltage reduction is absent, because the same voltage is applied, only the load is increased, and of course the effective plate voltage is lowered, but that is immaterial, except that current is reduced and bias reduced. The greater the voltage drop in the load resistors, in general, the better, for it is this drop that constitutes the input to the next tube. The isolating or blocking condensers serve merely to maintain the grid d-c voltage immune from the plate d-c voltage of the preceding tube.

The Extra 8 Mfd.

In the rectifier filter, at right, three 8 mfd. condensers are shown, one at a tap 300 ohms removed from the rectifier filament. But this condenser, while helpful in many instances (depending on the apportionment of the tap in respect to total inductance, and on the value of capacity next to the rectifier) is not always effective. The shift in phase taking place may cause increased hum, in some instances, but when there is opportunity to use the interior condenser, it should be used; for when the circuit justifies it, the improvement in hum elimination is considerable.

If there is one place where increased capacity decreases hum it is next to the rectifier, although 8 to 10 mfd. is about as high a capacity as one should put there, for reasons of safeguarding rectifier tube life, as the starting drain on the 280 becomes very high indeed when much beyond 8 mfd. is used in that position.

The rectifier filter is in the positive leg, while an independent resistor of 400 ohms is used for pentode bias. It is practical to put the rectifier filter in the negative leg, and get the bias for the pentode from the 300 ohm section of the field coil, in which case center of the 2.5 volt winding would be grounded, B minus would *not* be grounded, and the condenser from B minus to B plus would have to be insulated from a metal chassis, for the chassis will be grounded and B minus will not be, hence there is a voltage difference between cans. This subject was discussed more fully last week.

The voltage divider is made up of pigtail resistors of the low wattage type. Rating of 1 watt is all right.

Circuit and Waves

The circuit, looking it over as a whole, consists of two stages of tuned radio frequency amplification, using 235 variable mu tubes, and a tuned input to a special type of 224 detector; an audio channel comprising three stages of resistance coupling, using 227's, and a pentode output, 247. The rectifier is a 280. Total, seven tubes.

The wave band coverage is as follows: Broadcast band in full at either extreme setting of the switch; 204 to 67 meters at the next settings of the switch; above 67 meters to below 30 meters for the other setting of the switch.

The reason for the uncertainty of coverage on the last setting of the switch is that the primary is tuned, and the band will depend on the number of turns on the primary. It might seem that with 8 turns, as compared to 35 turns there would be a great difference, but sets of this kind do not prove very lively at the extremely low wavelengths, and it is not safe to expect much below 26 meters, no matter how few turns are used for the third band. The wavelength ratio for the condenser will be about 1 to 3, so a tap on the secondary would start you at 67 meters, and for the third case, any winding that would bring you up to 67 meters would tune you down as far as it is practical to tune with this system, anyway. The way out would be to use independent coils for each band, but that would mean seven coils, and a large set, relatively an expensive one, too. But the seven tube outfit diagrammed could

(*Continued on next page*)

(Continued from preceding page)

be built, including speaker, cabinet and everything except tubes, for less than $35.

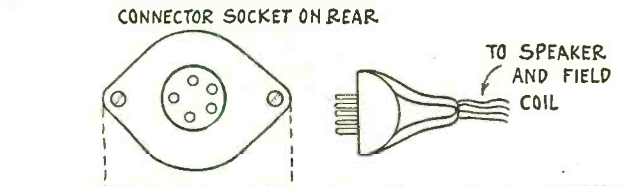
Below the broadcast band the set will oscillate, until it reaches its lowest region of workability, when oscillation stops and reception, too. There is a lowest limit to all sets, due largely to capacity factors associated with tube construction, the set wiring, etc.

Now for a few constructional pointers. The chassis may be laid out as shown in Fig. 3. The same constructional plan applies to a five tube, six tube or seven tube outfit. The five tube job would be built using the sixth hole for a socket into which would be plugged the connector from the dynamic speaker. This prevents breaking the speaker transformer and ch B field coil leads when making an installation in a midget cabinet. The plug is virtually standard practice. For a six tube circuit the six socket holes on top would be occupied by tubes, but there would be a speaker plug socket hole at rear flap. The seven tube job would be along the same lines as the six, except that an extra socket hole would be located behind the power transformer, where is now empty space.

The five tube chassis is covered by Blueprint 627, and is a set for broadcast coverage only, while the six tube design is for, say, 26-550 meter coverage, and is shown in Blueprint No. 626. The six tube design is like the seven tube circuit, Fig. 3, except for the extra stage of audio, so that Blueprint 626 will have to serve for both cases, the changes not being much, and the adjustment easily made.

The coil data for 0.00035 mfd. for Fig. 3 will be published next week.

[Extremely high gain at radio frequencies can be effectuated in this circuit, as will be disclosed next week.]



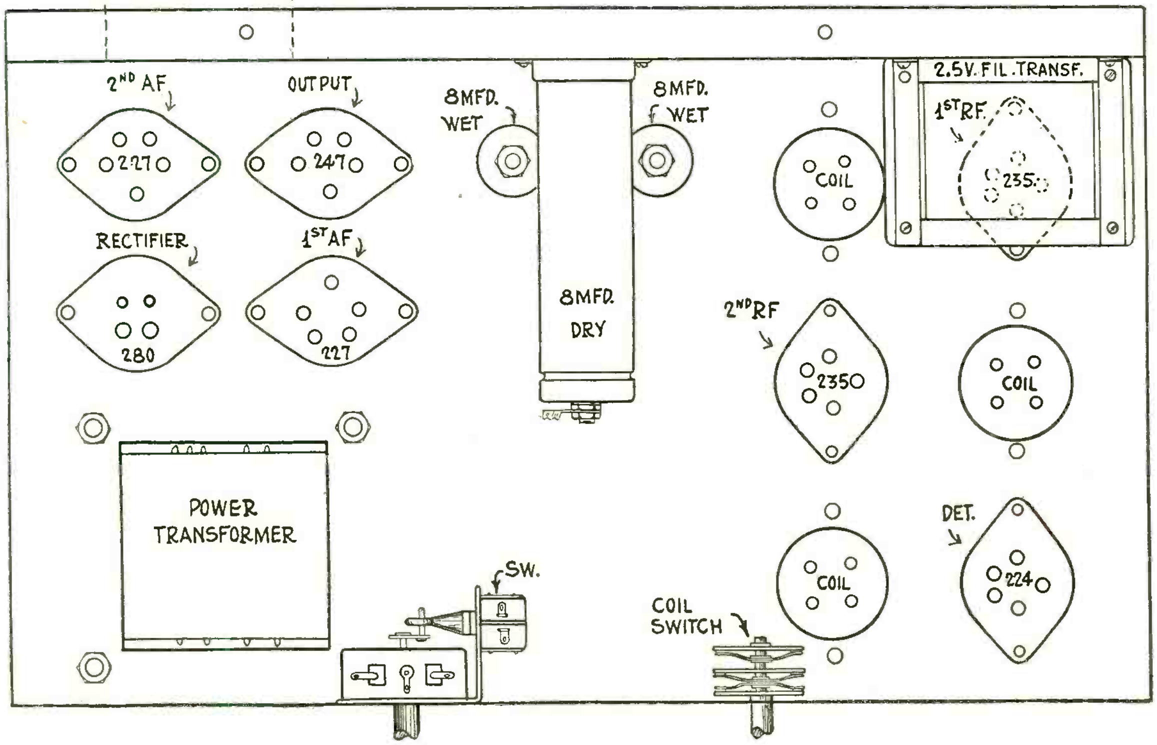


FIG. 3

Arrangement of parts for the circuit diagrammed in Fig. 2. A 2 1-2 inch square passes the power transformer winding through the chassis. The coils are shown staggered here, in case you desire to use 2 1-2 inch diameter shields, which would not fit in line.

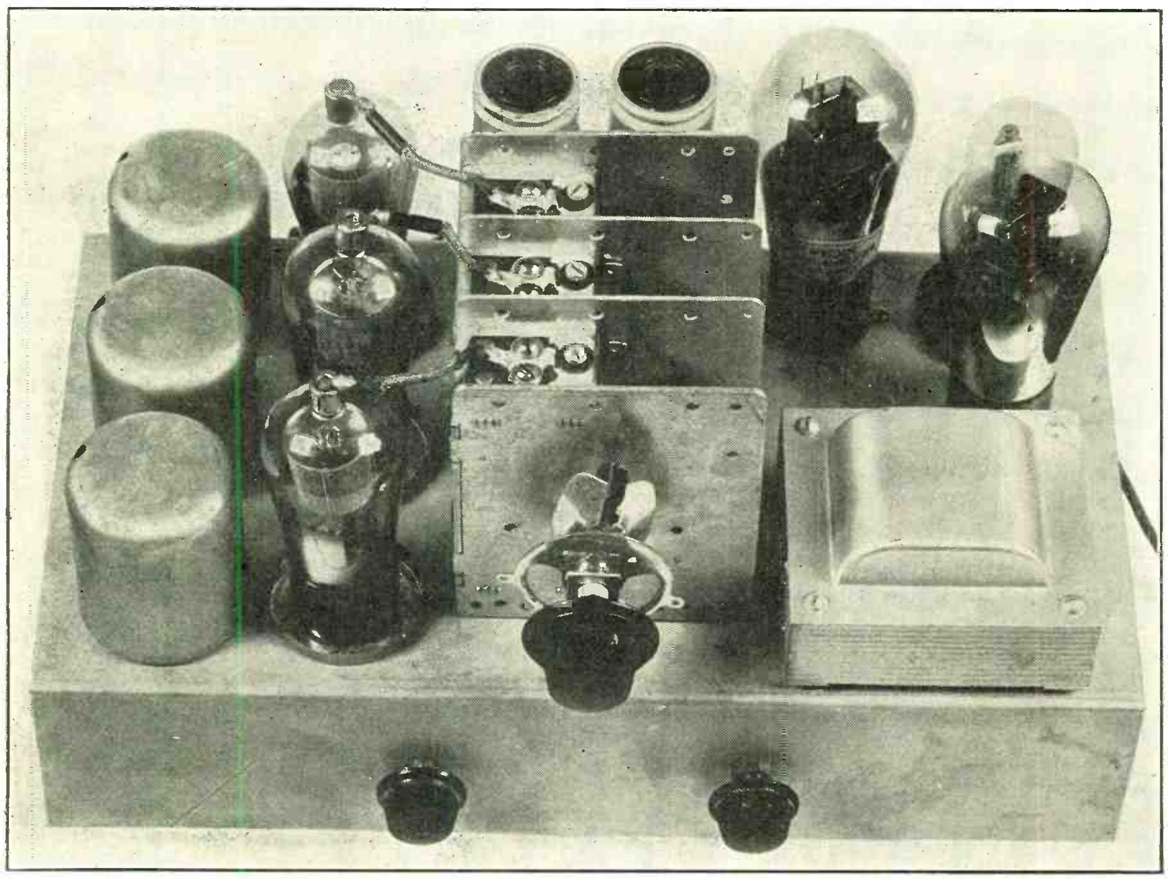


FIG. 4

Layout of parts for a five, six or seven tube midget. The width is 13½ inches, the depth 8½ inches, the chassis flap 3 inches. The two r-f stages and detector are at left. One tube more or less may be used at right for five or seven tubes.

Feedback Analyzed

The Action to the Bernard Amplifier Dissected

By J. E. Anderson

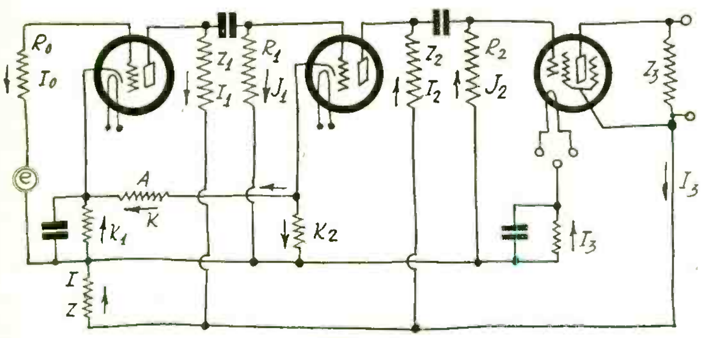


FIG. 1

The essential circuit of a three stage resistance coupled amplifier with the currents in the various impedances indicated as to direction to show the feedback.

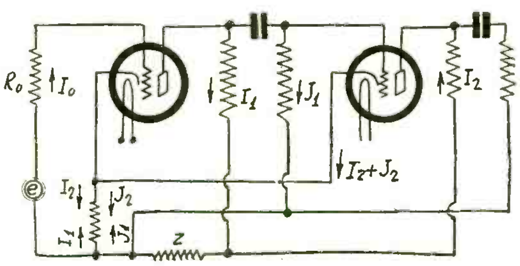


FIG. 2

This circuit shows how a grid bias resistor common to two similar tubes will cause regenerative feed back which may upset stability.

FEEDBACK, both regenerative and degenerative, can be studied qualitatively very simply by drawing arrows by the various impedances to represent the instantaneous direction of the signal current. Analysis of this kind shows what results should be expected from an amplifier, particularly one of the resistance coupled type.

Consider the circuit in Fig. 1. It contains three tubes and is a typical resistance coupled audio frequency amplifier. There are two familiar effects in such an amplifier. One is motorboating due to feedback through the impedance of the B supply, which is common to all the plate circuits. The other is degenerative feedback due to the presence of grid bias resistance not shunted with adequate condensers.

In Fig. 1 the impedance of the B supply is represented by Z and the signal current through it by I. Other impedances are indicated by subscripted Z's and R's and other currents are indicated by subscripted I's, J's and K's. The arrows indicate the directions of the instantaneous values of current, all based on the direction of the input voltage *e* at that instant. This voltage is assumed to be, at the instant considered, such that the current Io, if it could flow, would be in the direction indicated by the first arrow. The directions of all other currents are then determined.

Feed Back Through Z

The current through Z is mainly determined by the plate current in the last tube, because this current, in general, is many times larger than the sum of all the other currents, or at least to the sum of all the currents that flow in the opposite direction through Z. The current in Z, therefore, flows toward ground at the instant considered. It will be noted that the current Z1 flows in the same direction. Hence the feedback from the third tube to the plate circuit of the first cause regenerative feedback which might cause motorboating.

If the conditions of the circuit should be such that the current in the third tube were equal to or less than the current in the plate circuit of the second, the feedback would either become zero or degenerative. This is not likely to happen in ordinary circuits.

It will be noticed that the feedback from the second tube to the first is such as to reduce the amplification, for the I2 part of I flows in the opposite direction to I1. If there were one more plate circuit to contribute to I, the circuit would become relatively stable because I in this case would be opposed to I1.

The diversion of currents through the grid leak, as currents J1 and J2, help a little to stabilize the amplifier because the diverted current does not flow through Z. Still, in most cases, unless special precautions have been taken, a circuit having three tubes on the same supply and a common impedance Z is oscillatory. That is, it motorboats.

Reverse Feedback

If there is a bias resistance in any cathode lead serving one tube only, the feedback in this resistance is degenerative. This can be seen in all three tubes in the figure. Consider the first, for example. Io is in the direction toward the grid and away from the ground. The feedback current K1 is toward the cathode and away from the ground. The input voltage is the drop in the bias resistance plus the drop in Ro, that is, the total voltage drop encountered in going from the cathode to the grid. It is clear in view of the direction of K1 that the bias resistance drop is such as to oppose the input voltage.

The same holds true in the second tube in which the bias resistance drop due to K2 is opposed to the input voltage, which is the voltage drop due to J1 in R1. Again, in the third tube the drop due to I3 is opposed to the drop in R2 due to J2. Every bias resistance causes a reduction in the amplification in the tube it serves provided that the resistance does not serve two or more tubes simultaneously.

Combining Bias Resistances

It is interesting to note what will happen if we put two successive tubes on one bias resistance. This is shown in Fig. 2. The plate currents of both tubes now flow through the single resistance, as well as the two J currents diverted into the grid leaks. Due to the amplification in the first tube, I2 plus J2 is greater than I1 plus J1. Hence the net current in the bias resistance is in the same direction as Io and consequently the feedback is positive and aids the amplification.

We see, therefore, that if we use individual grid bias resistances without by-pass condensers across them the circuit is relatively stable and may not oscillate even if there is considerable positive feedback in the B supply, but will be weak and impaired. We also see that by combining two adjacent tubes on the same grid bias resistance, without using a by-pass condenser, we can again make the circuit regenerate. This regeneration may be so great that it upsets the stability of the circuit. Hence we should have some means of varying the amount of feedback.

Returning to Fig. 1 we note that there is one bias resistance for each tube and that the cathodes of the two first tubes are joined by a resistance A. This constitutes the Bernard amplifier. The resulting feedback may be estimated by the directions of the arrows and the magnitudes of the various currents. Part of the total plate current in the second tube goes through the bias resistance, and this part we represent by K2. The other part, which is the feedbacg part, goes through the connecting resistance A. and this part we call K.

Controlling the Regeneration

What happens when K comes to the cathode of the first tube? If it flows down to ground through the bias resistance it flows in the opposite direction to K1. It neutralizes the reverse feedback, in whole or in part, because K1 is less than it would be if K did not come up to the cathode. If K does not flow to ground through the bias resistance, it backs up through the cathode and joins I1 and J1, in phase. Hence there is regeneration. Either way the current flows the result is greater amplification in the first tube. Of course, both the effects occur—current K reduces the current K1 and increases I1 and J1. We are speaking only of the instantaneous current due to a signal impressed in the grid circuit of the first tube. The bias or the steady plate current in any tube does not enter the discussion.

(*Continued on next page*)

Receivers for Direct

Automotive type tubes make economical anc

By Brunsten

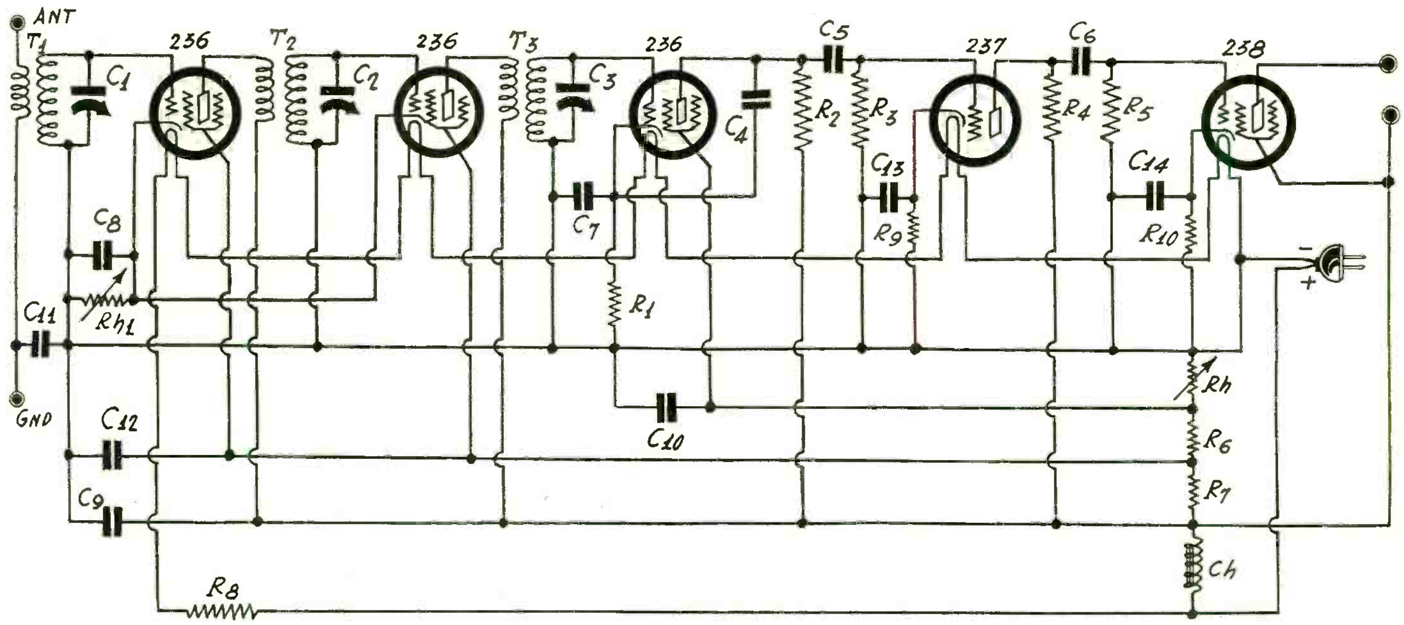


FIG. 1
The circuit of a five-tube receiver designed for automotive tubes and d-c line operation. In this circuit the grid bias is obtained with bias resistances. Fig. 2 will be published next week.

THE automotive tubes are not only useful for automobile receivers but also for home receivers designed to operate on direct current power lines. For this purpose these tubes are superior to any of the filament type of tubes because they will hum less and they do not take any of the plate voltage for the heaters. That is, the full 110 volts may be applied to the plates even though the heaters may require a total of 36 volts or more. There is an exception to this. If it is not desired to have a battery for grid bias, this must be taken in part at least from the voltage that should be used for plate voltage.

There are two ways in which the circuit may be connected. In one the grid bias is obtained by suitably returning the cathodes and the grid circuits. In the second, individual grid bias resistances are used to provide the bias. The first of these is less expensive to build but it may result in a louder hum because the bias voltage is not well filtered. The second method costs more to use because grid bias resistances are needed. With this method the bias is the result of the flow of filtered current through the bias resistances and hence there is little chance of hum.

Bias Resistor Circuit

In Fig. 1 we have the circuit which utilizes the grid bias resistances for all the tubes. In this circuit it will be noted all the grid returns are made to the negative side of the line. Likewise all the cathode returns are made to the same point. By cathode return in meant the negative end of the grid bias resistance, or the cathode itself in case there is no grid bias resistor.

The first two tubes have a common bias resistor Rh1. This serves not only to bias the grids but also to control the volume, because the maximum value of the variable resistor is much higher than the resistor which gives best amplification. A 3,000 ohm wire wound resistor is suitable. A condenser, C8, of 0.01 mfd., is large enough across this resistor.

The detector, which is the third and a screen grid tube, requires a much higher bias than the radio frequency amplifiers. R1 provides bias for the detector. If the applied voltage in the plate circuit is 180 volts, and if the plate coupling resistance R2 is 250,000 ohms, and if the applied voltage in the screen circuit is 40 volts, the value of R1 should be 30,000 ohms for optimum detection. A 2 mfd. condenser C7 across

LIST OF PARTS

Coils—
T1, T2, T3—Three shielded radio frequency transformers for 460 mmfd.
Ch—One low resistance filter choke coil.
Condensers—
C1, C2, C3—One triple gang of 460 mmfd. tuning condensers.
C4—One 250 mmfd. condenser.
C5, C6, C8—Three 0.01 mfd. condensers.
C7, C10, C12, C13—Four 2 mfd. by-pass condensers.
C9, C14—Two 4 mfd. by-pass condensers.
C11—One 0.001 mfd. condenser.
Resistors—
Rh—One 2,500 ohm variable resistor.
Rh1—One 3,000 ohm variable resistor.
R1—One 30,000 ohm resistor.
R2—One 250,000 ohm plate resistor.
R3—One 2 megohm grid leak.
R4—One 100,000 ohm plate resistor.
R5—One 1 megohm grid leak.
R6, R10—Two 1,300 ohm resistors.
R7—One 6,500 ohm resistor.
R8—One 262 ohm heavy duty resistance, 25 watts or more.
R9—One 5,000 ohm resistor.
Other Parts—
Five UY sockets.
Four binding posts.
Four grid clips.
One dial for condensers.
One line plug.

Current Flow in Ne

(*Continued from preceding page*)

If resistance A be made variable the amount of feedback may be controlled since the value of K can be controlled. There is one value of K at which the feedback is just sufficient to neutralize the reverse feedback in the first tube due to the plate current of the tube. If the feedback is increased a little more it will be just sufficient to offset the reverse feedback in the second tube. Hence by means of a resistance it is possible to secure the effect of enormously large by-pass condensers across the bias resistances.

Even more can be accomplished, for if the feedback is increased still further reverse feedback in the last tube can be compensated for, and even then the limit has not been reached. Of course, it is assumed that the circuit is practically non-reactive.

Current Line Operation

efficient receivers; Ideal for DC operation

Brunn

the bias resistance and a 0.00025 mfd. condenser from the plate to the cathode, add to the detecting efficiency.

The fourth tube in the circuit is a 237 and operates as a resistance coupled audio frequency voltage amplifier. Its plate resistance R4 is 100,000 ohms and the grid bias resistance R9 is 5,000 ohms. A 2 mfd. condenser C13 is across the bias resistance to prevent reverse feed back.

The Power Stage

The power stage utilizes a 238 pentode, which takes the same heater current as the other automotive tubes. It requires a bias of 13.5 volts and the combined plate and screen currents are 10.5 milliamperes. Hence the bias resistance should be approximately 1,300 ohms. This may be made up by connecting 1,000 ohm and 300 ohm resistors in series. A condenser, C14, of at least 4 mfd., should be connected across this bias resistance.

All the heaters are connected in series. Since there are five of them, and each requires a voltage of 6.3 volts, the series will require 31.5 volts. Now the line voltage may be 110 volts. Therefore there is a difference of 78.5 volts, which must be dropped in a ballast resistor. R8 serves this purpose. The current required by the tubes is 0.3 ampere. Hence this current will flow in the ballast as well as in the heaters. Therefore the value of R8 should be 78.5/.3, or 262 ohms. If the line voltage is higher than 110 volts, it is necessary to use more ballast resistance. And if it is less than 110, the ballast should be less. For every volt the line voltage is in excess of 110 volts, there should be added 10/3 ohms to the ballast, and for every volt deficit there should be 10/3 ohms less than 262 ohms. As a matter of fact, the automotive tubes are not critical and even if the voltage is as high as 8 per tube, there is no danger, so that even if the voltage of the line is 125 volts there is no need of increasing the ballast resistor above 262 ohms, unless the voltage excess is permanent.

The Voltage Divider Design

The total available voltage is 110 volts. A few volts are dropped in the choke Ch, and another part, as we have seen, is utilized for bias. Hence the effective voltage on the plates is much less than it should be, but this cannot be helped unless we want to use a booster battery.

The voltage on the screen of the detector should be 40 volts, provided the other conditions laid down are satisfied for the detector. They are not, since the plate voltage is much less than it should be. Hence let us reduce the screen voltage in proportion. The voltage on the plate is low in the ratio 110/180. Hence the screen voltage on the detector should be 25 volts. This is to be the drop in Rh. We can choose any reasonable current through this. Let us choose 10 milliamperes. The Rh should be 2,500 ohms. If it is variable it furnishes an additional volume control.

The voltage on the screens should be 45 volts when the plate voltage is 135 volts. Since the plate voltage is low in the ratio 110/135, the screen voltage should be low in the same proportion. Therefore the screen voltage should be 38 volts. The drop in R6 should therefore be 13 volts. The current in R6 is practically the same as that in Rh, namely, 10 milliamperes. Hence R6 should be 1,300 ohms. The value of R7 should be 6,500 ohms. The resistance in the choke coil Ch should be low, so that the voltage drop will be small.

If we allow a total current of 25 milliamperes and the resistance in the choke is 400 ohms, the drop will be 10 volts. This is too much. A choke of only 200 ohms, or one of even lower resistance, would be better. It is not necessary to have as much inductances in the filter when the supply is direct current, because it is already fairly well filtered.

The Modified Circuit

Fig. 2 shows the wiring of the circuit when the bias for all the tubes except the detector is taken from the filament circuit. In this case there is relatively little filtering of the current so that there will be some hum voltage introduced into the grid circuits. This does not necessarily mean that there will be an audible hum in the output. But if there should be it is easily removed by putting a large by-pass condenser across the line from the plug. This condenser might be of 4 or more microfarads capacity.

The designated parts in Fig. 2 are the same as the corresponding parts in Fig. 1 and may be taken from the list of parts. If any part in the list is missing in Fig. 2, it is not needed. There is one main difference. In Fig. 2 is a potentiometer P across the power tube filament. This is the volume control and it varies the grid bias on the first two tubes because the cathodes of those two tubes are returned to the slider. The lower part of the potentiometer is a common bias resistance and carries the screen and plate currents of the first two tubes in addition to the current which flows because it is connected across the 6.3 volts of the power tube filament.

Variation of Volume

A suitable value for this potentiometer is 400 ohms, and it should preferably be wire wound. When the slider P is at the top the grid bias on the first tubes is 6.3 volts or a little more. This is high enough to reduct the amplification in the tubes to a very low level. By sliding down on P the volume increases gradually until it is maximum, which occurs when the bias is around 1.5 volts.

The bias on the detector is provided in the same manner in this circuit as in the preceding, namely, with a 30,000 ohm resistance R1 in the cathode lead.

The bias on the first audio frequency amplifier, a 237 triode, is obtained by connecting the grid return to the negative terminal of its heater and the cathode to the positive terminal. This makes the bias on the tube 6.3 volts, or equal to the voltage on the heater, which is near the recommended bias for this tube and voltage.

The bias for the power tube is obtained by connecting the grid return to the negative end of its heater, which coincides with the negative of the line, and by connecting the cathode to the positive end of the heater of the 237 tube. That is, the cathode of the power tube is connected by two heaters up from the point to which the grid return is connected. This makes the bias on the power tube 12.6 volts, which is all right even when the voltage on the plate is only 110 volts. The recommended bias is 13.5 volts when the plate voltage is 135 volts. If more satisfactory results are obtained when the bias on the power tube is only 6.3 volts there is nothing against using this voltage. It can be obtained in the same manner as it was obtained for the 237 tube. The cathode of the power tube is returned to the positive end of its own heater reader than to the positive end of the heater of the 237 tube.

High Amplification

The amplification in either of these circuits is very great so that a high sensitivity can be expected. However, the actual sensitivity in any case depends on how well the tuned circuits have been lined up. If the three condensers C1, C2, and C3 are on one gang it is necessary to have a trimmer across at least the first two, assuming that both the condensers and the coils in the three stages are equal effectively. The reason the trimmer may be omitted across C3 is that the input capacity to a tube having a resistance load is greater than the input capacity to a tube having an inductive load.

If the trimmers are not mounted on the condensers, 20-100 mmfd. detached trimmers may be used. By means of two of these, one across each of the first two tuning condensers, it is usually possible to trim the circuit accurately if the coils are equal. Coils may be obtained in sets to insure practical equality.

The better the circuits are trimmed the sharper will the selectivity be. Hence both sensitivity and selectivity are achieved by careful trimming.

While the set is sensitive and selective when adjusted

(*Continued on next page*)

---

w Audio Amplifier

In the practical case established in the Bernard amplifier the value of each of the bias resistances for the first two tubes was 5,000 ohms, and the connecting resistance A was a resistance having the same amount.

It will be noticed that when the connecting resistance A is used between the two cathodes in addition to the bias resistances, there is a change in the resulting bias. Part of the steady plate current in the second tube is diverted from the bias resistance and sent to the first. Hence, to maintain the bias constant it would be necessary to increase the bias resistance on the second tube and to decrease it on the first. However, neither bias resistance is critical. Since the last tube (247) overloads first, for practical purposes it is not necessary to make any changes. There is no change in the bias if the two tubes are equal and equally adjusted.

The Construction of a Nii

New tubes and tuned radio frequency am

By Burto

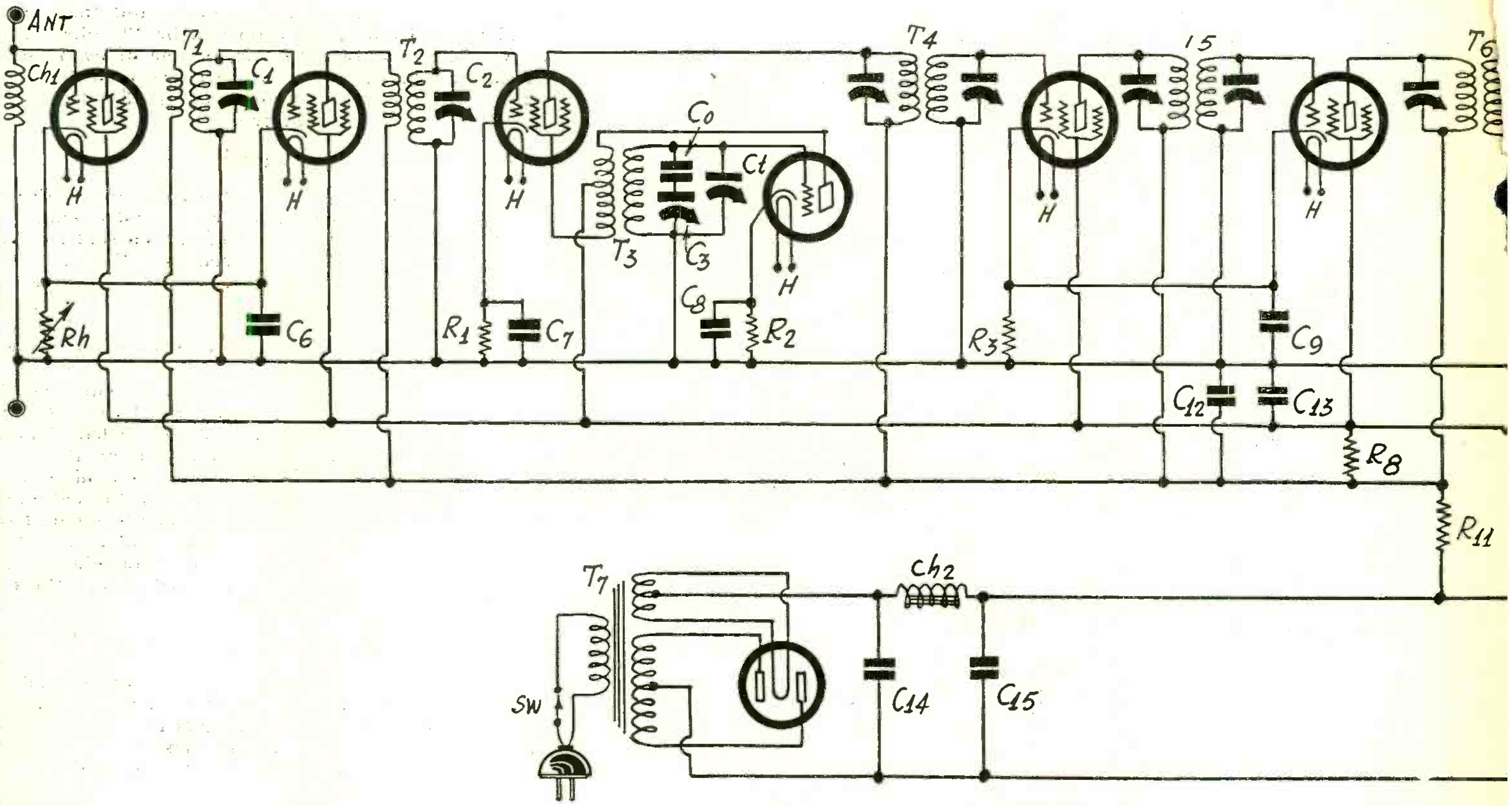


Fig. 1.
The circuit diagram of a nine tube superheterodyne utilizing the latest tubes, 175 kc. intermediate, and two stages of

MANY radio fans still want to try their hand building superheterodynes, and the circuits must have exceptional selectivity and sensitivity. If these are the two main conditions the superheterodyne answers the purpose. But there are also those who demand "a real superheterodyne which is supersensitive and superselective and which does not bring in any noise on distant stations." There is no real super of this kind and it is probable there never will be. If a set is supersensitive it will bring in noise with the distant stations, and there is no means at present of avoiding it. This does not mean that at some time signals will not come in clearly. Sometimes DX signals will be nearly as clear as locals.

The experimenter who is interested in superheterodynes might try his hand at the circuit shown in Fig. 1, which is nine-tube affair using the latest tubes wherever they are advantageous. At first we have two 235 r-f amplifier tubes. Then follow a 224 first detector and a 227 oscillator. In the intermediate frequency level we again have two 235 amplifiers, which are followed by a 224 detector. The second detector is coupled by resistance-capacity to a 247 pentode power tube. The 280 rectifier in the power supply is the ninth tube.

Gang Tuning

There are three tuned circuits in the radio frequency level. all controlled by the same dial. Two of the sections of the triple condenser are in the radio frequency tuner and the third is the oscillator circuit. The capacity of each section of the particular condenser used is 460 mmfd. The coils were made to match this capacity and the broadcast band.

The coils used for the radio frequency tuner are of miniature size. The secondary windings are wound on one inch bakelite tubing with No. 38 enameled wire. The primaries are wound over the secondaries with No. 40 silk covered wire. There is a thick layer of insulator between the two windings so that the primary winding diameter is nearly 1.125 inches. Each of these coils is housed in a metal shield measuring 2.125 inches in diameter and 2.625 inches in height. The location of these coils may be seen on the photograph of the set, which is reproduced on the front cover of this issue.

The oscillator coil is wound on a 1.75 inch diameter and is mounted under the subpanel, where it may be seen on Fig. 2. It contains 57 turns of No. 24 double cotton covered wire for the tuned winding, 30 turns of No. 32 enameled wire for the tickler, and 10 turns of the same wire for pick-up. That is, the tap on the fine wire winding is placed 10 turns from one end.

Tracking

It was not attempted to adjust the circuit so that it would track automatically throughout the tuning range. A trimmer was put across each of C1 and C2 of the triple condenser and the trimmers were adjusted until the tracking of these con-

110-V Direct C

(*Continued from preceding page*)

properly, it is not capable of a great deal of volume because of the limitation of the voltage. However, with a loudspeaker of average sensitivity the output will be more than ample for any living room, except possibly for dancing purposes. But in that case the noise may be increased by overloading the tube, since it does not matter whether or not the quality is perfect when the rhythm is the prime consideration.

It is quite possible to double the undistorted volume by adding another 238 power tube in parallel with the first. To make the connections the screens, plates and control grids of the two tubes are joined together. The heater of the added tube is cut into the heater circuit next to the first 238, in series, and resistance R8 is reduced by 21 ohms. That leaves the cathode of the added tube to be taken care of. It must be so connected that the added tube gets exactly the same grid bias as the first.

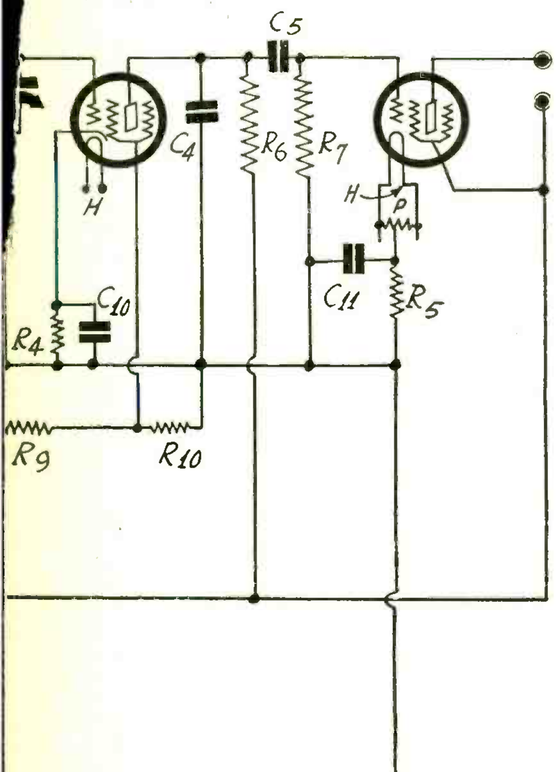
The two tubes have a common grid return, which should be the minus side of the line. The bias may be measured from this point to the cathodes. In order to give the same bias to the two tubes it is necessary to connect the cathodes to two different points. Connect them so that the bias, as measured with an ordinary voltmeter, either reads 6.3 or 12.6 volts for both tubes.

When two 238 tubes are to be used in the final stage it is

e-Tube Superheterodyne

lification insure high gain and Selectivity

Williams



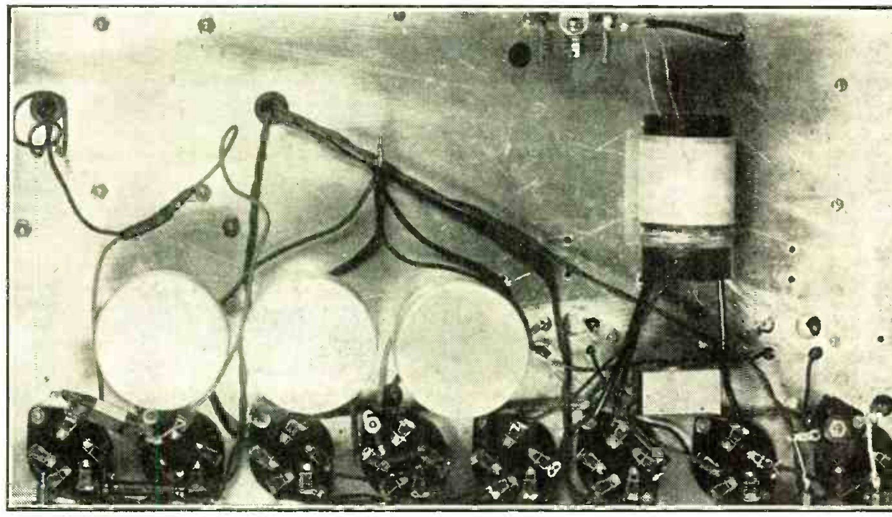


Fig. 2.
Bottom view of the nine tube superheterodyne showing the layout of the parts under the subpanel. Top view is shown on front cover. The pictures were taken before completion of the circuit.

tuned radio frequency amplification.

densers was satisfactory. As a course approximation of tracking in the oscillator a 0.001 mfd. condenser Co was put in series with the variable section. For fine adjustment a variable midget condenser Ct of 50 mmfd. was connected across the oscillator coil. The inductance of the coil was determined on this basis, as well as on the fact that the intermediate frequency was 175 kc.

Two radio frequency tuned stages were used to increase the sensitivity and the selectivity.

(Continued next week)

urrent Receiver

simpler to use the circuit in Fig. 1. The grid bias resistance R10 for two of the tubes becomes 650 ohms. The heater of the extra tube can be inserted in series in this circuit without causing any upset of bias. The only precaution is that the ballast resistance R8 should be reduced by 21 ohms when the extra tube is added. Reducing the grid bias resistance by a factor of two is also necessary, as was suggested above in giving the new value of 650 ohms.

Either of these circuits is very economical to operate. The heater current is only 0.3 ampere and the plate and bleeder currents do not amount to much more than 25 milliamperes. Hence the total current taken from the line is only 325 milliamperes. If we assume that the average line voltage is 118 volts, which is a closer estimate than 110 volts, the power is only 38.4 watts. At 7.5 cents a kilowatt-hour, it takes only 0.288 cents an hour to run it, which would add about 35 cents a month to the electric bill if the set were in operation four hours every day.

If operation costs so little, how much does it cost in the first place? To expend $20.00 would be an extravagance, for all the parts included in the circuit are inexpensive, including the triple tuning condenser. Even the tubes may be thrown in without exceeding the $20.00 limit. By careful shopping it might be obtained for $10.00.

LIST OF PARTS

Coils

Ch1—One 800 turn duolateral wound r-f choke coil
Ch2—One 30 henry filter choke
T1, T2—Two shielded radio frequency transformers
T3—One oscillator coil as described
T4, T5, T6—Three 175 kc intermediate frequency transformers
T7—One Kelford power transformer

Condensers

Co—One 0.001 mfd. condenser
Ct—One 50 mmfd. trimmer condenser with knob
C1, C2, C3—One triple 460 mmfd. tuning condenser
C4—One 0.0005 mfd. condenser
C5—One 0.01 mfd. condenser
C6, C7, C8—Three 0.1 mfd. condensers in one case
C9—One 0.1 mfd. condenser
C10, C12, C13—Three 2 mfd. by-pass condensers
C11—One 4 mfd. or larger by-pass condenser
C14—One 4 mfd. high voltage by-pass condenser
C15—One 8 mfd. high voltage by-pass condenser

Resistors

Rh—One 3,000 ohm variable resistor
R1—One 3,000 ohm fixed resistor
R2—One 1,000 ohm resistor
R3—One 150 ohm resistor
R4—One 30,000 ohm fixed resistor
R5—One 400 ohm grid bias resistor, 5 watt rating
R6—One 250,000 ohm plate resistor
R7—One 1 megohm grid leak
R8—One 5,500 ohm resistor
R9—One 4,000 ohm resistor
R10—One 3,500 ohm resistor
R11—One 2,500 ohm resistor
P—One 30-ohm Humdinger

Other Parts

Eight UY sockets
One UX socket
One line switch
Two double phone tip jacks or four binding posts
Six grid clips
One National vernier drum dial

A Converter with All

Two Tuned Circuits, Dynatron

By Henry

IN January, 1930, experimental work was begun on short wave converters, as it was felt that a great many persons would like a device to use with their broadcast sets to bring in short waves. By April highly satisfactory models had been produced, after much experimenting and, it must be admitted, the solution of not a few troubles. Then, early in May, or seventeen months ago, the first of a series of articles was published in these columns, embodying the results of those experiments. The expected interest was exceeded by far and soon the mail began to rain in on converter questions, until the subject eventually evoked more correspondence than broadcast sets and even short wave sets.

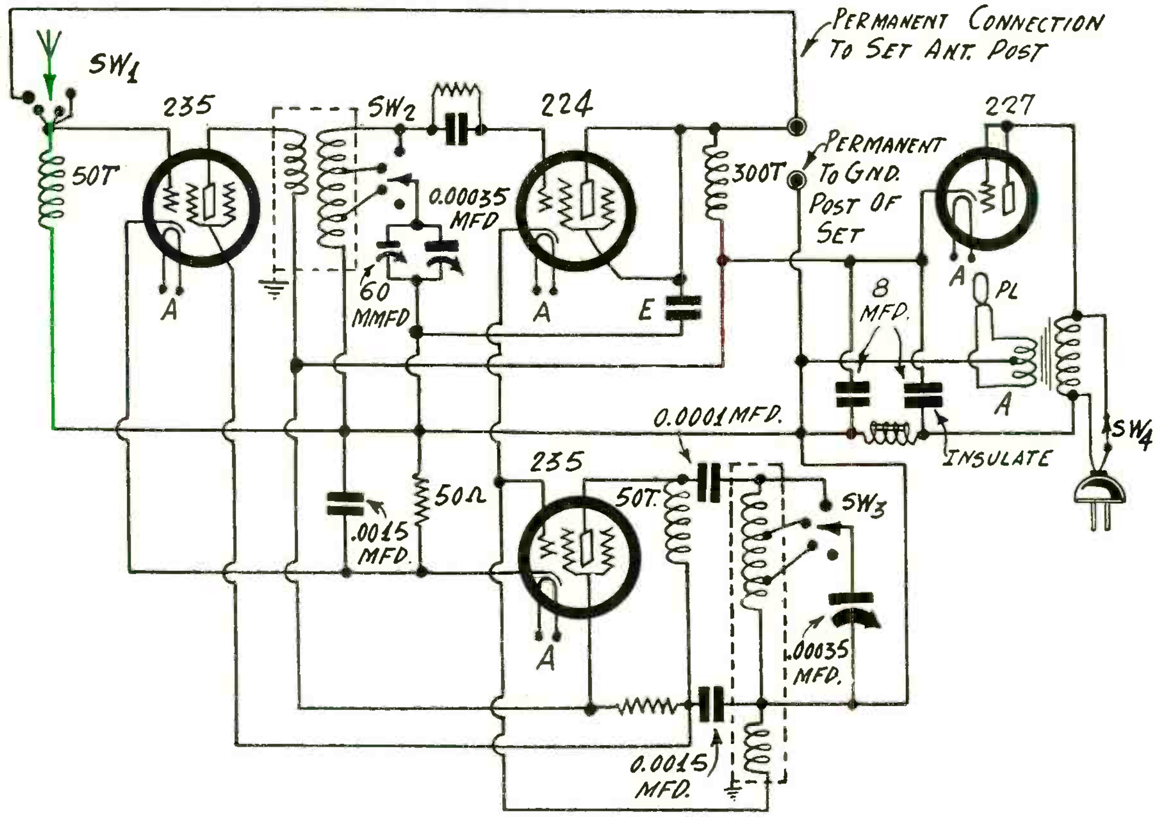


FIG. 1
The up-to-date short wave converter, 20 to 200 meters. A dynatron oscillator is used with grounded tuned circuit.

To-day, there is more interest in short waves than there was at any time previous.

Thus, seventeen months ago, RADIO WORLD started something when it began its converter series. Other magazines soon took up the subject, so that to-day you can hardly pick up any radio magazine without finding within its covers something about short wave converters.

Power for A-C Type

Improvements in converter design naturally have been made from time to time. The first converter published in these columns required that for alternating current models the B voltage be obtained from the receiver, although a filament transformer was included. The battery models of course did not require built-in power supply. However, the a-c type, it soon became apparent, would have to provide its own power, first because it was risky to run more tubes on a power transformer secondary than a set manufacturer intended (and none of the converters ran that risk), and second because there are so many different types of receivers that it is not practical to say, "find the B voltage," and let it go at that. In some instances it could not be found. Hence the converter with B supply built in was the result.

As it is not necessary to have high B voltage, around 100 volts being fully satisfactory, a hookup was designed, enabling the use of the 227 as rectifier. The current drain being small, less than 20 milliamperes in all instances, and in some instances only 6 ma., the voltage being around 100 volts, the 227 scheme would work out nicely.

The only drawback in the early models was that if the converter with such rectifier was to be grounded this grounding would have to be done through a fixed condenser. It was a satisfactory means, of course, but there was a voltage drop across the condenser, and if the condenser was large enough there might be a little hum if the ground lead was near a power line.

The next problem was to obtain a rectifier system using the 227 that did not prevent direct grounding, and the result was nicely achieved by putting the B supply choke in the negative leg of the rectifier. No short would result no matter which way

List of Parts

Coils

- **Two shielded tapped coils (see text) for modulator and oscillator**
- **Two 50 turn honeycomb coils**
- **One 300 turn honeycomb coil**
- **One 2.5 volt filament transformer with center tapped secondary**
- **One 15 henry B supply choke coil**

Condensers

- **One 0.00035 mfd. dual straight frequency line condenser**
- **One 0.00025 mfd. grid condenser, with clips; mounted on insulated wafer**
- **Two 0.0015 mfd. fixed condensers**
- **Two 8 mfd. electrolytic condensers, one with extruded and flat insulating washers and special connector lug**
- **One 0.00035 mfd. fixed condenser**
- **Two equalizers, 20-100 mmfd. (one used at full capacity as 0.0001 mfd., other to tune the 300 turn choke)**
- **One manual trimming condenser, variable (60 mmfd. or somewhat less)**

Resistors

- **One 5 meg. grid leak**
- **One 0.02 meg. pigtail resistor (20,000 ohms)**
- **One 50 ohm flexible biasing resistor**

Miscellaneous Parts

- **One chassis, 10x7x2⅞ inches**
- **One vernier flat type dial with pilot lamp and escutcheon**
- **One front panel, 10½ inches wide x 7.5 inches high**
- **One cabinet to fit**

the Modern Trimmings

Oscillator, Built in Power Supply

B. Herman

the a-c plug was inserted in the lamp socket or convenient outlet. The diagram, Fig. 1, includes the choke in the negative leg of the rectifier.

Then the dynatron oscillator was beginning to gain popularity, and also the 235 variable mu tube came along, and both considerations required that converter design keep pace. The dynatron oscillator was easily incorporated, for it consisted of tuning the plate circuit, with no load on the grid circuit, or only a pickup winding, while the usual voltage proportion was reversed, the higher voltage going to the screen.

Steady Frequency

A glance at Fig. 1 will confirm the fact that both the dynatron oscillator and the 235 tube are incorporated. In fact, there are two 235 tubes, one as untuned radio frequency amplifier, the other as oscillator. The modulator is a 224, while the rectifier is a 227.

The dynatron oscillator provides a steady frequency, and that is important. Previously the frequency drift was a little problem, where gang tuning was included and no manual trimmer to take up the difference.

On the other hand, some 235 tubes will not oscillate at as high a frequency as even non-screen grid tubes, but the limiting factor is not of great importance, for consistent results in oscillation down to 20 meters have been obtained, and there is no expectation that the converter will be of much service on lower waves.

In one of the early models published—not a dynatron and not a variable mu—a coil switch was included, so that plug-in coils were omitted. Just as the converter series itself was the forerunner of the present vogue, so was that coil switch the forerunner of the omission of plug-in coils. This omission is rendered possible by switching devices, various types of which have been introduced from many sources.

The present model goes one step farther and incorporates shielding. It probably will be found in months to come that nearly all the short wave devices will be shielded. Our first shielded converter circuit was published in June, 1931, so on the same basis there may be expected some shielded converters in commercial form in about a year.

Non-Shorting, Non-Dead-Ending

Few of the present day converters have a stage of untuned or tuned r-f ahead of the modulator, and while the gain from the untuned stage is small, the prime object is not to raise the amplification greatly, but to prevent radiation. The squealing present on short waves is just as bad now as it was on the broadcasting band during the chaos of 1927, and it is no indictment to be premature about preventing this trouble. In fact, the United States Department of Commerce, through its Radio Division, recently issued a warning against squealing on the short wave band, pointing out that it is tending to spoil the services rendered in this spectrum, and also warned against wobbling of transmission frequency.

From what users said and wrote it became apparent that they desired to hook up the converter permanently, and be able to switch the aerial from converter to set from the converter front panel. This convenience is introduced in the circuit, requiring an extra deck of the inductance switch. The device is a rotary selector switch of the four-pole, triple throw type, also known as a four point triple throw switch. There are three decks on it, one used in the antenna circuit (SW-1), another in the modulator circuit (SW-2), and the third in the oscillator plate circuit (SW-3). There are lugs on the switch for these purposes, and at non-symmetrical points there are three other lugs, one on each deck, representing the moving segment or index of the switch. The shaft to which the moving elements are joined is insulation material, and the switch is electrically independent of everything for that reason, even though the metal bushing at front is fastened to a metal panel.

Modern Improvements

So the converter may be said to incorporate most modern practice.

The wave band switching is accomplished by picking up either the full winding, to go a little above 200 meters, or either of two other points. The ratio is about 1-to-10 for the tap arrangement shown, in conjunction with 0.00035 mfd. tuning capacity, so the lowest limit is around 20 meters.

Since simplicity is necessary in a compact device, the method

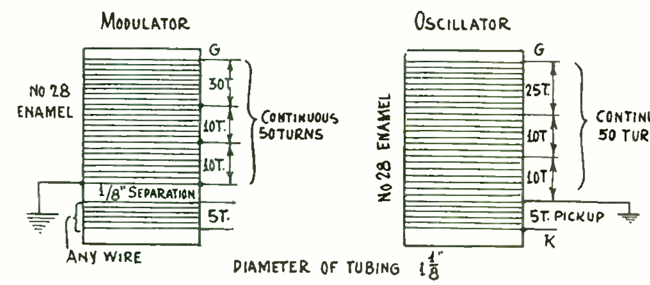


FIG. 2
Detail disclosing how to wind the coils for the timely converter.

of moving the tuning condenser to the desired tap is perhaps preferable, in the absence of separate coils for each band, because then the full coil is in circuit all the time, without dead ends or shorted **turns.**

By having the three taps corresponding to those used in the tuned circuits connected to aerial all the while, the converter gets its antenna input as long as the short wave taps are used. The fourth tap is useful only for switching the aerial over to the set, therefore in the two tuned stages the fourth tap is registered as a blank, meaning it is not used. It will be advisable to turn off the juice to the converter when switching to the set, but the shaft type a-c switch (SW-4) on the front panel serves that purpose.

The only peculiarity about the converter is the hookup of the modulator, as that is a 224 tube with screen and plate joined by a wire, the reason being that the output was greater when the tube was hooked up that way. However, those desiring to make the comparison themselves may do so by cutting the lead from modulator screen where it joins the plate connection to the 0.0001 mfd. bypass condenser, and putting screen of detector to screen of the untuned r-f tube.

Tuned Output

This 0.0001 mfd. condenser, by the way, is an equalized (E), 20-100 mfd., which may be set at any preferable value, depending on the frequency to which the set will be tuned. Sets do not usually have uniform sensitivity, but you will know from experience in what general region the set is most responsive, usually some high frequency, and indeed the highest frequency tunable may be used then. But perhaps your set is of the compensated type, and may be most sensitive at the opposite extreme. The equalizer permits you to tune the output of the converter rather roughly, but helpfully nevertheless, by turning down the setscrew with a driver (clockwise motion) for high wavelength setting of the set, the tuning being rather sharp from 600 to 550 kc, or turning the screw so that the plates of this tiny condenser (20-100 mmfd.) are less than fully engaged for any frequency higher than 600 kc. All you need do is make the test by ear after you have tuned in a short wave station. In some instances, particularly where the receiver is very sensitive, the setting of this condenser will seem to make little difference, but where the sensitivity is 25 microvolts per meter, or not as good as that, the condenser's effectiveness will show up readily.

The parts are arranged as suggested in Fig. 2, the tuning condenser (not shown) being at center, driven by a flat type dial, that is, the condenser is at right angles to the front panel. At left and right front are the shielded coils. Behind these coils are, left, the modulator, and right, the oscillator tubes, while behind these are, left, first r-f, and right, rectifier.

The two 8 mfd. condensers go in the small holes at center rear, being mounted inversely. One of these condensers must be supplied with two insulating washers, one washer extruded, the other flat, and a special lug that connects to the case of the condenser. This lug goes to B minus, and you will note B minus is not grounded, so there is a difference of potential between the case of one condenser (B minus) and that of the other (ground. The difference is the voltage drop in the B choke coil. The insulated condenser goes in the 7/8 inch hole, the other condenser (not insulated) in the 3/4 inch hole. The filament transformer and the B supply choke, 15 henries, go under the tuning condenser.

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Answers printed herewith have been mailed to University Members.

Radio University

To obtain a membership in Radio World's University Club for one year, send $6 for one year's subscription (52 issues of Radio World) and you will get a University number. Put this number at top of letter (not envelope) containing questions. Address, Radio World, 145 West 45th Street, New York, N. Y.

Annual subscriptions are accepted at $6 for 52 numbers, with the privilege of obtaining answers to radio questions for the period of the subscription, but not if any other premium is obtained with the subscription.

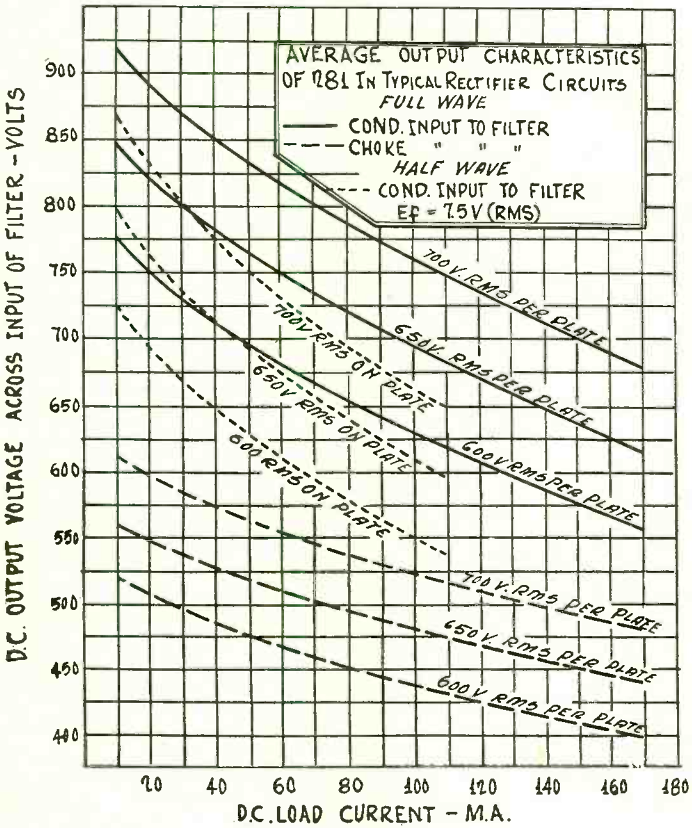


FIG. 956

Regulation curves of the 281 rectifier tube in half wave and full wave rectification as well as with condenser and choke input to the filter.

Behavior of Rectifiers

PLEASE show a diagram or a set of curves which will give the behavior of a rectifier tube, either a 280 or a 281, in a typical B supply circuit. What is the difference between choke and condenser input and how does half wave rectification compare with full wave rectification/—A. W. E.

Fig. 956 gives performance curves of the 281 rectifier tube in various setting. The solid full lines represent the performance of a full wave rectifier using two 281 tubes with a 4 mfd. condenser next to the rectifier. The dotted lines represent the same thing when only one tube is used, that is, half wave rectification. The dashed lines represent full wave rectification with choke input to the filter. In each group the upper curve represents input voltage of 700 volts, RMS, per plate. Note the rectified and filtered voltages at some current value, say 100 milliamperes, on the three curves. For full wave, condenser input the output voltage is 760 volts. For half wave, condenser input is 662 volts, and for full wave, choke input it is only 525 volts.

* * *

Ohms Per Volt Deduced

MY voltmeter reads from zero to 500 volts. I have been trying to measure its ohms per volt but have not succeeded. When I put a 250,000 ohm resistance in series with the meter, the indicated voltage drops from 180 to 120 volts. If this is sufficient to enable you to determine the ohms per volt of my instrument, I shall appreciate your doing so and letting me know the results.—W. L.

The current in the voltmeter is proportional to the voltage reading. Hence when there was no resistance in the circuit the current was proportional to 180. When the 250,000 ohm resistance was in series the current was proportional to 120. The total resistance when the instrument read 180 was the internal resistance of the meter itself. Let this be R. When 250,000 ohms were added, the total resistance was R+250,000 ohms. The voltage in the circuit is the same in both instances. Hence we can equate the two voltage drops, and we have $180 \times R = 120(R+250,000)$. We are using voltage readings instead of currents because the voltage readings are proportional to the current flowing. Solving the equation we get $R = 500,000$ ohms. Since full scale reading on the meter is 500 volts, the ohms per volt is 1,000.

* * *

Reversal of Image

DOES not the scanner which you described in the Sept. 26th issue reverse the image? It should, since the light is reflected.—W. B.

There is no image to be reversed until the light gets to the screen. It makes no difference whether or not the beam of light is reversed because at any instant it is of the same intensity throughout its cross section. If the screen were viewed through a mirror, then the image would be reversed, and it would be necessary to view the image by twice reflected light. That is, it would be necessary to use two mirrors.

* * *

Poor Voltage Regulation

A FILAMENT transformer which I have is rated at 20 volts. The voltage required by a 227, or by any tube of similar heater, is 2.5 volts. Therefore the 20-volt transformer should be able to handle eight of these tubes if their heaters are connected in series. I tried it and could hardly get anything out of the transformer. What is wrong?—G. W. B.

What is wrong is that you assumed that the only rating of a transformer that counts is the voltage. Another essential rating is the current carrying capacity. The transformer should be rated 20 volts at 1.75 amperes if it is to work eight of these tubes in series. If it is not rated at 1.75 amperes, it is probable that it will begin to sizzle after the power has been on a little while, provided the current drawn is 1.75 amperes or more.

* * *

Dynatron Oscillator

SOME say that the dynatron oscillator cannot be used on very short waves, while others claim that oscillations of very high frequencies can be obtained. Who are right?—B. W. N.

Both are undoubtedly right. There is no reason for doubting the statements made by experimenters. Even if direct oscillation cannot be obtained at very high frequencies with the dynatron, it is usually prossible to employ harmonics so that oscillator is useful even in the region where it might not oscillate on the fundamental.

* * *

Rated Pentode Output

WHAT is the rated output of the 247 pentode tube when the plate and screen voltages are 250 volts, the grid bias 16.5 volts and the input peak voltage is equal to the bias? It is assumed that the load on the speaker is such that the output is optimum.—W. A. J.

The rated output is 2.5 watts. This is near the output given by two 245 power tubes with three times the input. It is clearly advantageous to use a 247 pentode.

* * *

Advantage of Bleeder Current

SOMETIMES a bleeder resistance is inserted in a receiver as a part of the voltage divider. In other cases the voltage is dropped by individual resistors. Which is the better method and what is the advantage of the bleeder current?—B. H. A.

The voltage divider method is the better because the voltages applied to the tubes are more definite. When the individual bias resistor method is used, the applied voltage depends on the current in the tube. The advantage of the bleeder current is that it reduces voltage fluctuations due to the signal. The larger the bleeder current the greater the stabilizing effect. But the larger the bleeder current the more the current drawn from the rectifier and through the filter. Hum usually results if the current is too high.

* * *

Regeneration in I-F Amplifier

IN my intermediate frequency amplifier one 150 ohm grid bias resistance is used for two 224 tubes. There is a condenser of 0.01 mfd. across the resistance and the intermediate frequency is 175 kc. Is there any feedback through the common bias resistance, and if so is it enough to cause oscillation in the circuit? The reason I ask is that I have oscillation and I don't know how to stop it.—G. J. F.

There is feedback through the common bias resistance but it is small. Still it may be sufficient to cause oscillation, or at least help some other feed back to cause it. Whether or not the feedback through the bias resistance causes oscillation (positive regeneration) depends on the manner in which the intermediate transformers are connected. If it is now positive so as to increase the amplification, it will be negative if you reverse a pair of leads on the transformer between the two tubes served by the common bias. It is more likely that the oscillation is due to feedback through the mutual inductance between two circuits tuned to the intermediate frequency. You may have shields around the coils but usually shields are not thick enough to stop the coupling. If this is the cause of the oscillation you can stop it by reversing a pair of leads as before.

* * *

Design of Oscillator Coil

THE tuning condenser in my superheterodyne oscillator has a capacity of 460 mmfd. In series with this condenser is a 0.001 mfd. fixed condenser, and across the series is a 50 mmfd. midget trimmer. The intermediate frequency is 175 kc and I want to tune in the broadcast band. What should the inductance of the mm oscillator coil be, and how many turns of No. 28 enameled wire on a 1.75 inch form are needed?—W. A. J.

You need an inductance of 132 microhenries. You will require 50 turns. The axial length of the winding will be about 2/3 inch.

* * *

Resistance in Parallel

WILL you kindly give a simple rule, if there is such, for computing the resistance of several resistors in parallel? I know how to get the resistance of two resistors in parallel but not when there are more.—E. G. A.

If you can get the resistance of two resistors in parallel you can also get the resistance of any number in parallel. First get the resistance of any two. You get a certain value. Then combine this with one of the resistances you have not used and you get another value. Use this in combination with one of the others. Continue until you have used all the resistances in parallel. To get the resistance of two resistances in parallel divide their product by their sum. In case you do not want to get the resistance of many in parallel by this continued operation, add the reciprocals of all of them and then take the reciprocal of the sum. Incidentally, capacities connected in series are combined in the same way as resistances connected in parallel.

* * *

Resistance Coupled Amplification

ABOUT what amplification can be obtained from a 240 high mu tube? Is it preferable to use this tube over a DC screen grid tube?—W. T.

An amplification of close to the amplification factor of the tube can be obtained. This is 30, nominally. A gain of 28 times is easily obtained. In Fig. 97 is a family of plate current, plate voltage curves for different grid bias values which can be used to estimate the amplification under different load conditions. The long dotted line is for a load of half megohm and a voltage of 300 volts in the plate circuit. If the dotted line parallel to the plate voltage axis is the minimum current allowable, we can vary the grid bias from zero to 8.5 volts. While the grid voltage changes by this amount the plate voltage changes from 67 to 275 volts, or by 208 volts. Therefore the amplification is 24.5 times. It can be increased by increasing the plate load resistance. The 240 tube is not so critical as the screen grid tube.

* * *

Small Variation in Resistance

A RESISTOR supposed to be 1,000 ohms is slightly more than that and I want to put something in parallel, say a grid leak, to bring it down to just 1,000 ohms. Will you kindly explain how to go about determining the correct value?—W. G. H.

The formula to use is that which gives the resistance of two resistances in parallel. If the resistance of the resistor supposed to be 1,000 ohms is R1 ohms, let the resistance of the grid leak to be connected in parallel be R2. Then R1R2/(R1+R2) must equal 1,000 ohms. Since you know R1 you can easily solve the equation for R2 and get the value of the grid leak to be used. The solution is R2=1.000R1/(R1—1.000). As an example, suppose that the so-called 1,000 ohm resistor is actually 1,005 ohms. Then R2=1,000x1,005/5, or 201,000 ohms.

* * *

Change in Speaker Design

WHEN dynamic speakers first came out the field electromagnet was large and heavy. Now for the same size of diaphragm the field magnet is very small and light. Previously it was of cast iron; now it is of wrought iron. Are the modern speakers just as efficient as the old heavy ones?—W. G. A.

The efficiency of a loudspeaker does not depend on the weight of the field magnet but on the strength of the magnetic field where the voice coil is. The same strength can be obtained with a wrought iron structure as with a cast iron structure. Hence the modern speaker may be fully as efficient as the old type speaker. Particularly, it should be much more efficient in the field. That is, a field of given strength can be obtained with less wattage, due to the fact that the permeability of the wrought iron is much higher than that of the cast iron.

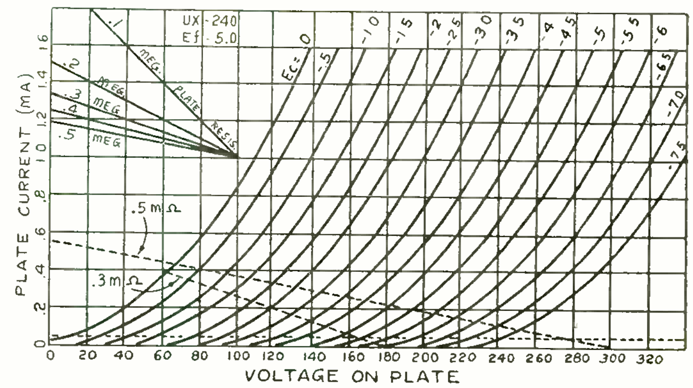


FIG. 957

Performance characteristics of the 240 high mu tube from which the amplification in a resistance coupled circuit can be estimated.

* * *

About the Echelon Scanner

IT is not quite clear to me how the beam of light in your spiral echelon scanner traces a band of light on the screen when the light beam has extension in the axial direction. Will you kindly explain?—W. A. K.

Cut a strip of paper an eighth of an inch wide and a foot or more long. Bend the strip near the middle so that it forms a right angle. One end then represents the incident beam of light, that is, the light coming from the source, and the other leg represents the reflected beam. If you turn the right angle about the leg representing the incident beam, the end of the other leg will sweep out a band. The width of this band is equal to the width of the incident beam, that is, to 1/8 in. in this case. If the reflected beam just reaches to the screen, the band will be traced on the screen. A material right angle will not reach to the screen except at one point, but a ray of light will intercept the screen even though it is flat.

* * *

Mutual Effects of Windings

DOES the inductance of the secondary winding of a radio frequency transformer in any way depend on the inductance of the primary winding? Also, does the inductance of the primary depend on that of the secondary? If there is a relationship, can it be stated in simple words so that allowance may be made for it in winding coils or in selecting condensers?—A. W. S.

The inductance of either winding does not depend on that of the other, but the effective inductance of one winding depends on what is in the circuit of the other winding. Possibly there is no distinction between the two statements, but it is desired to emphasize that the circuits should be closed. If a current flows in the primary circuit, the effective inductance and resistance of the primary depend on the kind of secondary there is, and on how closely it is coupled to the primary. The effect is mutual. Hence the effective inductance and resistance of the secondary depend on the type of primary and on the coupling.

* * *

Parallel Resonance Impedance

WILL you kindly give a formula for the computation of the impedance of a coil and condenser in parallel at resonance, the coil having resistance and the condenser assumed not to have any?—T. S.

The formula is simply L/RC, in which L is the inductance of the coil, R the resistance in the coil branch of the circuit, and C the capacity of the condenser. The impedance is a pure resistance, and if R is very small the resistance is very large. Let us take a numerical example. Suppose we have a coil of 160 microhenries which has an effective resistance of 5 ohms at the resonant frequency. Let the value of C be 250 mmfd. We have for L/RC 128,000 ohms. If we increase the resistance of the coil we decrease the resistance of the parallel combination, as will be seen from the fact that the resistance occurs in the denominator of the expression. It will also be seen that the effective resisstance goes up as the capacity of the condenser goes down. For high selectivity the expression L/RC should be as large as possible.

A THOUGHT FOR THE WEEK

NEVER was there any doubt that Weber and Fields would eventually become great radio favorites. Joe and Lew—those two Grand Old Men of the stage, albeit, they are still vigorous and progressive and have not lost a whit of their comic appeal—were headed for the air years before they actually appeared before the mike. They didn't seem to know how great a hold they had on American theatregoers until somebody came along and offered them large sums of money to be themselves once again via the radio. Now they're established favorites, not only with those who knew them in the old days but also those to whom their delightful idiocies are a new experience. Incidentally, Joe and Lew are to be congratulated on the new material they are using. It proves that you can teach old boys new tricks when the boys are intelligent and a framer of comedy has taken their measure intelligently.

RADIO WORLD
Trade Mark Reg. U. S. Pat. Off.

The First and Only National Radio Weekly
Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; L. C. Tobin, advertising manager.

Radio in 1940

By FRANK A. ARNOLD

Director of Development, National Broadcasting Company

From his new book, "Broadcast Advertising"

BY 1940 we shall have learned how to overcome static and magnetic barriers, and by our additional discoveries in the short wave field render international broadcasting as possible and as practical as the best we are now doing locally. Ten years from now to broadcast around the world will be just one item in the day's work. The great broadcasting organizations in the United States will be operating their studios and plants on a twenty-four-hour basis. Differences in time will be utilized so that while the rest of us sleep the night shift will be sending programs abroad, reaching countries during their daylight periods.

We shall be exchanging programs with every civilized nation of the world. The Oxford lecturer will no longer be obliged to leave England in order to give his message to the colleges of America, for it will be easily possible, even though at some inconvenience to him due to the difference in time, to speak to audiences gathered in the assembly rooms of our American colleges for that purpose.

Speaking of colleges, the time will come when our major institutions of learning will have endowed chairs of broadcasting—not that there will be professors of radio broadcasting—but the money thus provided will render possible the wire charges and other incidentals whereby such a college may be in a position to obtain either an international broadcast or a broadcast distributed from some central point in this country.

Television, which for the last year or two has been peeking around the corner, will be walking up and down the street long before the next decade is finished. It is already a laboratory success. It simply awaits its development along practical and business lines, acceptable to, and in accord with, the desire of the radio audience.

This is something which will affect tthe American home more intimately than any one of the great developments of the future. I can picture the modern living room a few years hence, equipped for radio with speakers concealed in the walls and regulated by a simple wall switch. There will be sound movies, compactly installed and easily operated, whereby the family may see and listen to the best offerings of the silver screen. Television in its more perfected form will render it possible for you (by synchronization between the two instruments employed) to see an actual football game in action as well as hear the announcer giving his play-by-play account. Your radio receiving set ten years from now will be so attuned and synchronized for television that in connection with certain radio programs you will have the pleasure of seeing the prima donna, the quartette or the musical ensembles, as well as listening to the program. In the ultimate development of the Damrosch Music Appreciation Hour millions of school children will be able to see the conductor as well as listen to his message. Dramatizations will then be in costume and the wonderful dramatic offerings that you have now been hearing, but greatly improved in technique, will be given to you by television with a fidelity comparable only with the actual stage presentation.

Methods of education in 1940 will be in process of reorganization. History, literature and art will then be universally taught by radio, and television and our up-to-date educational systems will by that time be fully equipped with radio and television sets for that purpose.

In the field of religion, the rural sections will have their solution of the problem now facing them of the abandoned church. By radio and television the humblest rural center so desiring can have at its command the visible presence on the screen together with the actual message from the great religious leaders of the day.

Speaking internationally, I believe that radio and television and the other kindred developments that are bound to come will mean the salvation of the world. The more closely we bring people together the less likely disagreements and misunderstandings will occur. Ten years from now international conferences will be possible through television and radio. Meetings of the League of Nations may be held at times in this way. A convocation of the great rulers of the world might be so arranged that each would see and hear the other, although separated by land and ocean. In spirit and partly in operation the nations of the world may gather about a conference table upon a few hours' notice for the discussion of their problems and the ramification of their agreements.

Power for Converters

SHORT wave converters were exhibited at the New York public radio show this year for the first time, these being principally the products of set manufacturers who find there is a growing interest even among "laymen" for short wave reception. The familiar mixing circuit is used, with band selection by front panel knob actuation. But there is no power supply built in. A plug is used for picking up the 2.5 volts for the heaters of the two tubes required by the converter, and as for B voltage, a lead is brought out with the intention that it be connected to the field coil of the dynamic speaker of the set.

The converter is a device enabling the reception of short waves by tuning them in, changing the frequency in the mixer, and putting out a frequency to which the broadcast set will respond. However, for proper results it is imperative that the receiver's sensitivity be not reduced. If a set that may have a power transformer with 2.5 volt winding closely rated for the tubes used in that set has an extra drain of 3.5 amperes placed on it, in most instances the voltage on all the heaters served will be reduced, perhaps severely, sensitivity will fall off badly, and in some instances the power transformer's 2.5 volt secondary may burn out. This is not alluring, to be sure.

Then, as for B voltage, if it is not in the converter itself there will be too many instances where the user has to hunt around for a method of obtaining it. He may not have a dynamic speaker, or he may have one where the field coil is not of the B supply choke type, that is, the voltage is low, the current high, to constitute the necessary power, or the coil may be inaccessible, or he may have a catacomb set. It becomes an annoying problem to apprise all users of how to find the necessary B voltage, and in some instances it is virtually impossible to obtain it, at least without alteration of the set wiring.

It is therefore preferable that alternating current model converters have the heater and B power supply built in, for then there is greater certainty of results. Yet where a set manufacturer has a device of the other kind, he may be seeking principally the sale of the converter in conjunction with his own set, with which the converter works well, and to which the connections can be made readily. But for general consumption you can't beat the self-powered converter.

Several manufacturers, of the type catering largely to the constructionally inclined, have models with the power in the converter, and these looked very well indeed, and promise much. The devices are obtainable as kits and also as wired models, so even the "layman" can obtain right now converters that meet the full requirements, although at somewhat greater cost.

IMPORTANT NOTICE TO CANADIAN SUBSCRIBERS — RADIO WORLD will accept new subscriptions at the present rates of $6 a year (52 issues); $3 for six months; $1.50 for three months; (net, without premium). Present Canadian subscribers may renew at these rates beyond expiration dates of their current subscriptions. Orders and remittance should be mailed not later than October 17, 1931. Subscription Dept., Radio World, 145 W. 45th St., New York, N. Y.

THE DERELICT ROAD

("The Happy Vagabond"—WOR 11:15 a.m., Tuesday, Wednesday and Friday)

YOU'VE heard of derelict ships and men—
That roll into port and out again!
A derelict ship with spars all bare;
A derelict man with a haunted stare.
Did you ever see a derelict road—
All given over to frog and toad!

It starts out fair in a broad, smooth way,
Looks so inviting it leads you astray,
With well-kept hedges on either side,
Lined with trees budding out in pride.
No stones nor wheel ruts your feet impede.
You wonder whither the road might lead.

You say to yourself, "This broad expanse
Surely leads to a stately manse—
With jovial host and mistress fair,
And laughing children without a care!"
And yet—the road itself seems strange,
And soon, very subtly, starts to change.

At first you discover a weed or two;
A broken tree limb disturbs the view;
A post at the side is knocked awry;
An unclipped hedge offends the eye;
You scratch your hand on a ragged briar,
And grass in the ditch grows higher and higher.

The path narrows down to rut and stone,
With burdocks and nettles overgrown.
Neglected trees so thick and high
Meet overhead and hide the sky,
Wearing so weary, forlorn an air,
As giving up in sheer despair.

And then at the end of this derelict road,
You come upon what was once an abode—
A derelict wraith of a house you find,
With unhinged door swaying wild in the wind.
Windowless, roofless, friendless and old,
Covered with creepers, dirt and mold.

No smoke arises from hearth fires bright.
No merry laughter resounds through the night.
No children tumble about the stair—
The toad, the frog, and the owl live there.
A derelict house with a ghostly load
Of memories—down a derelict road.
—A. R.

* * *

Jack Arthur is "The Happy Vagabond" on WOR and if you haven't listened to him you have missed a treat. Jack is also the baritone of "Footlight Echoes," same station, Sundays at 10:30 p. m. He may be heard on Wednesday at 9:00 p. m. with Beth Challis and the Two Pianos, WOR; and Thursday at 9:30 p. m. with his Blackout Review. This versatile young man is one of the best bets on WOR. He is talented and versatile, doing dramatic, comedy and straight work equally well. As soon as I can get him to talk about himself shall run his biography, but he's rather shy when it comes to publicity, which is a pleasant thing to find nowadays.

* * *

Another Good Bet of a Different Sort on WOR is Allan Broms. Saturdays, 9:00 p. m., Mr. Broms gives radio science chats and they have become a weekly treat to a vast audience, as evidenced by the flood of appreciative letters that keep pouring in—this is a fact, because I've seem 'em. If you are not listening to Mr. Broms you are missing a liberal education in the sciences, for on each program he discusses clearly and fully some important problem on which modern science has thrown light, and he does a wonderful job of clear and delightful explanation.

Then, too, for those who are near enough, there follows each Sunday a public field trip or museum visit to illustrate the radio subject, led by Mr. Broms himself. Hundreds are taking advantage of this opportunity and are gaining new in-

Sparkles

By Alice Remsen

sight into the wonders of science and nature.

* * *

The Month of October is rich in international broadcasts over the Columbia networks. Erich Pommer, Germany's leading film producer, speaks from Germany on October 11th; the Viscountess Rhondda, one of the ablest business women in England, speaks from that country on October 18th, at 12:30 p. m.; The Prince of Wales, speaking at a dinner of the Navy League in London, will be heard from 3:45 to 4:15 p. m. on October 21st; John Masefield, the Poet Laureate of England, will speak on October 22nd; and from Berlin, on October 25th, Professor Moritz J. Bonn will talk on "Germany's Hopes and Fears."

* * *

Lee Morse, the Swanee Singer, has another program over the NBC-WEAF network every Saturday from 7:00 to 7:15 p. m., commencing October 10th. Lee has a style peculiarly her own and is well worth a listen.

* * *

Landt Trio and White have another commercial program, together with Raymond Knight, each Thursday and Saturday, over NBC-WJZ network, from 6:30 to 6:45 p. m. They will be known as the Breyer Leaf Boys.

* * *

Veronica Wiggins is now appearing on three different networks—NBC, with A. & P. Gypsies, WOR with "Moonbeams" and the Hoffman Hour and Columbia with the Love Story Hour.

* * *

Heard Annette Simpson on one of those delightful Little Symphony programs over WOR a short time ago. Miss Simpson gave a very excellent performance. It's a wonder her sweet soprano voice is not heard on more programs.

* * *

And Maybe Claude MacArthur hasn't got himself a swell orchestra. Thirty-five pieces, able to play symphonic, light music and jazz. Heard this wonderful organization last week give an audition that was simply marvelous. Much will be heard from this group and its great conductor.

* * *

Young Ross MacLean, the 24-year-old baritone discovered by George White and now in the current "Scandals," did a good job as guest artist on "Footlight Echoes," over WOR, on September 27th. He sang two numbers from the show, "My Song," and a very dramatic semi-spiritual, "That's Why Darkies Were Born." This was the first time the latter has ever been sung on the air. This lad has a pip of a voice and he knows how to handle it.

* * *

SIDELIGHTS

Al Llewelyn once sold cemetery plots. . . . **Raymond Van Sickle** used to be in the tombstone business. . . **Ernest Naftzger** has already told 88,200 jokes over the air, all contributed by listeners. . . **Harry Salter** says: "The way of the transcription is hard." . . . **Jack Smart** is fond of pie a la mode. . . While **Singin' Sam** likes just plain pie. . . **Kate Smith** and **Morton Downey** prefer ice cream, as does **Billie Dauscha. . . Jane Froman** leans on a music rack while conducting her orchestra. . . **Count Felix Von Luckner** always kisses the "mike" goodbye with a resounding smack when he is through broadcasting. . . **Harry Reser** plays six instruments. . . **George Shackley** can juggle three batons and a music rack at one time. . . **Sherman Keene** likes to skate. . . **Philip James** is fond of Wagner. . . . **Roger Bower** smokes a pipe. . . . **Carl Fenton** never is seen without a cigar. . . **Arthur Hale** prefers cigarettes.

* * *

BIOGRAPHICAL BREVITIES

ABOUT BING CROSBY

The Crosbys named him Harry L., but he has been Bing for all but three of his twenty-seven years. Acquired the nickname from his fondness for Indian and cowboy games, wherein he could and did shout "Bing, bing, bing," from morning till night, with redskins by the hundred biting the Tacoma dust.

Attended college at Gonzaga in Seattle. Too light for football except freshman squad, but got on the Varsity baseball team. Edited school papers, being afflicted with the writing bee, the virus of which still hangs on. Imagines he could earn his living as an author if only his voice would let, but he can't turn down all that money.

Started singing professionally while still in Gonzaga. Income wasn't sufficient to support him, however, so he clerked in a law office, but jurisprudence lost out when an offer came from a Los Angeles booking office.

Since 1926 has appeared in theatres throughout this country, Mexico and Canada. Never has been abroad, but wants to go there; has a special urge to see Lichtenstein and Andorra.

Started getting "raves" for his work a year or so ago while entertaining at Cocoanut Grove, Los Angeles. California syndicate and magazine writers discovered him about the same time his recordings became best sellers. Has worked for four recording companies, also has made talking shorts and appeared on lots of radio programs; but he is still nervous when approaching a microphone.

Golf is his favorite sport. Has a six handicap and with that support summoned enough courage to play both Bobby Jones and Johnny Farrell in friendly matches; they trounced him soundly. Drives a car like nobody's business, but traffic cops make it theirs. Never has been able to get enough summonses to paper a room, but is still hopeful.

Likes Los Angeles domestically and New York professionally. Doesn't like Manhattan riveters. Reads a lot. Taste in clothes runs to browns and blues. Has played drums, but doesn't think he's very good at them. Cares in a big way for the radio work of the Boswell Sisters. He's five feet, nine inches tall, weighs 165, has blue eyes, brown hair and is tanned. Has a very husky speaking voice. Is extremely serious about his work and usually rehearses an hour and fifteen minutes for a fifteen-minute broadcast.

* * *

Sundry Suggestions for Week Beginning October 11th

Sunday, Oct. 11: Cathedral Hour	WABC	4:00 p.m.
Sunday, Oct. 11: Footlight Echoes	WOR	10:30 p.m.
Monday, Oct. 12: Vaugh de Leath	WEAF	6:30 p.m.
Monday, Oct. 12: Arthur Pryor's Orchestra	WABC	8:00 p.m.
Tuesday, Oct. 13: Eddy Brown, Violinist	WOR	9:30 p.m.
Tuesday, Oct. 13: Old Stager	WJZ	10:00 p.m.
Wednesday, Oct. 14: Frank Parker	WABC	7:15 p.m.
Wednesday, Oct. 14: Sherlock Holmes	WJZ	9:00 p.m.
Thursday, Oct. 15: Stebbins Boys	WEAF	6:45 p.m.
Thursday, Oct. 15: Weaver of Dreams	WOR	10:00 p.m.
Friday, Oct. 16: Street Singer	WABC	11:00 p.m.
Saturday, Oct. 17: Little Symphony	WOR	8:00 p.m.
Saturday, Oct. 17: Alice Remsen	WOR	9:15 p.m.
Saturday, Oct. 17: The First Nighter	WJZ	9:30 p.m.

[*If you would like to know something of your favorite radio artists or announcers, drop a card to the conductor of this page. Address her, Miss Alice Remsen, care of* RADIO WORLD, 145 *West 45th St., New York City, N. Y.*]

Reallocation Will Be Made, Due to Census

Washington.

The Federal Radio Commission has formally adopted the 1930 decennial population figures as computed by the Census Bureau, Department of Commerce. As a result there will be a reallocation of the radio facilities among the several states and territories to give each its proportionate share according to the latest population distribution. Each of five zones into which the country is divided is entitled to 80 units of radio facilities, a unit being defined as a 1,000 watt regional station operating full time.

The differences between the quota units due under the "Preliminary Figures" and the "Fifteenth Census Figures" are as follows:

New Jersey, +.05; Kentucky, —.04; New York, —.03; Indiana, +.03; Utah, +.03; Connecticut, +.02; Porto Rico, —.02; District of Columbia, +.02; New Hampshire, —.02; Ohio, +.02; Alabama, —.02; Louisiana, +.02; Illinois, +.02; Minnesota, —.02; Nebraska, —.02; Colorado, —.02; New Mexico, —.02; Massachusetts, —.01; Maryland, —.01; Pennsylvania, —.01; Michigan, +.01; Virginia, +.01; West Virginia, +.01; North Carolina, —.01; Georgia, +.01; Arkansas, —.01; South Carolina, +.01; Missouri, —.01; Wisconsin, +.01; Kansas, —.01; South Dakota, +.01; North Dakota, —.01; California, +.01; Washington, —.01; Montana, +.01.

No state, therefore, receives more than .05 unit nor loses more than .04 unit.

Kilocycle-Meter Conversion Table

The conversion table printed on the opposite page is highly accurate, because worked out by the factor 299,820. Most tables are based on the factor 300,000, which is erroneous to 6 parts in 100,000.

The table is entirely reversible, for instance, 10 meters equal 29,982 kc., or 29,982 meters equal 10 kc. Any quantities not included in the table may be read by shifting the decimal point. If moved to the right for frequency the point is moved to the left for wavelength, and vice versa. The shift is therefore in opposite directions.

The factor 299,820 is based on the velocity of a radio wave, which is equal to the velocity of light, or 299,820,000 meters per second. By dropping the three ciphers (dividing by 1,000), the factor 299,820 is used, and the answer reads in kilocycles.

Wavelength in meters is equal to velocity divided by frequency. Frequency in cycles is equal to the velocity divided by the wavelength.

THE BIGGER, THE EASIER

WOR's press department tells us: Alice Remsen, one of WOR's star contraltos and stellar figures and who broadcasts every Saturday night at 9:15 P.M., is sympathizing with newspaper writers who have to interview people. While always gracious she has become doubly so in her chats with the members of the station's publicity department. Alice has become a columnist for RADIO WORLD and she has to do her own interviewing. One of the first things she learned is that the bigger the radio artist is, the easier he or she is to interview. This fact is to form the theme of a new character song which she is to broadcast in one of her forthcoming programs.

Ten More Seek Board License for Television

Washington.

Twenty-two experimental television radio stations are licensed by the Federal Radio Commission, according to the records, and all but five of these stations are operating on fixed schedules. Ten applications for authority to establish new television stations in various parts of the country have been filed and have been set for hearing by the Commission. Besides these there are twelve others awaiting action by the Commission, either to be set for hearing or following hearing.

The Commission has set aside four bands, each of 100 kc width, in the continental short wave band, ranging in frequency from 1,500 to 6,000 kc, and the same number of channels of much greater widths in the ultra high frequencies.

The 10 new applications designated for hearing are those of Gimble Bros. Television and Development and Research Co., Philadelphia; Trav-Ler Manufacturing Corporation of Illinois, St. Louis; WJR, the Goodwill Station, Inc., Pontiac, Mich.; Memphis Commercial Appeal, Inc., Bartlett, Tenn.; Easton Coil Co., Inc., New York City; American Television Laboratories, Inc., Hollywood, Calif.; Indiana's Community Broadcasting Corp., Hartford, Ind.; National Co., Inc., Malden, Mass.; Pilot Radio & Tube Corp., Lawrence, Mass., and the Crosley Radio Corporation, Cincinnati.

Most of the stations in actual operation are near New York or Chicago.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits, should send a request for publication of their name and address. Send request to Literature Editor, RADIO WORLD, 145 West 45th Street, New York, N. Y.

George Hewitt, 915 Atlantic Ave., Brooklyn, N. Y.
Chas. S. Sutton, 413 12th St., Toledo, Ohio.
Roy J. Terou (162AC14), 212 N. 8th St., Hamilton, Mont.
R. D. Thornton, Service, 404 So. Ashland Blvd., Roob No. 87, Chicago, Ill.
J. M. Sellers, care Bradley Hotel, Santa Maria, Calif.
Carl E. Goiens, 1041 Main St., Sturgis, So. Dak.
John J. Camarda, 2253 86th St., Brooklyn, N. Y.
M. A. Gowing, 1294 Corbett St., Portland, Ore.
John Y. Supone, 236 Harrison Ave., Lodi, N. J.
Elmer Rexin, 3814 N. 29th St., Milwaukee, Wis.
Dagoberto Valdes, Member of California Institute of Radio, Versalles 51, Matanzas, Cuba.
Frank A. Toth, Toth Directory System, 9910 Cumberland Ave., Cleveland, Ohio.
Raphael R. Quiñones, Radio Distributor and Service Man, 47 Luna St., San Juan, Porto Rico.
Alexander Dykes, 319 Hayward Ave., Rochester, N. Y.
James Outland, 652 Tenth Ave., S.E., Roanoke, Va.
Milton Y. Ede, 39 North St., Stamford, Conn.
John M. Ford, 439 Jefferson Ave., Brooklyn, N. Y.
J. R. Fishel, 1887 48th St., Brooklyn, N. Y.
M. D. Sanchez, P. O. Box 95, Central Tacajo, Oriente, Cuba.
Henry Piekniewski, 305 East 75th St., New York City.
John Erickson, 414 E. Mary St., Fort Hamilton, Ont., Canada.
Stanley Kozek, 5500 Wrightwood A9ve., Chicago, Ill.
B. T. Himes, P. O. Box 1287, West Palm Beach, Fla.
R. S. Marshall, 804 Commerce Exchange Bldg., Oklahoma City, Okla.
T. Dave Davidson, 72 S St., Waterford, N. Y.
W. J. Masilan, 115 E. 4th St., Ellensburg, Wash.
G. M. Stahl, Emporium, Pa.
F. O. Watson, Watson Radio Shop, 321 Murchison St., Palestine, Texas.
Andrew Albertson, 2621 S.W. 8th St., Miami, Fla.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of Radio World published weekly at New York, N. Y. for October 1, 1931.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Roland Burke Hennessy, who, having been duly sworn according to law, deposes and says that he is the Editor of the Radio World, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher Hennessy Radio Publications Corp., 145 West 45th St., N. Y. C. Editor Roland Burke Hennessy, 145 West 45th St., N. Y. C. Managing Editor Herman Bernard, 145 West 45th St., N. Y. C. Business Manager Herman Bernard, 145 West 45th St., N. Y. C.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of the stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Hennesy Radio Publications Corp., 145 West 45th St., N. Y. C. Roland Burke Hennessy, 145 West 45th St., N. Y. C. Mrs. Mary J. McArthur, The Breakers, 9823 Lake Avenue, Cleveland, O.

3 That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent, or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers, during the six months preceding the date shown above is .... weekly. (This information is required from daily publications only.)

ROLAND BURKE HENNESSY.
(Signature of Editor.)

Sworn to and subscribed before me this 29th day of September, 1931.

[Seal.] HARRY GERSTEN.
Notary Public, Kings Co. Clks. No. 121, Reg. No. 2133, N. Y. Co. Clks. No. 214,, Reg. No. 2-G-153.
My commission expires March 30, 1932.

Note.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

Table, Kilocycles to Meters, or Meters to Kilocycles

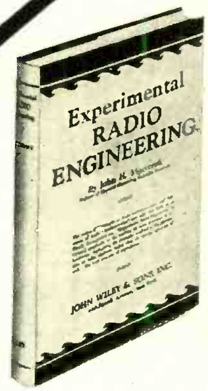
[See Explanation on Opposite Page]

kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc	kc or m	m or kc
10	29,982	1,010	296.9	2,010	149.2	3,010	99.61	4,010	74.77	5,010	59.84	6,010	49.89	7,010	42.77	8,010	37.43	9,010	33.28
20	14,991	1,020	293.9	2,020	148.4	3,020	99.28	4,020	74.58	5,020	59.73	6,020	49.80	7,020	42.71	8,020	37.38	9,020	33.24
30	9,994	1,030	291.1	2,030	147.7	3,030	98.95	4,030	74.40	5,030	59.61	6,030	49.72	7,030	42.65	8,030	37.34	9,030	33.20
40	7,496	1,040	288.3	2,040	147.0	3,040	98.62	4,040	74.21	5,040	59.49	6,040	49.64	7,040	42.59	8,040	37.29	9,040	33.17
50	5,996	1,050	285.5	2,050	146.3	3,050	98.30	4,050	74.03	5,050	59.37	6,050	49.56	7,050	42.53	8,050	37.24	9,050	33.13
60	4,997	1,060	282.8	2,060	145.5	3,060	97.98	4,060	73.85	5,060	59.25	6,060	49.48	7,060	42.47	8,060	37.20	9,060	33.09
70	4,283	1,070	280.2	2,070	144.8	3,070	97.66	4,070	73.67	5,070	59.13	6,070	49.39	7,070	42.41	8,070	37.15	9,070	33.06
80	3,748	1,080	277.6	2,080	144.1	3,080	97.34	4,080	73.49	5,080	59.02	6,080	49.31	7,080	42.35	8,080	37.11	9,080	33.02
90	3,331	1,090	275.1	2,090	143.5	3,090	97.03	4,090	73.31	5,090	58.90	6,090	49.23	7,090	42.29	8,090	37.06	9,090	32.98
100	2,998	1,100	272.6	2,100	142.8	3,100	96.72	4,100	73.13	5,100	58.79	6,100	49.15	7,100	42.23	8,100	37.01	9,100	32.95
110	2,726	1,110	270.1	2,110	142.1	3,110	96.41	4,110	72.95	5,110	58.67	6,110	49.07	7,110	42.17	8,110	36.97	9,110	32.91
120	2,499	1,120	267.7	2,120	141.4	3,120	96.10	4,120	72.77	5,120	58.56	6,120	48.99	7,120	42.11	8,120	36.92	9,120	32.88
130	2,306	1,130	265.3	2,130	140.8	3,130	95.79	4,130	72.60	5,130	58.44	6,130	48.91	7,130	42.05	8,130	36.88	9,130	32.84
140	2,142	1,140	263.0	2,140	140.1	3,140	95.48	4,140	72.42	5,140	58.33	6,140	48.83	7,140	41.99	8,140	36.83	9,140	32.80
150	1,999	1,150	260.7	2,150	139.5	3,150	95.18	4,150	72.25	5,150	58.22	6,150	48.75	7,150	41.93	8,150	36.79	9,150	32.77
160	1,874	1,160	258.5	2,160	138.8	3,160	94.88	4,160	72.07	5,160	58.10	6,160	48.67	7,160	41.87	8,160	36.74	9,160	32.73
170	1,764	1,170	256.3	2,170	138.1	3,170	94.58	4,170	71.90	5,170	57.99	6,170	48.59	7,170	41.82	8,170	36.70	9,170	32.70
180	1,666	1,180	254.1	2,180	137.5	3,180	94.28	4,180	71.73	5,180	57.88	6,180	48.51	7,180	41.76	8,180	36.65	9,180	32.66
190	1,578	1,190	252.0	2,190	136.9	3,190	93.99	4,190	71.56	5,190	57.77	6,190	48.44	7,190	41.70	8,190	36.61	9,190	32.62
200	1,499	1,200	249.9	2,200	136.3	3,200	93.69	4,200	71.39	5,200	57.66	6,200	48.36	7,200	41.64	8,200	36.56	9,200	32.59
210	1,428	1,210	247.8	2,210	135.7	3,210	93.40	4,210	71.22	5,210	57.55	6,210	48.28	7,210	41.58	8,210	36.52	9,210	32.55
220	1,363	1,220	245.8	2,220	135.1	3,220	93.11	4,220	71.05	5,220	57.44	6,220	48.20	7,220	41.53	8,220	36.47	9,220	32.52
230	1,304	1,230	243.8	2,230	134.4	3,230	92.82	4,230	70.88	5,230	57.33	6,230	48.13	7,230	41.47	8,230	36.43	9,230	32.48
240	1,249	1,240	241.8	2,240	133.8	3,240	92.54	4,240	70.71	5,240	57.22	6,240	48.05	7,240	41.41	8,240	36.39	9,240	32.45
250	1,199	1,250	239.9	2,250	133.3	3,250	92.25	4,250	70.55	5,250	57.11	6,250	47.97	7,250	41.35	8,250	36.34	9,250	32.41
260	1,153	1,260	238.0	2,260	132.7	3,260	91.97	4,260	70.38	5,260	57.00	6,260	47.89	7,260	41.30	8,260	36.30	9,260	32.38
270	1,110	1,270	236.1	2,270	132.1	3,270	91.69	4,270	70.22	5,270	56.89	6,270	47.82	7,270	41.24	8,270	36.25	9,270	32.34
280	1,071	1,280	234.2	2,280	131.5	3,280	91.41	4,280	70.05	5,280	56.78	6,280	47.74	7,280	41.18	8,280	36.21	9,280	32.31
290	1,034	1,290	232.4	2,290	130.9	3,290	91.13	4,290	69.89	5,290	56.68	6,290	47.67	7,290	41.13	8,290	36.17	9,290	32.27
300	999.4	1,300	230.6	2,300	130.4	3,300	90.86	4,300	69.73	5,300	56.57	6,300	47.59	7,300	41.07	8,300	36.12	9,300	32.24
310	967.2	1,310	228.9	2,310	129.8	3,310	90.58	4,310	69.56	5,310	56.46	6,310	47.52	7,310	41.02	8,310	36.08	9,310	32.20
320	936.9	1,320	227.1	2,320	129.2	3,320	90.31	4,320	69.40	5,320	56.36	6,320	47.44	7,320	40.96	8,320	36.04	9,320	32.17
330	908.6	1,330	225.4	2,330	128.7	3,330	90.04	4,330	69.24	5,330	56.25	6,330	47.36	7,330	40.90	8,330	35.99	9,330	32.14
340	881.8	1,340	223.7	2,340	128.1	3,340	89.77	4,340	69.08	5,340	56.15	6,340	47.29	7,340	40.85	8,340	35.95	9,340	32.10
350	856.6	1,350	222.1	2,350	127.6	3,350	89.50	4,350	68.92	5,350	56.04	6,350	47.22	7,350	40.79	8,350	35.91	9,350	32.07
360	832.8	1,360	220.4	2,360	127.0	3,360	89.23	4,360	68.77	5,360	55.94	6,360	47.14	7,360	40.74	8,360	35.86	9,360	32.03
370	810.3	1,370	218.8	2,370	126.5	3,370	88.97	4,370	68.61	5,370	55.83	6,370	47.07	7,370	40.68	8,370	35.82	9,370	32.00
380	789.0	1,380	217.3	2,380	126.0	3,380	88.70	4,380	68.45	5,380	55.73	6,380	46.99	7,380	40.63	8,380	35.78	9,380	31.96
390	768.8	1,390	215.7	2,390	125.4	3,390	88.44	4,390	68.30	5,390	55.63	6,390	46.92	7,390	40.57	8,390	35.74	9,390	31.93
400	749.6	1,400	214.2	2,400	124.9	3,400	88.18	4,400	68.14	5,400	55.52	6,400	46.85	7,400	40.52	8,400	35.69	9,400	31.90
410	731.3	1,410	212.6	2,410	124.4	3,410	87.92	4,410	67.99	5,410	55.42	6,410	46.77	7,410	40.46	8,410	35.65	9,410	31.86
420	713.9	1,420	211.1	2,420	123.9	3,420	87.67	4,420	67.83	5,420	55.32	6,420	46.70	7,420	40.41	8,420	35.61	9,420	31.83
430	697.3	1,430	209.7	2,430	123.4	3,430	87.41	4,430	67.68	5,430	55.22	6,430	46.63	7,430	40.35	8,430	35.57	9,430	31.79
440	681.4	1,440	208.2	2,440	122.9	3,440	87.16	4,440	67.53	5,440	55.11	6,440	46.56	7,440	40.30	8,440	35.52	9,440	31.76
450	666.3	1,450	206.8	2,450	122.4	3,450	86.90	4,450	67.38	5,450	55.01	6,450	46.48	7,450	40.24	8,450	35.48	9,450	31.73
460	651.8	1,460	205.4	2,460	121.9	3,460	86.65	4,460	67.22	5,460	54.91	6,460	46.41	7,460	40.19	8,460	35.44	9,460	31.69
470	637.9	1,470	204.0	2,470	121.4	3,470	86.40	4,470	67.07	5,470	54.81	6,470	46.34	7,470	40.14	8,470	35.40	9,470	31.66
480	624.6	1,480	202.6	2,480	120.9	3,480	86.16	4,480	66.92	5,480	54.71	6,480	46.27	7,480	40.08	8,480	35.36	9,480	31.63
490	611.9	1,490	201.2	2,490	120.4	3,490	85.91	4,490	66.78	5,490	54.61	6,490	46.20	7,490	40.03	8,490	35.31	9,490	31.59
500	599.6	1,500	199.9	2,500	119.9	3,500	85.66	4,500	66.63	5,500	54.51	6,500	46.13	7,500	39.98	8,500	35.27	9,500	31.56
510	587.9	1,510	198.6	2,510	119.5	3,510	85.42	4,510	66.48	5,510	54.41	6,510	46.06	7,510	39.92	8,510	35.23	9,510	31.53
520	576.6	1,520	197.2	2,520	119.0	3,520	85.18	4,520	66.33	5,520	54.32	6,520	45.98	7,520	39.87	8,520	35.19	9,520	31.49
530	565.7	1,530	196.0	2,530	118.5	3,530	84.94	4,530	66.19	5,530	54.22	6,530	45.91	7,530	39.82	8,530	35.15	9,530	31.46
540	555.2	1,540	194.7	2,540	118.0	3,540	84.70	4,540	66.04	5,540	54.12	6,540	45.84	7,540	39.76	8,540	35.11	9,540	31.43
550	545.1	1,550	193.4	2,550	117.6	3,550	84.46	4,550	65.89	5,550	54.02	6,550	45.77	7,550	39.71	8,550	35.07	9,550	31.39
560	535.4	1,560	192.2	2,560	117.1	3,560	84.22	4,560	65.75	5,560	53.92	6,560	45.70	7,560	39.66	8,560	35.03	9,560	31.36
570	526.0	1,570	191.0	2,570	116.7	3,570	83.98	4,570	65.61	5,570	53.83	6,570	45.63	7,570	39.61	8,570	34.98	9,570	31.33
580	516.9	1,580	189.8	2,580	116.2	3,580	83.75	4,580	65.46	5,580	53.73	6,580	45.57	7,580	39.55	8,580	34.94	9,580	31.30
590	508.2	1,590	188.6	2,590	115.8	3,590	83.52	4,590	65.32	5,590	53.64	6,590	45.50	7,590	39.50	8,590	34.90	9,590	31.26
600	499.7	1,000	187.4	2,600	115.3	3,600	83.28	4,600	65.18	5,600	53.54	6,600	45.43	7,600	39.45	8,600	34.86	9,600	31.23
610	491.5	1,610	186.2	2,610	114.9	3,610	83.05	4,610	65.04	5,610	53.44	6,610	45.36	7,610	39.40	8,610	34.82	9,610	31.20
620	483.6	1,620	185.1	2,620	114.4	3,620	82.82	4,620	64.90	5,620	53.35	6,620	45.29	7,620	39.35	8,620	34.78	9,620	31.17
630	475.9	1,630	183.9	2,630	114.0	3,630	82.60	4,630	64.76	5,630	53.25	6,630	45.22	7,630	39.29	8,630	34.74	9,630	31.13
640	468.5	1,640	182.8	2,640	113.6	3,640	82.37	4,640	64.62	5,640	53.16	6,640	45.15	7,640	39.24	8,640	34.70	9,640	31.10
650	461.3	1,650	181.7	2,650	113.1	3,650	82.14	4,650	64.48	5,650	53.07	6,650	45.09	7,650	39.19	8,650	34.66	9,650	31.07
660	454.3	1,660	180.6	2,660	112.7	3,660	81.92	4,660	64.34	5,660	52.97	6,660	45.02	7,660	39.14	8,660	34.62	9,660	31.04
670	447.5	1,670	179.5	2,670	112.3	3,670	81.70	4,670	64.20	5,670	52.88	6,670	44.95	7,670	39.09	8,670	34.58	9,670	31.01
680	440.9	1,680	178.5	2,680	111.9	3,680	81.47	4,680	64.06	5,680	52.79	6,680	44.88	7,680	39.04	8,680	34.54	9,680	30.97
690	434.5	1,690	177.4	2,690	111.5	3,690	81.25	4,690	63.93	5,690	52.69	6,690	44.82	7,690	38.99	8,690	34.50	9,690	30.94
700	428.3	1,700	176.4	2,700	111.0	3,700	81.03	4,700	63.79	5,700	52.60	6,700	44.75	7,700	38.94	8,700	34.46	9,700	30.91
710	422.3	1,710	175.3	2,710	110.6	3,710	80.81	4,710	63.66	5,710	52.51	6,710	44.68	7,710	38.89	8,710	34.42	9,710	30.88
720	416.4	1,720	174.3	2,720	110.2	3,720	80.60	4,720	63.52	5,720	52.42	6,720	44.62	7,720	38.84	8,720	34.38	9,720	30.85
730	410.7	1,730	173.3	2,730	109.8	3,730	80.38	4,730	63.39	5,730	52.32	6,730	44.55	7,730	38.79	8,730	34.34	9,730	30.81
740	405.2	1,740	172.3	2,740	109.4	3,740	80.17	4,740	63.25	5,740	52.23	6,740	44.48	7,740	38.74	8,740	34.30	9,740	30.78
750	399.8	1,750	171.3	2,750	109.0	3,750	79.95	4,750	63.12	5,750	52.14	6,750	44.42	7,750	38.69	8,750	34.27	9,750	30.75
760	394.5	1,760	170.4	2,760	108.6	3,760	79.74	4,760	62.99	5,760	52.05	6,760	44.35	7,760	38.64	8,760	34.23	9,760	30.72
770	389.4	1,770	169.4	2,770	108.2	3,770	79.53	4,770	62.86	5,770	51.96	6,770	44.29	7,770	38.59	8,770	34.19	9,770	30.69
780	384.4	1,780	168.4	2,780	107.8	3,780	79.32	4,780	62.72	5,780	51.87	6,780	44.22	7,780	38.54	8,780	34.15	9,780	30.66
790	379.5	1,790	167.5	2,790	107.5	3,790	79.11	4,790	62.59	5,790	51.78	6,790	44.16	7,790	38.49	8,790	34.11	9,790	30.63
800	374.8	1,800	166.6	2,800	107.1	3,800	78.90	4,800	62.46	5,800	51.69	6,800	44.09	7,800	38.44	8,800	34.07	9,800	30.59
810	370.2	1,810	165.6	2,810	106.7	3,810	78.69	4,810	62.33	5,810	51.60	6,810	44.03	7,810	38.39	8,810	34.03	9,810	30.56
820	365.6	1,820	164.7	2,820	106.3	3,820	78.49	4,820	62.20	5,820	51.52	6,820	43.96	7,820	38.34	8,820	33.99	9,820	30.53
830	361.2	1,830	163.8	2,830	105.9	3,830	78.28	4,830	62.07	5,830	51.43	6,830	43.90	7,830	38.29	8,830	33.95	9,830	30.50
840	356.9	1,840	162.9	2,840	105.6	3,840	78.08	4,840	61.95	5,840	51.34	6,840	43.83	7,840	38.24	8,840	33.92	9,840	30.47
850	352.7	1,850	162.1	2,850	105.2	3,850	77.88	4,850	61.82	5,850	51.25	6,850	43.77	7,850	38.19	8,850	33.88	9,850	30.44
860	348.6	1,860	161.2	2,860	104.8	3,860	77.67	4,860	61.69	5,860	51.16	6,860	43.71	7,860	38.14	8,860	33.84	9,860	30.41
870	344.6	1,870	160.3	2,870	104.5	3,870	77.47	4,870	61.56	5,870	51.08	6,870	43.64	7,870	38.10	8,870	33.80	9,870	30.38
880	340.7	1,880	159.5	2,880	104.1	3,880	77.27	4,880	61.44	5,880	50.99	6,880	43.58	7,880	38.05	8,880	33.76	9,880	30.35
890	336.9	1,890	158.6	2,890	103.7	3,890	77.07	4,890	61.31	5,890	50.90	6,890	43.52	7,890	38.00	8,890	33.73	9,890	30.32
900	333.1	1,900	157.8	2,900	103.4	3,900	76.88	4,900	61.19	5,900	50.82	6,900	43.45	7,900	37.95	8,900	33.69	9,900	30.28
910	329.5	1,910	157.0	2,910	103.0	3,910	76.68	4,910	61.06	5,910	50.73	6,910	43.39	7,910	37.90	8,910	33.65	9,910	30.25
920	325.9	1,920	156.2	2,920	102.7	3,920	76.48	4,920	60.94	5,920	50.65	6,920	43.33	7,920	37.86	8,920	33.61	9,920	30.22
930	322.4	1,930	155.3	2,930	102.3	3,930	76.29	4,930	60.82	5,930	50.56	6,930	43.26	7,930	37.81	8,930	33.57	9,930	30.19
940	319.0	1,940	154.5	2,940	102.0	3,940	76.10	4,940	60.69	5,940	50.47	6,940	43.20	7,940	37.76	8,940	33.54	9,940	30.16
950	315.6	1,950	153.8	2,950	101.6	3,950	75.90	4,950	60.57	5,950	50.39	6,950	43.14	7,950	37.71	8,950	33.50	9,950	30.13
960	312.3	1,960	153.0	2,960	101.3	3,960	75.71	4,960	60.45	5,960	50.31	6,960	43.08	7,960	37.67	8,960	33.46	9,960	30.10
970	309.1	1,970	152.2	2,970	100.9	3,970	75.52	4,970	60.33	5,970	50.22	6,970	43.02	7,970	37.62	8,970	33.42	9,970	30.07
980	303.9	1,980	151.4	2,980	100.6	3,980	75.33	4,980	60.20	5,980	50.14	6,980	42.95	7,980	37.57	8,980	33.39	9,980	30.04
990	302.8	1,990	150.7	2,990	100.3	3,990	75.14	4,990	60.08	5,990	50.05	6,990	42.89	7,990	37.52	8,990	33.35	9,990	30.01
1,000	299.8	2,000	149.9	3,000	99.94	4,000	74.96	5,000	59.96	6,000	49.97	7,000	42.83	8,000	37.48	9,000	33.31	10,000	29.98

Prepared by Bureau of Standards, Department of Commerce. Reprinted by permission of Government Printing Office.

BOOKS

A New Volume by
Prof. Morecroft
An Event in Radio Literature



PROF. JOHN H. MORECROFT, of the department of electrical engineering, Columbia University, is the outstanding writer of radio text books in the United States. Two of his volumes, "Principles of Radio Communication," a large volume for advanced students, and "Elements of Radio Communication," a smaller volume, for those not yet in the advanced stages of radio studies, have won him the reputation of being foremost in this line.

Now Prof. Morecroft has just brought out a new book, "Experimental Radio Engineering," just the volume for the radio experimenter, a valuable adjunct to the actual work performed by radio enthusiasts in their laboratories, whether at home or in shops or factories.

Also, the new volume marks the Professor's recognition of the great amount of experimental work and receiver and amplifier construction going on throughout the world. He has handled the experimental subject with the same deft skill and authority that marked his two previous volumes.

It behooves every radioist to possess all three books by Prof. Morecroft, but if he can choose only one at a time the experimenter of course wants to start with "Experimental Radio Engineering."

Prof. Morecroft's style is clear and definite and besides he writes with the authority of a scientist. Problems that have vexed you will be found solved and explained in as simple a manner as is consistent with accuracy.

The volume contains fifty-one experiments on the more important phenomena of radio. It is intended to be companion book to the author's "Principles of Radio Communication" but is in itself a text on practical radio measurements. Contains a vast fund of useful information for the beginner as well as for the advanced student of the principles of radio.

Measurements of resistance, self-inductance, mutual inductance, capacity, radio frequency voltages and currents, frequency, amplification; characteristics of antennas, tubes, loud-speakers, vacuum tube voltmeters, rectifiers, detectors; study of selectivity, sensitivity, fidelity, filters, modulation, and many other phases of radio are fully discussed.

The book has 345 pages, 250 illustrations, and is cloth- bound.

Order Cat. M-EXRE @ $3.50

"ELEMENTS OF RADIO COMMUNICATION"

"ELEMENTS OF RADIO COMMUNICATION," written in plain language, requiring little foundation knowledge of radio, is a complete course on the elements of radio, and gives one an insight into radio phenomena in such a way as to clear them up. For instance, take tuning. A variable condenser commonly is connected across the secondary of a tuning coil. Just what processes take place to accomplish tuning? Obtaining full knowledge of the causes of resonance, and learning how to compute the resonant frequency of a circuit, contribute toward the enjoyment of radio construction. Resistance, impedance, reactance, inductance and capacity are explained with fitting analogies, and the whole theoretical story of radio laid bare in such a fascinating and compelling manner as to make the volume of inestimable value.

The book contains much material never before published, is up-to-date and contains 226 pages, 170 illustrations and a complete index. Cloth bound.

Order Cat. M-ELEM @ $3.00

(Remit with order and we pay transportation. Five-day money-back guarantee attaches to the purchase of all books.)

"PRINCIPLES OF RADIO COMMUNICATION"

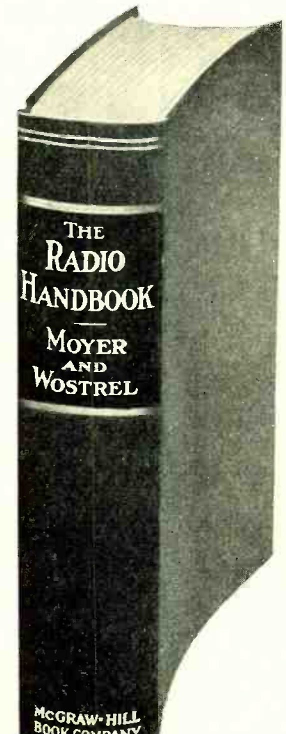
"PRINCIPLES OF RADIO COMMUNICATION," the larger and deeper volume by this outstanding authority and former president of the Institute of Radio Engineers, covers essentially the same ground as "Elements of Radio Communication," but does so more extensively and with a mathematical treatment that commends this book to radio engineers and college and university students in radio engineering.

"Principles of Radio Communication," which is in its second edition, contains 1,001 pages, 831 illustrations and is cloth-bound.

Order Cat. M-PRN @ $7.50

[Remit with order and we pay transportation. Five-day money-back guarantee attaches to the purchase of all books.]

BOOKS BY MOYER AND WOSTREL



ANOTHER new volume is "The Radio Handbook," by James A. Moyer and John F. Wostrel, both of the Massachusetts Department of Education. This handbook meets the need for a complete digest of authoritative radio data, both theoretical and practical.

From the fundamentals of electricity, magnetism and the electron theory, right down to the latest commercial and industrial applications of radio, this book covers the field, with descriptions, definitions, design data, practical methods, tables and illustrations in profusion. It is a complete modern manual of practical and technical radio information.

Some of the subjects covered are: modern transmitters, piezo crystal control, percentage modulation, commercial and amateur short-wave receivers and transmitters, Kennelly-Heaviside layer effects and measurements, marine radio equipment, auto alarm, automobile receivers, latest tubes including photo-electric cells, television, sound motion pictures, etc.

If you want a book that quickly refers you to the correct information contained within its covers on any subject pertaining to radio, this is the volume. It has 886 pages, 650 illustrations. Flexible binding.

Order Cat. MW-RH @ $5.00

The need for an up-to-date book on radio tubes that answers all the important questions has been filled by Moyer and Wostrel. This book is a complete discussion of tube principles, functions and uses. The essential principles underlying the operation of vacuum tubes are explained in as non-technical a manner as is consistent with accuracy. The book covers the construction, action, reactivation testing and use of vacuum tubes as well as specifications for vacuum tubes and applications for distant control of industrial processes and precision measurements. 297 pages, cloth bound. Order Cat. MWT. .... @ $2.50

"Practical Radio," including the testing of radio receiving sets. 378 pages, 223 illustrations. Cloth bound. Order Cat. MWP. .... @ $2.50

"Practical Radio Construction and Repairing," 319 pages, a companion volume to the above. New edition, new price. Order Cat. MWC. .... @ $2.50

(Remit with order and we pay transportation. Five-day money-back guarantee attaches to the purchase of all books.)

THREE BOOKS BY ANDERSON AND BERNARD

AUDIO POWER AMPLIFIERS

The book begins with an elementary exposition of the historical development and circuit constitution of audio amplifiers and sources of powering them. From this simple start it quickly proceeds to a well-considered exposition of circuit laws, including Ohm's laws and Kirchhoff's laws. The determination of resistance values to produce required voltages is carefully expounded. All types of power amplifiers are used as examples: AC, DC, battery operated and composite. But the book treats of AC power amplifiers most generously, due to the superior importance of such power amplifiers commercially. Tube characteristic tables and curves profusely included. Cloth cover, 193 pages. Order Cat. APA @ $1.50

THE SUPERHETERODYNE

This volume by Anderson and Bernard deals with the principles and practice of the Superheterodyne method of receiving and is particularly important now, because this is a superheterodyne year. It explains the function of the oscillator, the modulator, the pre-modulator selector, and the intermediate frequency amplifier. It explains the cause of repeat points and gives methods for avoiding them or minimizing their effect. It illustrates various forms of oscillators and tells of the advantages of each. Different types of modulators and pick-up systems are explained and their advantages stated. Different methods of coupling in the intermediate frequency amplifier are shown. Order Cat. SH @ 85c

FOOTHOLD ON RADIO

In simple English that any one can understand, the technical side of radio is presented by Anderson and Bernard in their book, "Foothold on Radio" Any one who can read English can understand this book. It is intended for the sheer novice. The treatment is non-mathematical. Order Cat. FOR @ 60c

(Remit with order and we pay transportation. Five-day money-back guarantee attaches to the purchase of all books.)

RADIO WORLD, 145 West 45th St., New York, N. Y.
Enclosed please find $...... for which mail postpaid the following books in 5-day money-back absolute guarantee:

☐ Cat. M-EXRE @ $3.50
☐ Cat. M-PRN @ $7.50
☐ Cat. MWT @ $2.50
☐ Cat. MWC @ $2.50
☐ Cat. SH @ 95c.
☐ Cat. M-ELEM @ $3.00
☐ Cat. MW-RH @ $5.00
☐ Cat. MWP @ $2.50
☐ Cat. APA @ $1.50
☐ Cat. FOR @ 69c.

Name ....

Address ....

City ....

State ....

A Record in the Radio Publication Field

RADIO WORLD

will, on October 24, issue its

500TH CONSECUTIVE NUMBER

This is, of course, more important to the publishers than to the rest of the world, but we believe that the radio field in general will be interested in the continued publishing of the paper for 500 consecutive times in a field that has seen very many changes.

You will make us happy if you will help us to celebrate this event by being represented in our

SPECIAL 500TH NUMBER

We don't care about the size of your copy—but we are honest in saying that we do care very much about having your firm represented in this issue, which will have an increased circulation because of our efforts to call the attention of the radio public to our special edition. Last form closes October 13, 1931.

Our advertising rates will remain the same, as follows:

	1 Inser.		1 Inser.
1 page	$150.00	1/6 page	$25.00
1/2 page	75.00	1/8 page	18.75
1/3 page	50.00	1 inch	5.00
1/4 page	37.50		

Classified advertisements, 7 cents a word; $1.00 minimum; remittance with order.

May we hear from you by an early mail, with order and copy for such space as may suit your purpose?

PUBLISHERS OF RADIO WORLD

RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y. — Telephone: BRyant 9-0558

NEW BOOKS

"EXPERIMENTAL RADIO ENGINEERING," by Prof. John H. Morecroft, of the Department of Electrical Engineering, Columbia University. A companion book to the author's "Principles of Radio Communication," but in itself a text on practical radio measurements. Cloth bound, 345 pages, 6 x 9, 250 figures....................**$3.50**

"THE RADIO HANDBOOK," by James A. Moyer and John F. Wostrel, both of the Massachusetts Department of Education. Meets the need for a complete digest of authoritative radio data, both theoretical and practical. Flexible binding, 886 pages, 650 illustrations....................**$5.00**

"RADIO FREQUENCY MEASUREMENTS," by E. B. Moulin, M.A., A.M., E.E., M. I. Rad. Eng. Reader of Engineering Science in the University of Oxford. Second Edition, entirely reset and greatly enlarged. For advanced students with mathematical foundations. Cloth, 487 pages and 289 illustrations....................**$12.50**

"FOUNDATIONS OF RADIO," by Rudolph L. Duncan. A treatise for the beginner, setting forth clearly and carefully the electrical phenomena associated with radio. Just the book to give you a firm grip on the subject....................**$2.50**

Remit with order. We pay transportation. Ten-day money-back guaranty on all books.

Radio World, 145 45th St., New York, N. Y.

SYNCHRONOUS MOTOR, $4.25

For use on 60-cycle AC line. 12-inch turntable included. 80 revolutions per minute. The speed is self-regulated. This compact synchronous motor may be used with a phonograph pickup to play records. Cat. SYN-M @ $4.25.

DIRECT RADIO CO., 143 W. 45th St., New York, N.Y.

SHORT-WAVE NUMBERS OF RADIO WORLD. Copies of Radio World from Nov. 8, 1930 to Jan. 3, 1931, covering the various short-wave angles sent on receipt of $1.00. Radio World, 145 W. 45th St., N. Y. City.

NATIONAL DRUM DIAL

National Velvet Vernier drum dial, type H, for ¼" shaft. An automatic spring take-up assures positive drive at all times. Numbers are projected on a ground glass. Rainbow wheel changes colors in tuning. Modernistic escutcheon. Order Cat. ND-H @ $3.13.

GUARANTY RADIO GOODS CO.

143 West 45th Street, New York, N. Y.

Tubes at 30¢ Each

Four for $1.00

171 245

Sold on basis of remittance with order. We will pay the postage.

RELIABLE RADIO CO.

143 West 45th Street New York, N. Y.

Two for the price of *One*

Get a FREE one-year subscription for any ONE of these magazines:

- ☐ RADIO CALL BOOK MAGAZINE AND TECHNICAL REVIEW (monthly, 12 issues)
- ☐ POPULAR MECHANICS AND SCIENCE AND INVENTION (combined) (monthly, 12 issues).
- ☐ POPULAR SCIENCE MONTHLY
- ☐ RADIO INDEX (monthly, 12 issues), stations, programs, etc.
- ☐ **RADIO** (monthly, 12 issues; exclusively trade magazine).
- ☐ RADIO LOG AND LORE. Monthly. Full station lists, cross indexed, etc.
- ☐ AMERICAN BOY–YOUTH'S COMPANION (monthly, 12 issues; popular magazine).
- ☐ BOYS' LIFE (monthly, 12 issues; popular magazine).

Select any one of these magazines and get it FREE for an entire year by sending in a year's subscription for RADIO WORLD at the regular price, $6.00. Cash in now on this opportunity to get RADIO WORLD WEEKLY, 52 weeks at the standard price for such subscription, plus a full year's subscription for any ONE of the other enumerated magazines FREE! Put a cross in the square next to the magazine of your choice, in the above list, fill out the coupon below, and mail $6 check, money order or stamps to RADIO WORLD, 145 West 45th Street, New York, N. Y. (Add $2.00, making $8.00 in all, for extra postage to Canada for both publications.

Your Name....................

Your Street Address....................

City....................State....................

DOUBLE VALUE!

☐ If renewing an existing or expiring subscription for RADIO WORLD, please put a cross in square at beginning of this sentence.

☐ If renewing an existing or expiring subscription for other magazine, please put a cross in square at the beginning of this sentence.

RADIO WORLD, 145 West 45th Street, New York. (Just East of Broadway)

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

7 cents a word—$1.00 minimum—Cash with Order