MARCH 1 1930 — PENTODE CIRCUITS — 15¢ Per Copy

RADIO WORLD

REG. U.S. PAT. OFF.

414th Consecutive Issue—EIGHTH YEAR

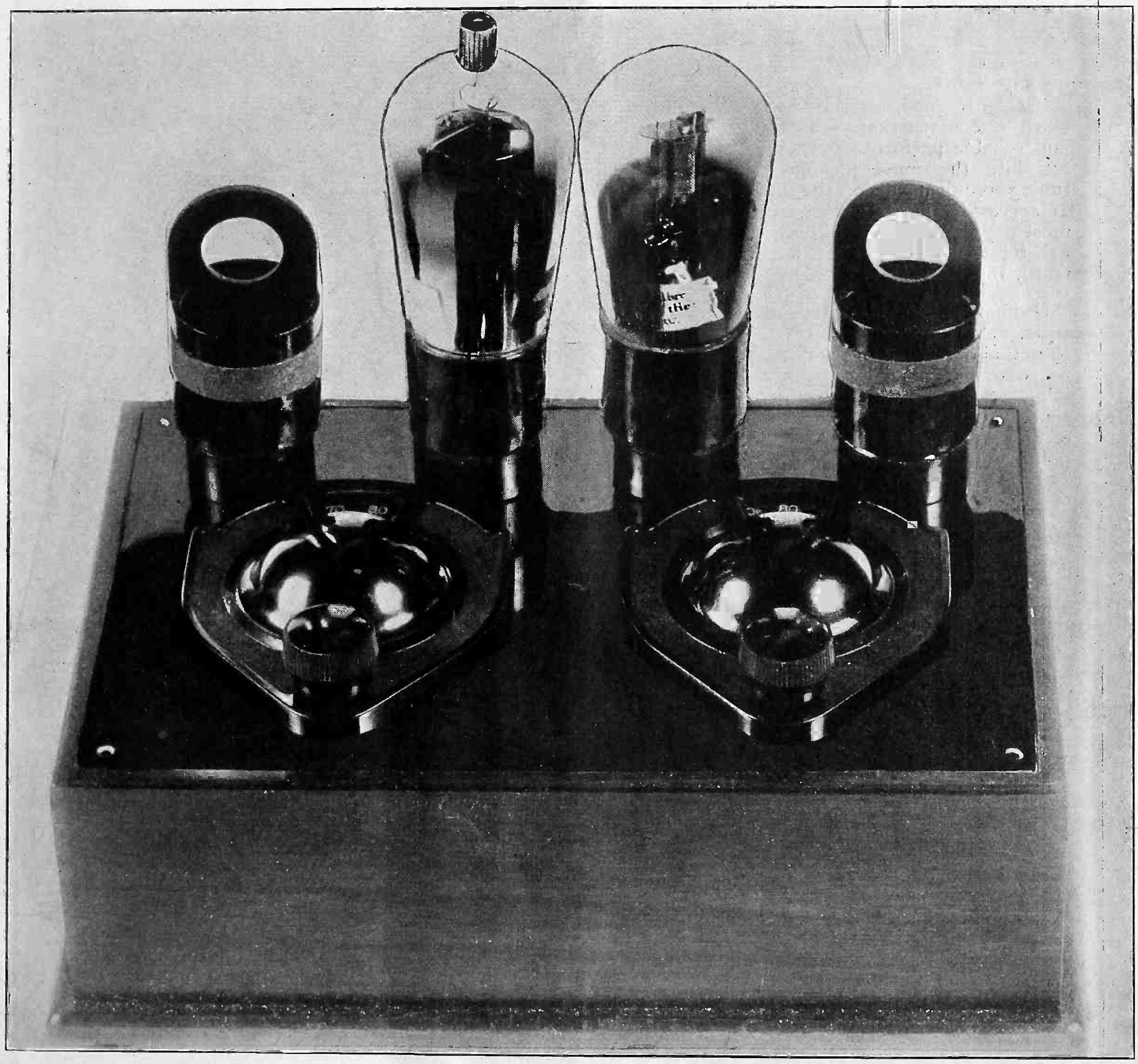
Vacuum Tube Voltmeter for Loftin-White Circuits

New Developments Outlined by Experts

Many Changes Announced of Stations' Waves

NEW AC SCREEN GRID SHORT-WAVE ADAPTER

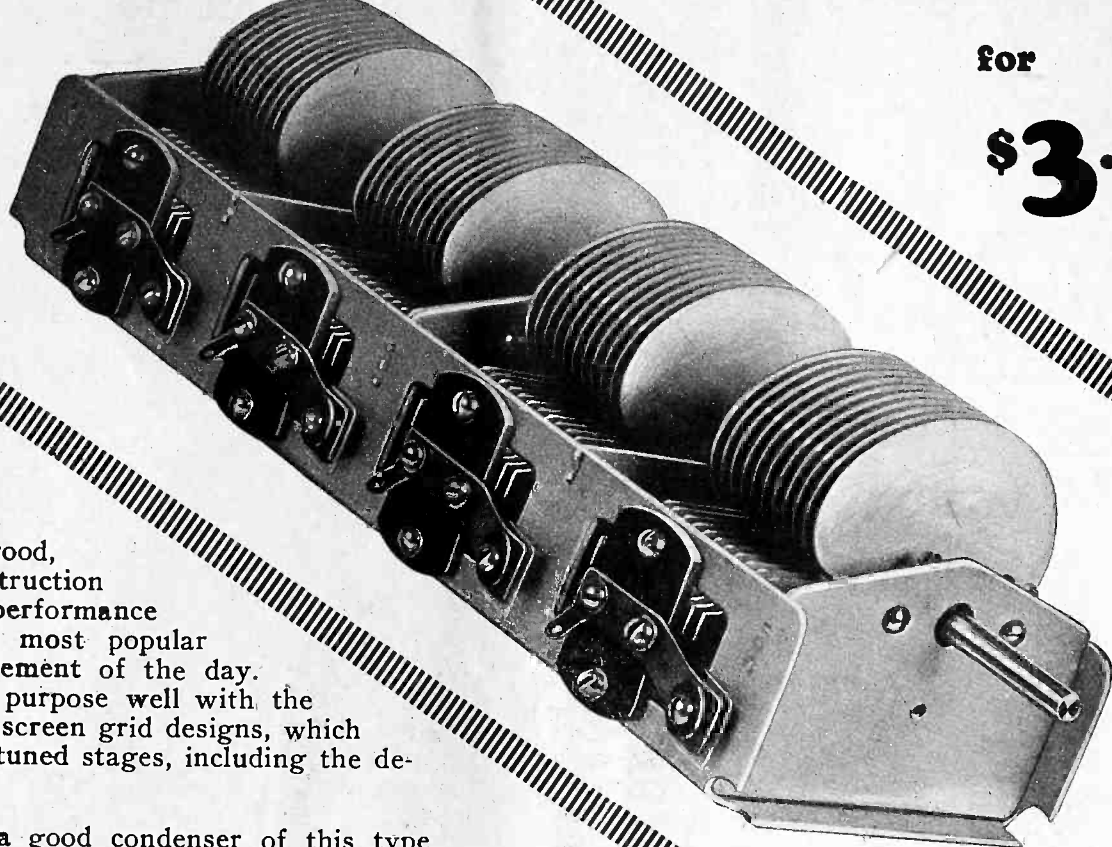
See page 5



A Substantial Four-Gang Condenser

for

$3.95



A FOUR-GANG condenser of good, sturdy construction and reliable performance fits into the most popular tuning requirement of the day. It serves its purpose well with the most popular screen grid designs, which call for four tuned stages, including the detector input.

Ordinarily a good condenser of this type costs, at the best discount you can contrive to get, about twice as much as is charged for the one illustrated **and even then the trimming condensers are not included.** The question then arises, has quality been sacrificed to meet a price? As a reply, read the twenty-six points of advantage. The first consideration was to build quality into the condenser.

The reason for the low price is that the condenser was manufactured in very large quantities and is sold to the consumer with only one handling between factory and him, at a price only 10% above the cost of production.

All claims are backed up by our guaranty—**MONEY BACK IF IN FIVE DAYS AFTER RECEIPT OF CONDENSER YOU ARE NOT COMPLETELY SATISFIED.**

The Capacity is .00035 mfd. for each section. We haven't this condenser in any other capacity. The price is net to all, no matter what quantity. Order one shipped C. O. D.

[Overall length is 11 inches.]

GUARANTY RADIO GOODS CO.
143 West 45th St., New York, N. Y.
(Just East of Broadway)

Please ship me within one day of receipt of this order one four-gang tuning condenser capacity of each section .00035 mfd., with trimmers built in, as advertised, at $3.95. Please send C. O. D.

Name ....

Address ....

City ....

State ....

5-DAY MONEY-BACK GUARANTY

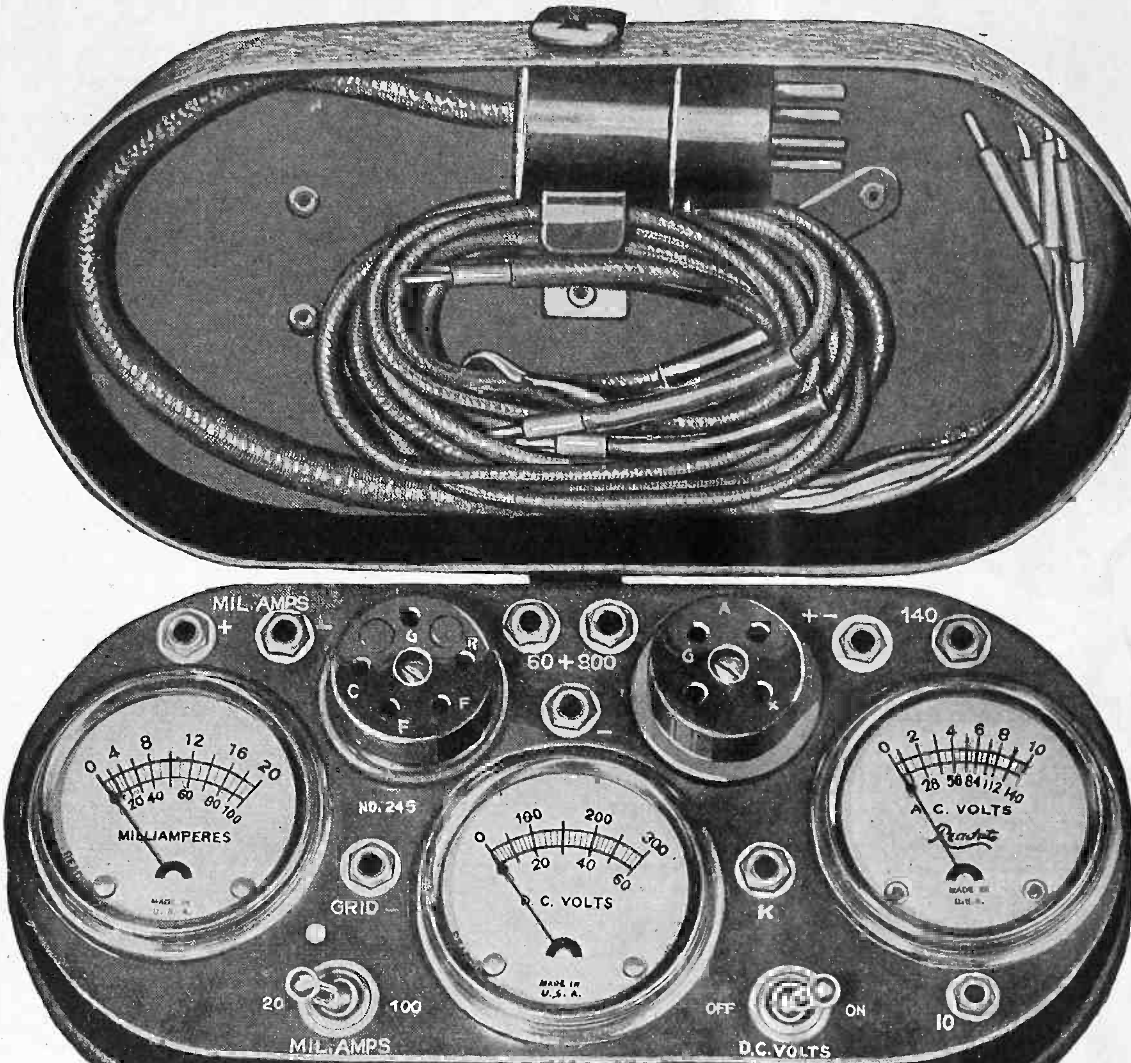
26 Points of Advantage!

THE desirability and dependability of this condenser are attested by the following roster of features:

(1)—Rigid steel frame.
(2)—Accurate mechanical alignment.
(3)—Single steel shaft.
(4)—Shaft supported at both ends and at the center.
(5)—Accurate spacing of rotor and stator plates.
(6)—Plates made of aluminum of uniform thickness.
(7)—Stator plates shielded from each other and from external conductors.
(8)—Each section provided with a built-in adjustable trimmer condenser.
(9)—Steel spring bearings.
(10)—Adjustable tension on bearings.
(11)—Shaft and rotor plates removable.
(12)—Low minimum capacity in each section.
(13)—Low loss insulation between stator and rotor plates.
(14)—Common rotor connection to steel frame.
(15)—Each rotor attached to common shaft with two set screws.
(16)—Exact equality of all condenser sections at all settings.
(17)—Side and bottom mounting provisions.
(18)—Straight line wavelength shape of plates.
(19)—Brass soldering lug for each condenser stator section.
(20)—Capacity increases with counter clockwise rotation of shaft.
(21)—Capacity of each section, .00035 mfd.
(22)—Plates cannot short.
(23)—Easy turning shaft.
(24)—Will last a lifetime.
(25)—Eleven rotor and eleven stator plates in each section.
(26)—Weight (condenser alone), 3¼ lbs.

NEW J-245-X TROUBLE-SHOOTING JIFFY TESTER

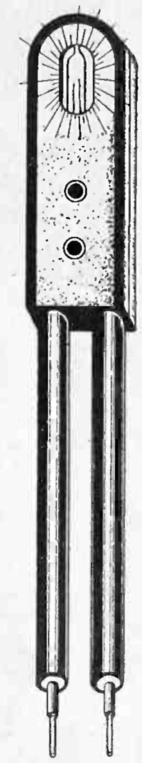
Illumination Continuity and Polarity Tester FREE with Each Outfit!



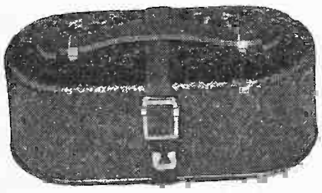
Your Price

$15.82

Complete



Illumination Tester. Vest Pocket Size. Shows Shorts and Opens Visually, also polarity of DC line. A Neon lamp is built in.



The three-meter assembly, in the crackle-brown finish carrying case, with slip-on cover in place. The handle is genuine leather. The buckled strap holds the cover on.

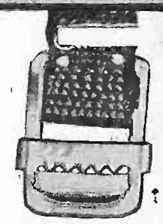
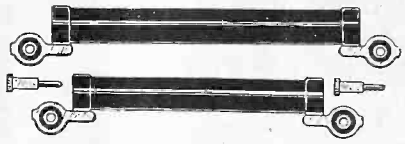
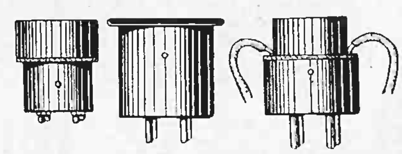


Illustration above is 2/3 scale.





J-111 Multiplier, upper left, with tip; below it, J-106 Multiplier with tip; plugs, left to right, J-19, conforms UV socket to UX plug; J-20, conforms UX tester socket to UV199 tube; J-24, to test Kellogg and old style Arcturus tubes.

Makes All Necessary Tests in a Jiffy and Simplifies Service Work!

WHEN servicing a radio set, power amplifier, speech amplifier or sound reproduction or recording equipment, the circuits and voltages are almost inaccessible, unless a plug-in tester is used.

The Jiffy 245-X plugs in and does everything you want done. It consists of:

(1)—The encased three-meter assembly, with 4-prong (UX) and 5-prong (UY) sockets built in; changeover switch built in, from 0-20 to 0-100 ma.; ten vari-colored jacks, five of them to receive the vari-colored tipped ends of the plug cable; grid push-button, that when pushed in connects grid direct to the cathode for 224 and 227 tubes, to note change in plate current, and thus shorts the signal input.

(2)—4-prong adapter for 5-prong plug of cable.

(3)—Screen grid cable for testing screen grid tubes.

(4)—Pair of Test Leads for individual use of meters.

(5)—J-106 Multiplier, to make 0-300 DC read 0-600.

(6)—J-111 Multiplier, to make 0-140 AC read 0-560.

(7)—Two jack tips to facilitate connection of multipliers to jacks in tester.

(8), (9), (10)—Three adapters so UV199 and Kellogg tubes may be tested.

(11)—Illumination Tester.

The illumination tester will disclose continuities and opens and also the polarity of DC house mains. It is as handy as a pencil and fits in your vest pocket. It works on voltages from 100 to 400. There are two electrodes in a Neon lamp in the top of the instrument. On AC both electrodes light. On DC only one lights, and that one is negative of the line, the light being on the same side as the lead. Hence the illuminator shows whether tested source is AC or DC, and if DC, which side is negative.

Even the output of the speaker cord will show a light.

Also, the device will test which fuses are blown in fused house lines, AC or DC. Besides it tests ignition of spark plugs of automobiles, boats and airplanes, also faulty or weak spark plugs.

Just flash on the illumination tester momentarily. It will last about 4,000 flashes.

THE new Jiffy Tester, J-245-X, is a complete servicing outfit. It consists of a three-meter assembly in a metal case, with slip-on cover and a cable plug. There are ten adapters. It is vital to have the complete outfit so you can meet any emergency.

With this outfit you plug the cable into a vacated socket of a receiver, putting the removed tube in the tester, and using the receiver's power for making these tests: plate current, up to 100 milliamperes; plate voltage up to 300 volts; filament or heater voltage (AC or DC), up to 10 volts.

Each meter may be used independently. One of the adapters—a pair of test leads, one red, the other black, with tip jack terminals—serves this purpose. Multiplier J-106 extends the range of the DC voltmeter to 600 volts, but this reading must be obtained independently, as must readings on the 0-60 scale of the DC voltmeter. Independent reading of the AC voltmeter for line of voltage is necessary; also to use 0-140 scale while Multiplier J-111 extends the AC scale to 560 volts for reading power transformer secondaries.

The other adapters permit the testing of special receiver tubes, so that tests may be made, in all, of 22 different tubes: 201A, 200A, UX199, UV199, 120, 240, 171, 171A, 112, 112A, 245, 224, 222, 228, 280, 281, 227, 226, 210, 250, Kellogg tubes and old style Arcturus tubes.

GUARANTY RADIO GOODS CO.
143 West 45th Street, Just East of Broadway,
N. Y. City.

☐ Please send me on 5-day money-back guaranty your J-245-X Jiffy Tester, complete, with all 10 adapters, and with illuminated Tester FREE with each order. Also send instruction sheet, tube data sheet and rectifier tube testing information.

☐ Please ship C. O. D. @ $15.82 plus cartage and P.O. fee.

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5-DAY MONEY-BACK GUARANTY

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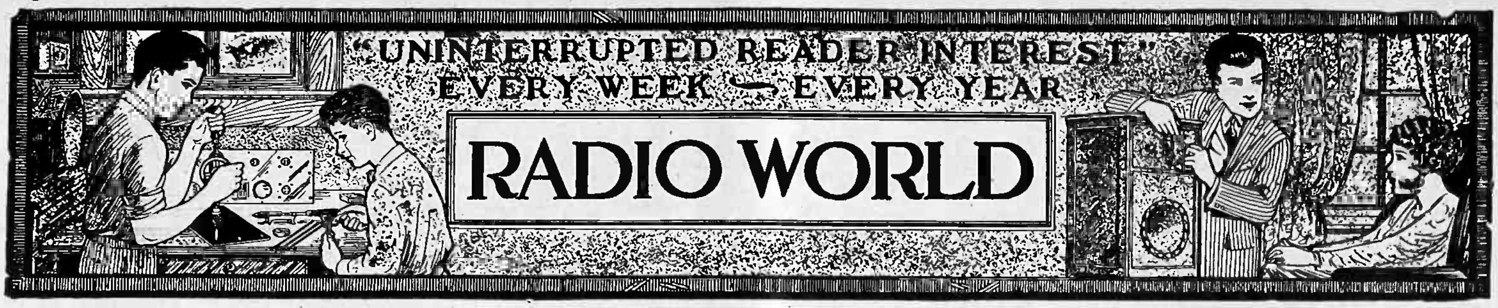

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Technical Accuracy Second to None
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A Short Wave Adapter for AC Screen Grid Sets

Works All Tubes of Receiver and Requires One Extra Valve

By Capt. Peter V. O'Rourke

INTEREST in direct reception on short waves runs high these days. The programs may be enjoyed through a separate short-wave receiver or by means of an adapter. The separate receiver may be battery-operated as to filament and plate supply, or may have a battery for the filaments alone, and a B eliminator for the plates. The AC type of separate short-wave receiver would furnish its own power of all types.

So an adapter would be AC operated, totally battery operated, or would embody composite operation, depending on the type of receiver into which it is plugged.

On the whole, better success has been obtained with separate short wave receivers, than with adapters, due principally to greater amplification. In receivers different methods of connection that the adapter picks up as it finds them, sometimes prevent oscillation, hence reception. And, at best, these adapters, which require no extra tube, simply plug into the detector socket of the receiver, delivering to it short-wave pickup, but without radio frequency or intermediate frequency amplification which is regarded as necessary for adequate sensitivity.

Uses an Extra 227 Tube

The adapter diagrammed herewith is of a new type, and it develops far more sensitivity than the varieties that discard the radio frequency channel of the receivers into which they are to be plugged. The present adapter is intended for use only with AC TRF sets that have a 224 as first radio frequency amplifier, and can not be used in this form on any other type of receiver. A 227 tube is required additionally.

The operation of the adapter is as follows:

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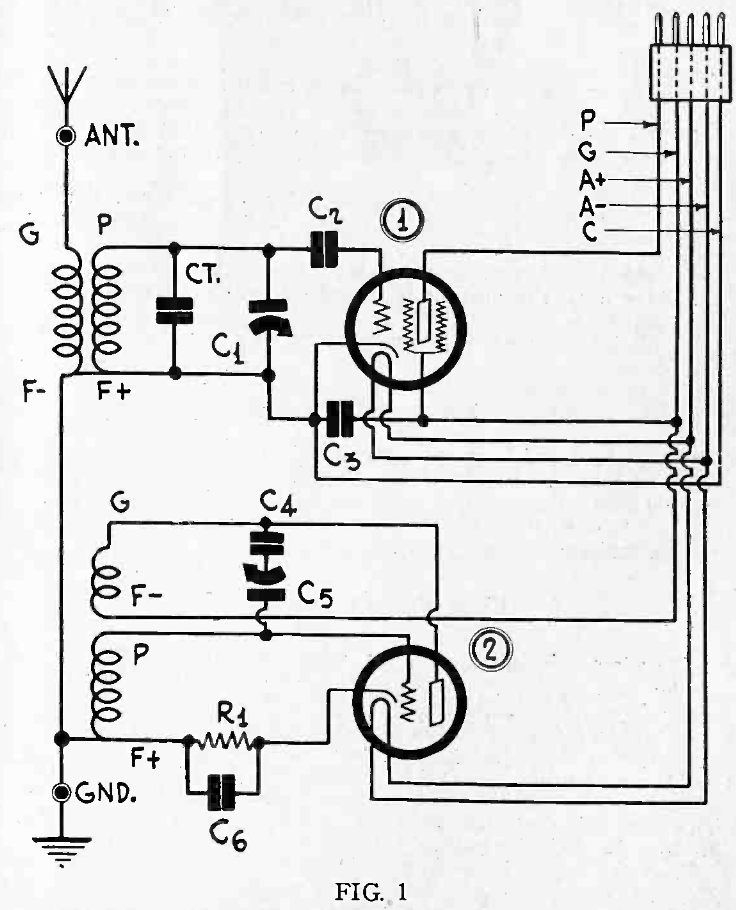
How To Tune In

A small variable condenser, with a trimmer across it in permanent position, tunes a short wave coil to afford signal inpua. Sim-



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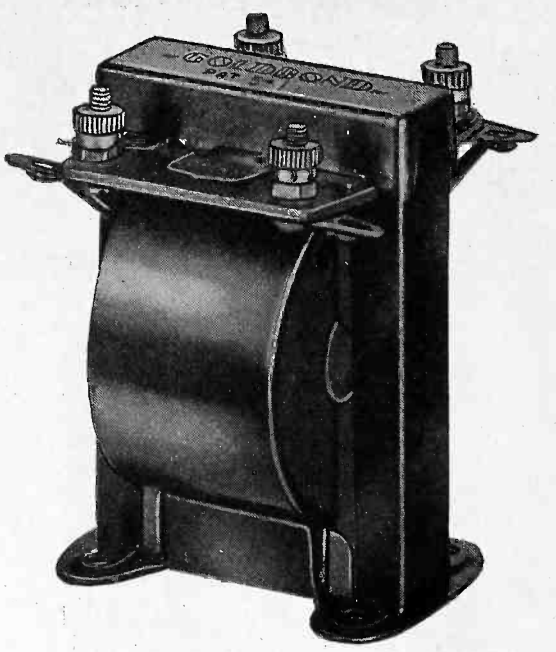
High Impedance Audio Transformers

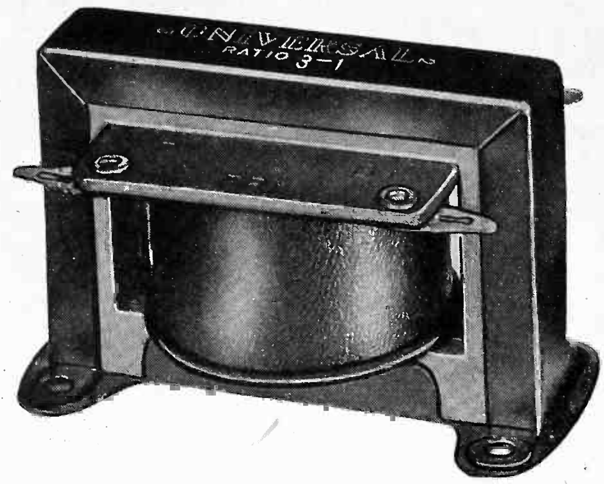


Audio frequency coupling transformers with high impedance primaries and secondaries are made in two models and two ratios of each model. At left is the "Gold Bond" shielded type, at right the "Universal" unshielded type for subpanel mounting, overall height 2¼". The ratios are 1-to-3 and 1-to-5, primary to secondary.

The shielded "Gold Bond" model has 4,000 turns on the primary, so the 1-to-3 model has 12,000 secondary turns and the 1-to-5 model 20,000 secondary turns. Extreme compactness and neatness prevail.

The "Universal" model for subpanel mounting has 3,200 primary turns.

Laminations in both are of best silicon steel in a strong steel frame. The coils in both are vacuum impregnated and therefore moisture-proof.



A single stretch of copper wire without soldered connections of in-between joints is used on each winding of both transformers. The "Gold Bond" model is illustrated.

Order Cat. GB-1-3 for 1-to-3 ratio
Order Cat. GB-1-5 for 1-to-5 ratio
$1.50 each

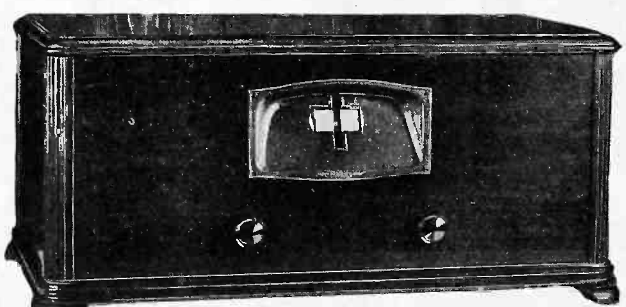
Excellent reproduction of tonal values as supplied by the detector or first audio tube is assured by use of either of the transformers. The "Universal" model illustrated above, is excellent for replacement purposes. Even on this model high plate voltages may be used, with consequent high plate currents, due to the relatively large diameter of wire used.

Order Cat. UVS-1-3 for 1-to-3 ratio
Order Cat. UVS-1-5 for 1-to-5 ratio
$1.13 each

GUARANTY RADIO GOODS Co., 143 West 45th Street, New York City

FIVE-DAY MONEY-BACK GUARANTY! ORDER THESE C. O. D.

Long Distance Reception Guaranteed!



The Balkite A5 neutrodyne, in real walnut table model cabinet by Berkey & Gay. Volume control at left, AC switch at right, drum dial at center, with space to mark in call letters.

You want DX—the more DX the merrier! But why take any chances? We positively guarantee that the Balkite Neutrodyne, made by Gilfillan, will get you all the DX you could desire! Try the set for five days. If not completely satisfied, return it in that time for prompt refund of purchase price!

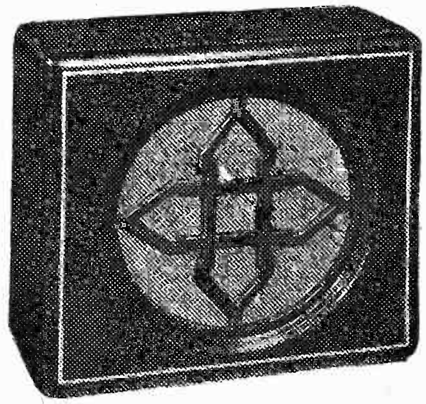
Three stages of tuned RF, neutralized, so there's no squealing; easy tuning; operation on short piece of wire indoors perfectly satisfactory; no repeat tuning points; no hum; phonograph pickup jack built in; excellent tone quality; good selectivity. These are outstanding points of the receiver, ONE OF THE MOST SENSITIVE BROADCAST RECEIVERS EVER DEVELOPED. The receiver alone lists for $135. Here you get the set, speaker and tubes at $9.50 less than half the list price of the receiver alone!

8-Tube Push-Pull AC Balkite Neutrodyne with Matched Speaker and All Tubes, Complete $57.50

A good many bargains in radio receivers are available today, because set manufacturers over-produced, and had to let their stock go at sacrifice prices. It does not follow that all sacrificed receivers are worth even the cut price. We turned down many "opportunities" to obtain large quantities of "sacrificed" receivers. When the Balkite was offered to us we tested its performance for five days and were delighted. We took the set apart completely to see what calibre of parts was used and how the wiring was done. When we tell you all the parts were ace-high and the wiring the best we've seen, you will know this is an extraordinary receiver. The tubes used are five 227, two 112A and one 280. The undistorted maximum power output is 780 milliwatts.

The line input must be 50-60 cycles, 105 to 120 volts. There is a voltage adjuster built in. The magnetic speaker has a matched impedance for the output of the receiver, and is itself housed in a real walnut cabinet with marqueterie inlay.

FIVE-DAY MONEY-BACK GUARANTEE ON RECEIVER, TUBES AND SPEAKER!



The speaker is of hand-rubbed genuine walnut and its list price alone is $35.00.

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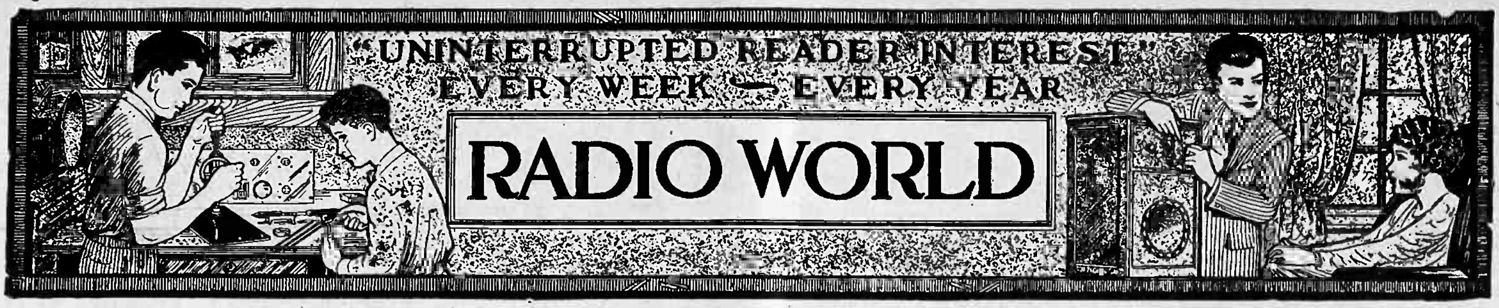

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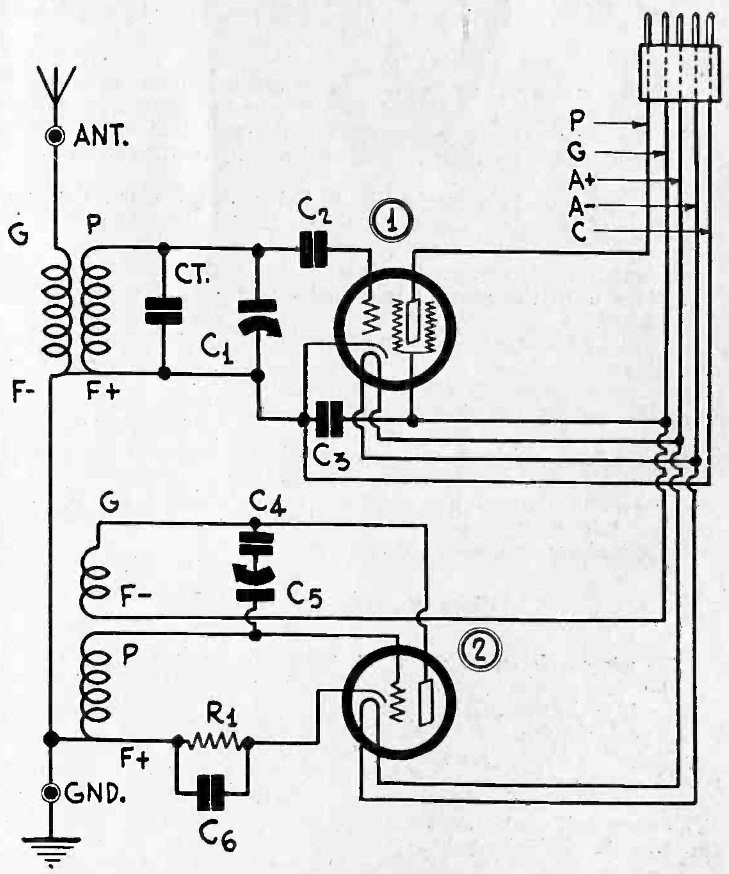

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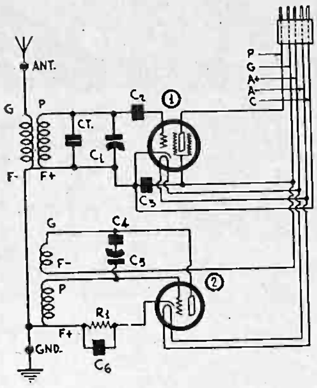
How to Make Short-Wave

What Action Takes Place When Devic



THE DIAGRAM AS IN FIG. 1, ON PAGE 5, REPEATED HERE SO THAT THE READER WILL HAVE A READY REFERENCE TO THE CONSTANTS DISCUSSED IN THE ARTICLE AND SPECIFIED IN THE LIST OF PARTS, WITHOUT HAVING TO KEEP TURNING BACK TO PAGE 5.

forms are close enough together, not more than 7 inches apart, so that coupling is produced simply by their relative positions. They are plug-in coils.

The switch is turned to an "on" position in the receiver, after the short-wave coils are put in the adapter sockets intended therefor, and then reception is obtained by tuning the first circuit of the adapter (represented by the formation about socket No. 1) and then tuning the other adapter circuit, until the difference in the frequencies is equal to the frequency to which the receiver itself (not the adapter) is semi-permanently tuned. At no time during operation is it necessary to touch the receiver, and only the adapter need be worked to bring in short-wave stations.

Unifying Dial Settings

You need not know what the frequency of the receiver is when the condenser plates are out of mesh, as you simply tune until you bring in short-wave stations. However, so that on at least some of the pairs of coils used for plugging-in there will be uniformity of adapter dial settings, a trimmer or equalizing condenser of 80 mmfd. is used across the first tuned circuit. There will be a tendency for this circuit to give higher readings than the other, and the added capacity contributed by the trimmer should be adjusted until the readings are equalized for the coil that brings in the greatest number of stations. This will usually be the coil designated as No. 2.

You may tune in a station, with dial readings apart, then reset the dial of the first tuned circuit so that it corresponds to the readings of the other, then, with a long wooden dowel stick, fashioned like a screw-driver, turn down the set-screw of the equalizer until the station is heard again. That completes the adjustment.

It will be observed that the first tube of the receiver is used in the adapter itself as a modulator, hence the number of intermediate stages of intermediate frequency amplification will be one fewer than the number of radio frequency stages of the receiver. With a two-stage TRF channel and detector in the receiver, using this adapter, you would have only one stage of intermediate amplification, but even this will provide fair sensitivity. Two stages greatly improve results, that is, the adapter is ever so much better if your receiver has three stages of TRF, since then you have two stages of intermediate frequency amplification.

Plate Voltage for the 227

The adapter is suitable for use with any receivers that have 224 as the first radio frequency amplifier, even if the first stage is untuned, as in the MB29.

A problem existed in obtaining the plate voltage for the 227 oscillator in the adapter, since the plate voltage of the 224 tube could not be utilized, being loaded already with a coil, that is, the primary of a radio frequency transformer in the receiver itself. The same coil could not be made common to both circuits and still produce the desired results.

Then the happy thought came that the screen grid voltage of the 224, in the adapter, was adequate for plate voltage on a 227, when the 227 was used as an oscillator at a negatively biased grid. So the 227 is hooked up that way, the bias being obtained through an 800-ohm resistor, bypassed by a 1 mfd. condenser which must not be omitted, nor should a smaller capacity be used.

There emerges one so-called "hot" lead, and it is one of the wires of the adapter cable, the one going from plate of the 224 tube in the adapter to the P post of the first RF tube in the receiver. This carries the signal frequency (modulated plate current) to the receiver, which amplifies the intermediate frequency and delivers it to the receiver's detector (the so-called second detector in this instance). Then the detected signal at audio frequencies passes through the receiver's audio channel, and short-wave reception is obtained in good fashion from the loudspeaker attached to the receiver.

LIST OF PARTS

C1, C5—Two short-wave tuning condensers (.0001 or .00015 mfd.)
C2—One .00025 mfd. fixed condenser
C3, C6—Two 1 mfd. bypass condensers
C4—One .01 mfd. mica fixed condenser
CT—One 80 mmfd. equalizing condenser
R1—One 800 ohm. wire-wound biasing resistor
Ant., Gnd.—Two binding posts
Two sets of short-wave plug-in coils, three coils to a set, total six coils
One AC short-wave adapter cable, five-prong plug at one end.
Two four-prong sockets (for coils)
Two five-prong sockets (for tubes)
One grid clip
Two vernier dials
One panel and cabinet

Four Sockets Used

Sockets are used not only to hold the tubes but to hold the coils as well. Hence there are four sockets in the adapter, two of the four-prong type for the coils, and two of the five-prong type for the tubes. The four-prong sockets receive the coils in such fashion that G is the beginning of the primary, F— is the end of the primary, P is the beginning of the secondary and F+ is the end of the secondary. The windings are separate. These facts are noted in the circuit diagram, Fig. 1.

Remember that the control grid connection of the 224 tube in the adapter goes from one side of the grid condenser C2 to the cap of the tube, by use of a flexible lead with grid clip, and that the G post (screen grid) of this socket obtains a positive voltage from the receiver itself. This voltage is usually around 67 volts, and is needed for oscillation of the tube in socket No. 2 of the adapter, so if the volume control of the receiver governs this voltage, turn this control to the position for maximum volume.

In socket No. 2, however, there is a 227 tube, which requires no grid clip, and the G post represents the control grid. The screen grid voltage of the 224, you will recall, is used as the plate voltage of the 227.

Cable Markings

The particular cable used had markers on it as follows: P, G, C, A— and A+, and these go respectively to plate, screen grid, cathode and two heater terminals on the socket intended for tube No. 1. The cable terminals may be soldered to the lugs of socket No. 1.

The simplicity of the circuit arrangement of providing, first and foremost, good reception of short-wave signals, as performance is always the prime requisite, and secondly, doing so in a most inexpensive manner, so as to capitalize on money already spent, is decidedly engaging. Persons who have put plugs into receivers in the expectation of hearing short waves, but without ever having realized the expectation, will find an experience of a different sort when they use the adapter herewith described.

To obtain any short-wave results it is necessary that the circuit surrounding socket No. 2 be oscillating. This can be determined by wetting the finger, while having earphones on that are connected to the speaker output and touching the condenser CJ at any point. The familiar "plop" will be heard. When the speaker is on it is harder to test for oscillation by the "plop" method as the response is weaker; nevertheless, by more careful listening it can be judged that way too.

Oddities on Broadcast Waves

It is a fact that with the short wave circuit going, you still can tune in broadcast wavelengths with your regular receiver, by turning the dial. This need not disturb you, as you are not going to turn that dial while the adapter is in use. The broadcast receiver does not work as well through the adapter, for broadcast wavelengths, as a stage of TRF is "missing".

Also it is true that even with the coil removed from socket No. 2 of the adapter, you can tune in some broadcast stations by manipulating only the oscillator tuning condenser, if the larger coils are plugged in, but this is mainly second harmonic reception of broadcasting stations, and you are not desirous of bringing in any

Adapter Coils and Cable

Plugged Into AC Screen Grid Adapter

of those stations by use of the adapter, which is for short waves only.

How great the receiving range will be on short waves depends considerably on the receiver with which the adapter is worked, but even a two-stage TRF receiver, affording only a single intermediate frequency stage of amplification, should bring in a dozen or so American short-wave stations that send out programs, and, of course, many more code stations.

On coil No. 2 KDKA's short wave station, on 49.75 meters, was picked up from New York City, also WCAU's station, W3XAU, on 49.5 meters, at about the middle of the oscillator dial. Both these experimental calls have lower wavelengths. KDKA uses several other short waves, on 8XP especially, and WCAU uses also 31.8 meters. KDKA is in Pittsburgh, WCAU in Philadelphia.

How to "Roll Your Own"

Those who like to make their own parts as far as possible, will welcome the opportunity of contriving the coils and the plugged cable.

At least seven bases of old tubes are required. You may not have so many duds around the house, but your radio dealer can help you out, at small cost. What you need essentially for the coils are the following parts:

Six bases of old four-prong tubes, such as 201A, 222, 226 and the like.

One base of an old five-prong tube, such as 227 or 224.

A spool of cotton covered wire, which may be No. 18, 20 or the like.

Suppose you want to prepare the base as a coil form. Shatter the glass over a receptacle, like a non-perforated waste basket, but be careful not to break the "seal" which is where the leading wires are connected from the prongs of the base, or the small wires emerging from the seal. Drill two small holes side by side near the bottom of the base, but on its side, and pass some one end of the wire through these, soldering the beginning of the wire to the P lead from the seal. Then wind the number of turns specified for the secondary and through two more drill holes, terminate by soldering to the F+ lead of the base.

The respective leads can be identified by using a pilot lamp and a flashlight cell or other small cell. Even a 1½ volt cell

(Continued on next page)

What Happens When You Plug in the New Screen Grid AC Adapter

THE operation of the short-wave adapter for AC screen grid circuits is such that the input to the receiver proper is automatically disconnected, when the grid clip that went to the first 224 is left free, and the adapter plug is put into the vacated receiver socket. The 224 tube is transferred to tube socket No. 1 of the adapter, and an additional tube, a 227, must be provided for insertion in the second tube socket of the adapter.

The antenna and ground connections are removed from the receiver itself and transferred to the antenna and ground posts of the adapter. The signal, now short waves, is delivered to the receiver through one of the cable leads.

Automatic Removal of Bias

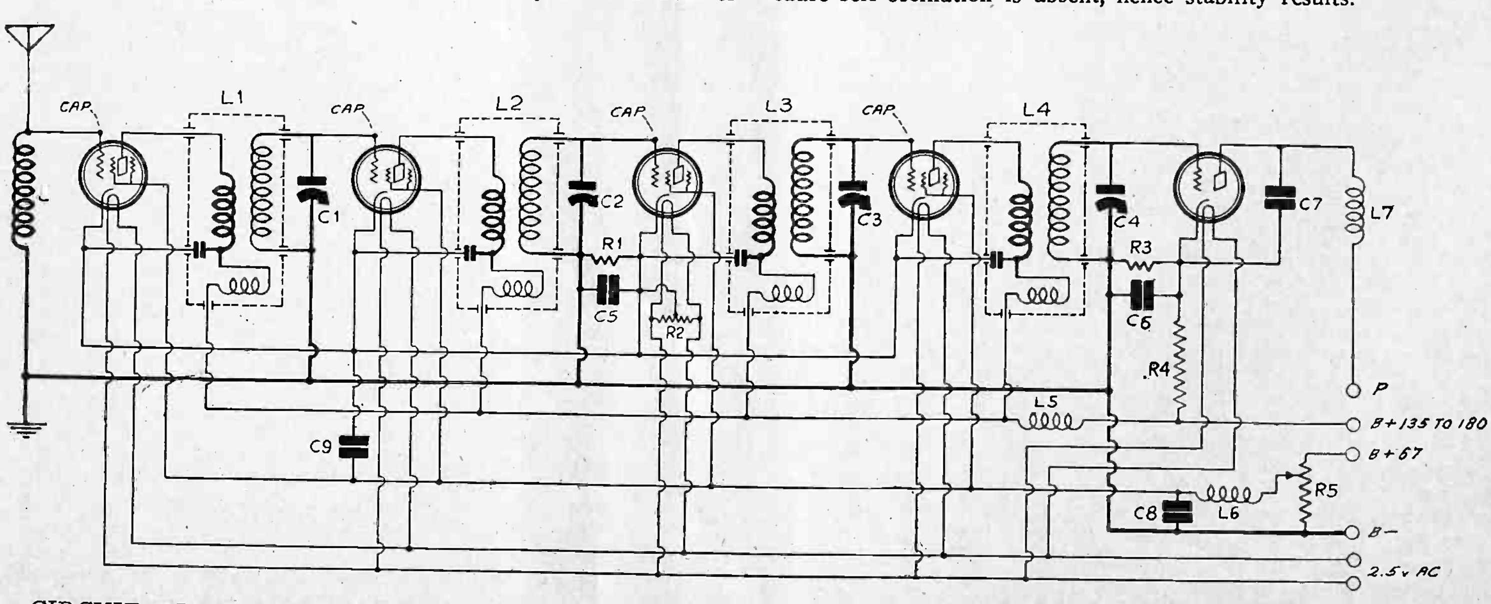
The connection of the 224 tube on the adapter is such that any biasing resistor in the receiver itself in conjunction with the first RF tube is shorted to ground, hence the bias is removed. It will be observed that the MB29 has a common biasing resistor for the radio frequency amplifiers, R1 in the diagram. Hence the bias is removed from the three resultant stages of intermediate frequency amplification. This is all right, as the condition prevails only when the adapter is used, and the original situation recurs as soon as the adapter is taken out of service, when the receiver is worked as usual on broadcast wavelengths.

No bias is needed on the 224 tubes when they are converted to use for intermediate frequency amplification, which condition results from plugging in the adapter. In fact, the amplification is higher on account of the removed bias. The reasons for the necessity of the negative bias on tuned radio frequency amplification do not apply to an intermediate frequency amplifier for short waves, as the receiver tuner becomes.

Input Becomes Tuned

The reason why the adapter is just as effective whether the first stage of the receiver itself was tuned or untuned is that this first circuit is replaced with a short-wave input, which is tuned in any event.

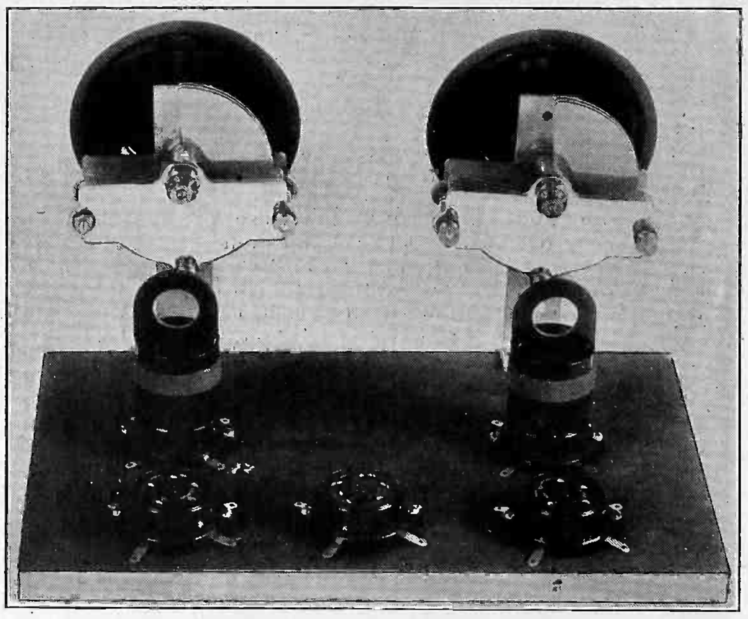
Any receiver with which this adapter is used should be free from self-oscillation at the highest frequency to which it can be tuned, which is the one used for intermediate amplification. While some receivers oscillate a little at the higher frequencies, the volume control, which is usually in the screen grid circuit, as in the MB29, can get rid of this oscillation, but at the same time that would reduce the B voltage on the 227 tube in the adapter, and we want that about as high as it comes. However, when it is remembered that a stage of TRF is omitted from the receiver itself by the adapter connection, it will be realized that the extra tube that may cause self-oscillation is absent, hence stability results.



CIRCUIT DIAGRAM OF THE MB29, WHICH REQUIRES A POWER AMPLIFIER TO WORK IT FOR SPEAKER OPERATION. THE AC SCREEN GRID SHORT WAVE ADAPTER MAY BE USED IN CONJUNCTION WITH THIS RECEIVER OR ANY OTHER THAT HAS AS ITS FIRST RF TUBE A 224.

Layouts for Adapter

Horizontal or Upright Type of Construction May Be Followed



THE CIRCUIT, AS DIAGRAMMED IN FIG. 1, MAY BE BUILT IN THE USUAL UPRIGHT FORM, IN WHICH INSTANCE A LAYOUT LIKE THIS WOULD BE SUITABLE, USING A BASEBOARD ABOUT 10" WIDE AND 7" DEEP. THE EXTRA SOCKET IS NOT NECESSARY UNLESS A CABLE IS USED THAT HAS A PLUG AT BOTH ENDS.

(*Continued from preceding page*)

will illuminate a 6-volt lamp sufficiently for the purpose of indication.

Next wind the primary. Two holes are drilled in alignment with the end-of-the-secondary holes, half an inch away or thereabouts, and the secondary is wound as specified, passed through two final parallel holes for usual anchorage, the beginning being soldered to the grid lead-out wire and the end to the F minus wire from the seal. Hence there is virtually no separation between windings.

You can easily distinguish the direction of winding, as the point where you started is the beginning of each winding, and the beginnings go respectively to the P prong (secondary) and to the G prong (primary). The ends of the windings go respectively to F+ and F— prongs, and you will not get them mixed if you remember that, reading a tube diagram, the primary consists of G and F minus, the secondary of P and F plus.

After this work is finished on one coil, sealing wax should be melted over the opening, and the wax should fill the receptacle to the brim. You can flatten down on a breadboard while the wax is soft, and trim off the surplus with a knife. If you wind your own coils it is probably just as well to omit putting any finger-handles on them, a difficult process, and you may not fasten them securely. You can easily plug the coils in and out without the aid of the finger handle, although this is undeniably handy.

Number of Turns

The directions for winding the three coils are as follows, and remember to wind two of each:

Coil No. 1: secondary, 7 turns; primary, 5 turns.
Coil No. 2: secondary, 11 turns; primary, 7 turns.
Coil No. 3: secondary, 20 turns; primary, 10 turns.
The diameter is 1¼".

With these coils you should be able to pick up the principal American stations that regularly send programs on short waves, such as KDKA, WABC, WTAU, WGY, etc., and particularly work in the frequency range where most of these stations are to be found. It should be remembered that some of the short-wave program stations use different wavelengths on different nights, and there is no definite advance telling, as to some of them, what they will be using, but you will find out where they come in for their respective frequencies, and can tune to these, one after another, until you get them.

As for foreign stations, how many of these, if any, will be received does not depend on the adapter, but on the receiver. As has been intimated, no foreign reception need be expected if the receiver has only two stages of screen grid RF, but most receivers of the screen grid AC type have three stage of RF, all of them tuned, and some have four stages, one of which, the input, is untuned. Where the gain is high in the receiver the range will be great when the adapter is worked, although even on two-stage-RF receivers once in a while you will reach out to incredible distances, due to the phenomenal behavior of short waves in this respect.

As for the cable, you may use either of two types: one that has five open leads at one end, and a five-prong plug at the other, or one that has no open leads, but five-prong plugs at both ends. The double plug type requires an extra five-prong socket in the adapter, to receive the extra plug, as well as requiring an extra 5-prong socket for this second plug.

There is no operating advantage of one type of plug over the other.

Let us assume that a cable is to be made with open leads at one end and a plug at the other. Shatter the glass of a dud 224 or 227 tube, and solder to each of the five out-leads from the seal an insulated length of wire, about three feet long, a different color insulation being used for each lead, to facilitate identification, or, if this is not handy, use all wire of the same color insulation. Solder to the outleads very carefully. Use twisted AC cable for the heater leads, if you like, but at all hazards nothing less than No. 18 wire in its stranded equivalent for the heater leads. By the continuity test, with flashlight bulb and dry cell, see that the plate wire connects to plate of the 224 tube's socket in the adapter, the one at left as you regard the adapter from the front; the heater leads to their proper destination on the adapter socket, and the screen grid and cathode leads likewise. The control grid takes no cable lead as this is the cap of the 224 in the adapter and goes to the first tuned circuit.

The wires may be held together with twine at different points along the lengths.

If a double-plug cable is used, provide the extra five-prong socket at center of the layout, as pictured, and instead of soldering the leads from a cable to the 224 socket, as previously described, simply solder leads from the springs of the five-prong socket intended for the cable plug, to the five-prong socket that will contain the 224 tube in the adapter. The socket for the oscillator tube also has five prongs, but this is for a 227, and the 227 does not figure directly in any discussion of the introduction of the cable.

Condenser Values

As for the tuning condensers, for experimental purposes you may use what you have on hand, provided the capacity is .00025 mfd. or less. It is not recommended that such a high capacity be used permanently, but just to make experiments, if you want to avoid buying any short-wave condensers, you may do so. The stations will be harder to find with the higher capacity condenser, but will come in just as clearly, if vernier dials are used.

Otherwise use capacities of .0001 mfd., .00014 mfd. or .00015 mfd. The reason why both .00014 and .00015 mfd. are specified is that some manufacturers standardize on one capacity, some on the other. But any condenser of .00025 or smaller capacity may be used, even midget condensers of 50 mmfd. or 100 mmfd. maximum.

Trouble shooting should center on the oscillator. Unless there is oscillation here, no short-wave stations will be received. The windings are such that when the diagram is followed there will be oscillation unless the 227 tube is in bad condition. Therefore, it is well, if no signals are heard, to test the tube for oscillation. Your dealer can do this for you, in most instances. You can use the wet-finger test yourself.

A rough test for opens and shorts in the oscillator tuning system, even if there is no oscillation, is to tune in for the lowest broadcast station you can receive loudly on your receiver, and plug in No. 3 coils in the adapter coil sockets. You should be able to tune the station in and out by turning the oscillator dial, if the station is around 210 meters or lower. If the oscillator is working properly, you can tune it alone, with modulator coil out of circuit, and bring in stations on their harmonics.

A Jiffy tester or similar device will be useful in checking up on the tubes of the adapter. Plug into one tube socket, put the tube in the tester socket, and see that you get the required readings. The heater voltage usually will be a little low, but this is all right. Anything at or over 2 volts, but not in excess of 2.5 volts, is a satisfactory report.

When the tester is used on the other socket, in conjunction with the 227, the screen grid voltage of the 224 is read directly as it is the plate voltage of the 227. This may be from 50 volts to 100 volts. At 50 volts there will be oscillation, if the biasing resistor of the oscillator is 800 ohms or more. Sometimes two 800 ohm resistors in series, for biasing this tube, raise the oscillatory strength a little.

[Other Illustration On Front Cover]

Read next week's issue, dated March 8th, for more data on this new AC screen grid Adapter. A picture diagram is being made ready for publication.—EDITOR.

A Pentode Circuit

New Methods of Double Tuning and Volume Control Shown

By Spencer Watson Pierce

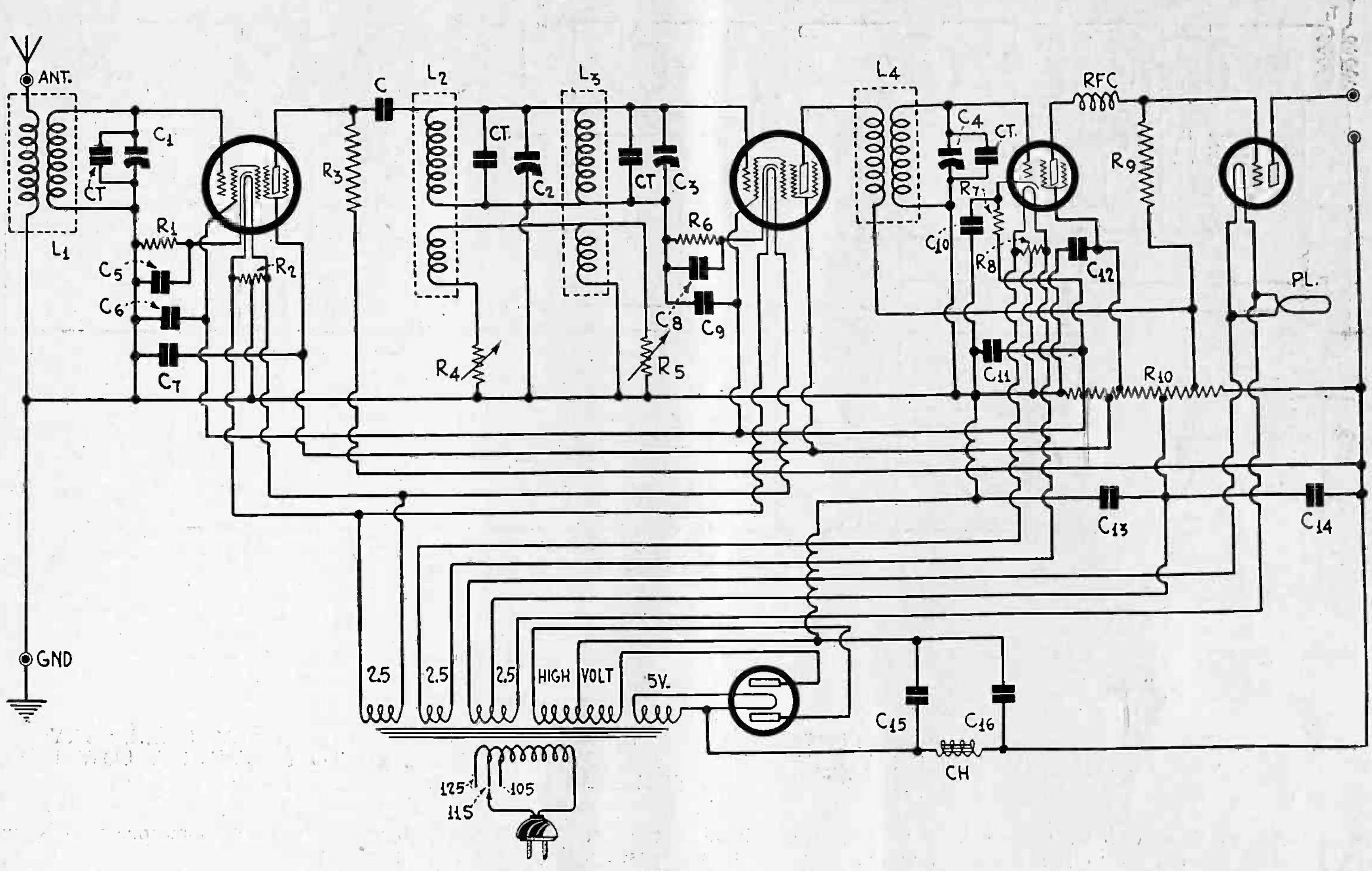


FIG. 1

A CIRCUIT THAT USES TWO PENTODES. THE "NEW" GRID IS THE SPACE GRID, WHICH SURROUNDS THE CATHODE. THE INTERSTAGE COUPLING TO THE SECOND PENTODE IS TWICE-TUNED, TO KEEP THE SELECTIVITY HIGH, AND UNIQUE METHODS OF COUPLING AND VOLUME CONTROL ARE SHOWN.

A DESIGN for utilizing the new pentode tube is shown in Fig. 1, wherein a novelty exists in the tuning of the coupling to the second pentode. The output of the first tube is taken through the voltage drop in a plate resistor, in parallel with which is a circuit tuned by C2. Another tuned circuit is used as input to the second pentode. The two tuned circuits just mentioned are united by the coupling of two small windings, like usual primaries, in parallel, volume controls being used in series with these coils. The controls are R4 and R5, and are to be actuated by a single shaft.

Thus an extra tuned circuit is present without an extra tube, as the pentode's amplification will atone for the absence of a tube, yet the selectivity will be maintained high enough. The tuning condensers may be of the four-gang variety, as all rotors are returned to ground, likewise, one end of the inductances that they tune.

One audio stage is used, at a gain of about 425, working into a 245 output tube. The detector has a bias of about five volts negative, obtained by the split method, part of the bias from the voltage divider, part from the flow of current through the resistor R7 from cathode of the detector to a positive point on the divider.

Extreme Voltage 400

A suitable maximum voltage for working this circuit is 400 volts. As the current drain is low, and only one choke coil, Ch, of low resistance, is used in the filter, this voltage will be obtainable from many power transformers intended to deliver 300 volts DC at a drain of 80 to 100 milliamperes.

A single voltage divider with an assortment of taps will provide adequate voltage distribution, but the joints should be selected that give a reading of about 200 volts effective on the plate of the last tube, when R9 is 0.5 meg.

The same type of coil may be used throughout the radio frequency portion of the receiver. For .00035 mfd., on a 1¾" diameter tubing, 85 turns of No. 28 enameled wire will make a satisfactory secondary, and 15 turns a satisfactory primary. Especially for the primary of L4 no more than 15 turns need be used, as the pentode will oscillate rather readily, even when shielding is used, should the number of primary turns be as large as is common for the 224 type of screen grid tube.

Drop in Plate Resistor

The plate resistor of the first tube is returned to maximum voltage because the drop in the resistor is relatively high, more than 100 volts when R3 is 20,000 ohms. R1 is 300 ohms. A higher bias than ordinarily required is the result, since the currents of three elements flow through it—screen grid, plate and space grid. By the way, the space grid current may be as high as or higher than the plate current.

One object of the higher bias is to reduce cross-modulation. The same purpose is aided by the use of a volume control of the type shown, which does not alter the screen, plate or biasing voltages, but only the signal voltage. R4 and R5 may be resistors of maximum values from 5,000 ohms up, and even may be of dissimilar values.

R6 is 300 ohms, R7 is 20,000 ohms, R10 is a total of 13,850 ohms, with fourteen taps (multi-tap voltage divider), not all of which are used for load connections. All the bypass condensers are 1 mfd. each, but C15 and C16 should be of the high voltage type, about 500 volts AC rms, or 1,000 volts DC rating. The RF isolating condenser, C, may be small, about .00025 mfd.

The trimming condensers, CT, of which there are four, may be of any maximum value, 35 mmfd. to 80 mmfd., and since they are adjustable, the higher value may be preferred. Adjustments once made are left thus.

Some power transformers have an extra winding for the detector heater alone. If so, follow the diagram exactly. If not, of course, use the same winding for the RF tubes and detector. If the primary is tapped, the diagram gives a key as to which taps are to be used on the switch for the relative voltages.

How to Adapt Screen G

New Tubes Useful in Resistance-Couple

By J. W. L

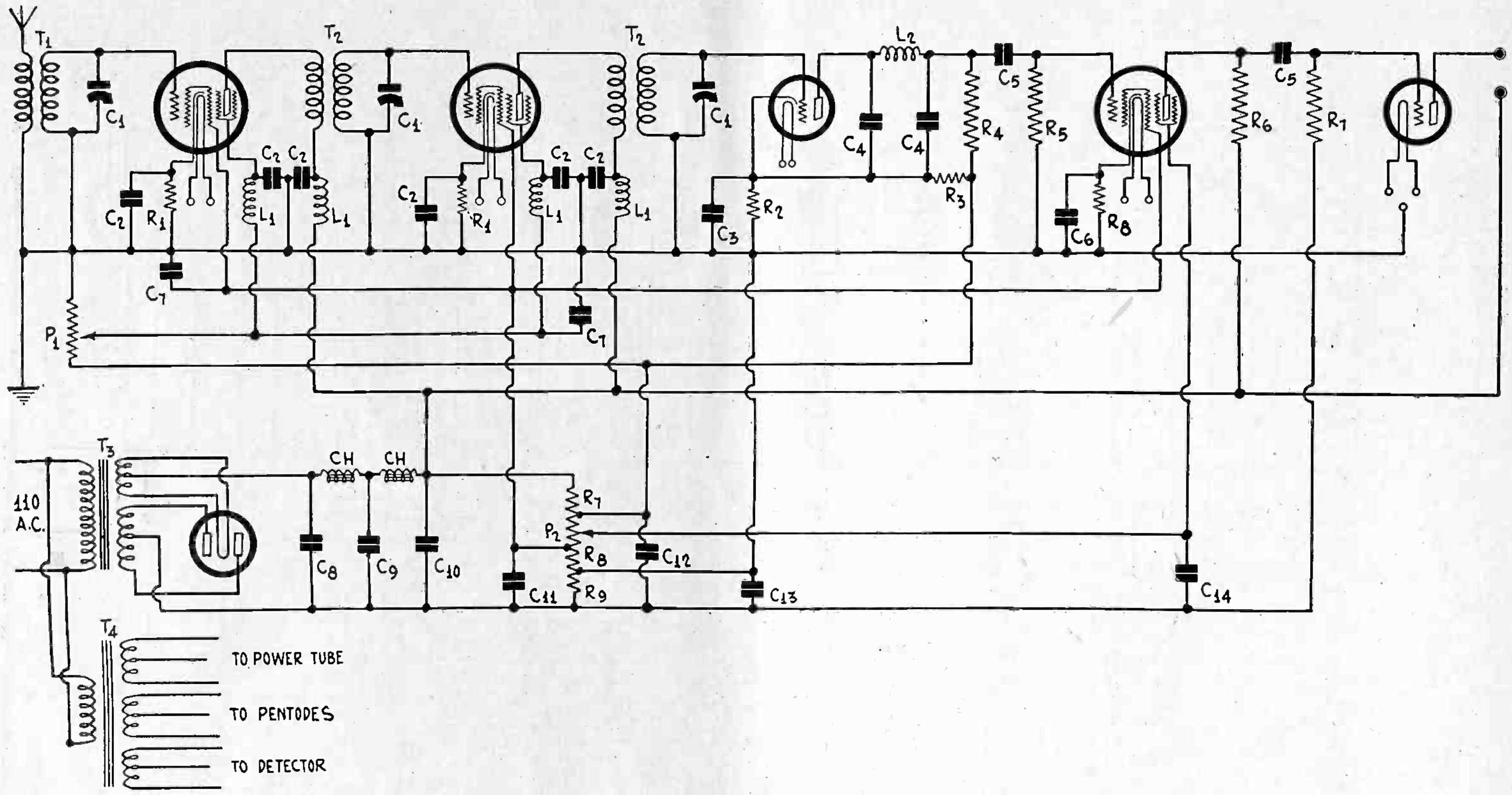


FIG. 1

WHEN PENTODE TUBES ARE SUBSTITUTED FOR SCREEN GRID TUBES IT IS ONLY NECESSARY TO INCREASE THE PLATE AND SCREEN VOLTAGES TO SUITABLE VALUES AND TO PROVIDE A LOW POSITIVE VOLTAGE FOR THE NEW ELEMENT.

MANY of those who have screen grid tube receivers already have inquired as to the changes required to adapt these receivers to the pentode tubes. There is no difficulty in making the required changes at all because the only change requiring new wiring can be made without doing more than running leads from the binding posts on the bases of the pentodes to suitable positive voltages. No change need be made in the grid bias voltages, no matter how these may be obtained in any receiver. It is necessary, however, to make changes in the screen and plate voltages, but these changes can be made by moving the corresponding returns to the voltage divider. In every case a higher voltage is necessary.

In some instances it may e that the tubes are not readily accessible because of shields or other obstructions, but these present mechanical rather than electrical problems. In other instances it may be that the required higher voltages may not be available on the voltage divider. In this case the problem is easily solved by providing shunts across the available taps and then tapping the shunt resistors at suitable points. It should be remembered that just because certain voltages are specified it is not necessarily wrong to use other voltages on the elements. For example, a voltage of 275 volts may be available and a voltage of 250 may be specified for the plates of the pentode. There is really no reason why the 275 volts should not be used. Again, it may that a voltage of 220 volts is available. This can be used directly without resorting to shunts.

Proportion Must Be Right

What is true of the voltages for the plates is also true for the voltages on the screens. Either higher or lower voltages than those specified can be used with assurance. However, there should be a certain relationship between the screen and plate voltages. It will not do, for example, to connect the screen to the same voltage taps as the plate. The screen voltage should always be considerably lower than the plate voltage. So if the plate voltage is increased by a certain amount over the specified voltage, the screen grid voltages should be increased in about the same proportion over the voltage specified for that. Likewise if the plate voltage is lowered, the screen voltage should be lowered proportionately.

Fortunately, the voltages are not extremely critical so that good results may be obtained in nearly all instances with the voltages directly available. Satisfactory amplification is always a good guide by which to judge when the voltage combinations are right. After all, that must be the ultimate test in any case. This test can be applied in any case so easily that it is not worth the trouble and the delay in writing to somebody or asking some one who is supposed to know the right combination.

When Voltage Is Low

It may happen that the available voltage in the B supply is not high enough to operate the pentodes under specified conditions. Will the pentodes operate, for example, if the maximum voltage is only 180 volts instead of 250 volts? That question has been asked many times already and is sure to be asked many more times. The answer is that the pentodes will work with 180 volts on the plates provided that the screen voltage is reduced proportionately. But it will not work as advantageously as when the voltage is higher. When the maximum voltage is low it is also advantageous to reduce the space charge voltage below that specified for the higher screen and plate voltages. Indeed, it is advantageous to use lower space charge grid voltages even when the maximum specified voltages are used on the other elements. For example, when the plate voltage is 250 and the screen voltage is 135 or 180 volts, it is well to try space charge voltages of 6 volts instead of 10 or 20 volts. Using lower space charge grid voltages tends to conserve the life of the tube for one thing and sometimes a higher amplification is obtained with the lower voltage on the space charge grid.

Another question that arises frequently in changing tubes relates to the coils in the radio frequency amplifier. Will the same coils work if pentodes are substituted for screen grid tubes? They will probably work better because the output impedance of the pentode is lower than that of the screen grid tube, and the load impedance of coils designed for screen grid tubes is almost always lower than it should be for that tube. This is not because of any skimping of wire but because of the physical impracticability of effecting a good match. One reason for the existence of pentodes is to make it more nearly possible to match the coil and the tube by lowering the output impedance of the tube to equal, approximately, that of the coil.

Expectation of Stability

Will the receiver be as stable with pentodes as with screen grid tubes? Or, in other words, will the receiver squeal no more than when screen grid tubes are used? The answer depends on the conditions. The higher amplification that can be expected from the pentode due to the better matching of impedances and the higher amplification factor would make the set less stable, because it is amplification that makes a set unstable. Another fact which would

id Receivers to Pentodes

udio—Proper Loads and Voltages Discussed

radford

make the circuit less stable is that in the pentodes the capacity between the plate and the control grid is about twice as high as the corresponding capacity in the screen grid tube. There will be greater reaction between the plate and the control grid and a greater tendency toward oscillation.

But this does not mean that the circuit will not be stable in operation. In all well-constructed screen grid receivers shielding is done throughout and there is little chance of feed back through the shields sufficient to cause oscillation, especially as there is a volume control by means of which the amplification can be controlled. The capacity between the elements is not lessened by the shielding so there may be considrable feed back through this route. But this also can be controlled indirectly by the volume control that is provided.

In case the provisions against oscillation are not sufficient the possibility of readjusting the voltages always remains. Just because certain voltages are specified, or because certain other voltages give the highest amplification, there is no reason for using these combinations in the face of uncontrollable oscillations. The best combination is that which gives the highest controllable amplification. The pentode tube is so versatile in respect to voltages and degree of amplification that there should be no difficulty in finding a combination that will give satisfaction from all points of view.

A Pentode Receiver

As an aid in changing a screen grid tube receiver to pentode operation, or as an aid in building a new receiver incorporating the new tubes, Fig. 1 is given. This is complete with two stages of pentode radio frequency amplification, grid bias detector and an ordinary resistance coupled amplifier using one pentode and one 245 power tube.

Some will have receivers in which transformer coupling is used instead of resistance, and the question will arise as to how to make the change in case the coupling is by transformer. The answer is, in the same manner. Just remove everything to the right of C4 and the leads. Then connect the cut terminals, eight of them, to the audio amplifier.

It will be assumed that the tuning condensers C1 are .0005 mfd. The secondaries of all the transformers T1, T2, T3 should be wound for this capacity. The primary of T1 should be rather small and loosely coupled to the secondary so that the antenna will not have too great an effect on the tuning characteristics of the coil. The primary might have one-fifth as many turns as the secondary, whatever they may be. It is well also that there be a separation, of about one-fourth of an inch between the closest parts of the two windings.

The primaries of the transformers T2 should be wound for screen grid tubes, that is, they should have nearly as many turns as the secondaries. Of course, if the receiver is already constructed it is only necessary to change the tubes as directed above without making any changes in any of the coils. There will be a slight change in the positions of the stations on the dial due to the higher grid to filament capacity of the tubes, but this will be negligible or so small that it may be compensated for by the trimmer condensers provided.

Increase in Bias

In making the change there will be an increase in the bias on the tube, especially if these are obtained as indicated in the circuit. The bias may indeed be doubled. But this will not make the tubes inoperative at all. It is, in fact, sometimes advantageous to use a higher bias on the grids in screen grid tubes, and the pentodes are screen grid tubes.

In the event a new circuit is being constructed it is easy to determine what the grid bias resistors should be. We shall assume that the plate voltage is 250 volts, the screen voltage 180 volts, the space charge voltage 10 volts, and the grid bias 1.5 volts. Under these conditions the total current in the grid bias resistor will be 7.9 milliamperes, and, therefore, the bias resistor should be 1.5/.0079, or 190 ohms. There are two of these resistors in the circuit. Each should be shunted with a condenser C2 of .1 mfd. or a large condenser. Wherever C2 occurs in the circuit it means that the capacity should be the same as given above.

The choke coils L1, four of them, are advantageous in keeping the circuit from oscillating, and each might well have an inductance of 85 millihenries.

The two condensers C7 should be larger, say not smaller than .5 mfd.

Detector Adjustments

Provision for volume control is made in the form of a high resistance potentiometer P1 connected between zero and the 180 volt tap. The resistance should be about 50,000 ohms and it should be able to carry 5 milliamperes without noticeable heating. By moving the slider any screen grid voltage between zero and 180 can be obtained.

The detector is designed for grid bias or power detection. The bias on the grid should be of the order of 18 volts and it is provided by the drop in R2. To determine the value of R2 we have to find the value of the sum of the currents in R3 and R4. Assuming that the current in R4 is one milliampere and that in R3 is 5 milliamperes, the total current is 6, and, therefore, the required value of R2 is 3,000 ohms. To get 5 milliamperes to flow through R3 with a voltage of 162 across it, the resistance should be 32,400 ohms. Since the current through R4 will be less than that assumed it will be safe to use 30,000 ohms for R3.

C3 should have a capacity at least 2 mfd. for it must have a low impedance to currents of as low as 30 cycles. Of course, a 2 mfd. condenser does not reduce the impedance much at 30 cycles but it is not necessary that it should because a resistance coupled amplifier, and some transformer coupled circuits, amplify more at this low frequency than the loudspeaker can support.

As a means of increasing the detecting efficiency of the circuit and at the same time suppressing radio frequency currents in the plate circuit of the detector the filter circuit consisting of L2 and the two condensers C4 are connected as indicated. L2 need not have an inductance greater than 5 millihenries, but it may be as high as 85. Each of the condensers should not be larger than .00025 mfd.

The Audio Amplifier

The audio amplifier begins with R4, which should have a value of one-quarter megohm. The grid leak R5 should be about one megohm and the coupling condenser C5 should have a capacity of .01 mfd.

R6, C5, and R7 in the plate circuit of the audio pentode tube should have the values .5 megohm, .01 mfd., and 1 megohm, respectively. It is necessary to have a rather high coupling resistor as well as a high leak resistance after the pentode in order to get a high degree of amplification. The combination given has an effective impedance about equal to the internal resistance of the tube.

The bias resistor R6 must be determined on the assumption that practically no current but the space charge grid current flows through it. Let us assume that this current is 5 milliamperes. It is sufficient that the bias is 1.5 volts provided that the screen voltage is not too high. Hence the value of R8 should be 300 ohms. If the total current through R8 is higher than that assumed, which is quite likely, the bias will also be higher, but this change is in the safe direction. It is advantageous to make the condenser C6 across R8 not less than 4 mfd.

The power tube in the amplifier should be a 245 with 250 volts applied to its plate.

The Power Supply

No special requirements are imposed on the B supply that is to operate the receiver. If it is designed for a 245 power tube it will have ample voltage for the pentode tubes, and it is only necessary to provide taps on the divider which will give the voltages necessary.

The lower portion of the voltage divider is used for bias on the power tube, making use not only of the plate current in the power tube but all the current flowing in the B supply circuit. To determine the value of R9, therefore, we must first find the total current flowing and then dividing this into the 50 volts required for bias on the power tube.

Let us assume that the bleeder current is 5 milliamperes. The total current drawn by the first two pentodes is 15.8 milliamperes. The current required for the detector we assumed to be 6 milliamperes when we found the values of R2 and R3. The current required by the third pentode we assumed to be 5 milliamperes. The current for the power tube will be 32 milliamperes. We have to add the current drawn by P1, which will be 3.6 milliamperes. Hence the total current sums up to 67.4 milliamperes. We conclude that R9 should be 740 ohms. A 750 ohm unit, or even one of 700 ohms, could be used safely.

We now have to determine the value of R8. Through this only the bleeder current of 5 milliamperes flows. Hence, in order to make the drop in it 10 volts for the space charge grids the value should be 2,000 ohms.

Tapping the Voltage Divider

The voltage drop in P2 should be 170 volts in order that the voltage on the screen should be 180 volts. We may assume that through this portion of the voltage divider the three space charge grid currents and the bleeder current flow. The sum of these is 14 milliamperes. This calls for 12,000 ohms. This is easily obtainable in fixed values but not in the form of a potentiometer. Now, the slider for the screen of the audio pentode will be much nearer the

(Contnued on next page)

A Vacuum Tube Voltmeter

Grid Bias of a Succeeding Tube Easily Measured

By J. E.

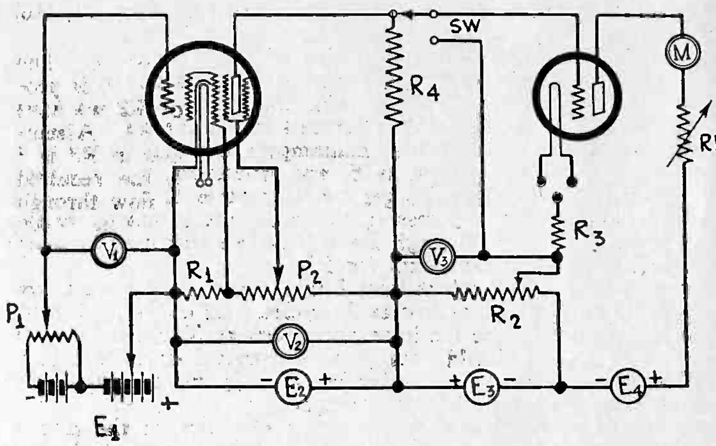


FIG. 1
BY MEANS OF THIS ARRANGEMENT CHARACTERISTIC CURVES OF GRID BIAS AGAINST OUTPUT VOLTAGE CAN BE TAKEN QUICKLY AND ACCURATELY

IT is impossible to design resistance coupled amplifiers intelligently without characteristic curves taken on the tubes to be used under conditions that will obtain in the circuit. But such curves are often not available, and for that reason it becomes necessary to take them and to devise a scheme for taking them. We particularly refer to non-reactive circuits in which two tubes are coupled without the intervention of an isolating condenser.

Curves that are especially useful are those giving the relationship between the control grid voltage and the voltage drop in the coupling resistor. Such curves should be available for grid voltages that are likely to be impressed on the tube and for various values of coupling resistances, and also for different values of voltages applied to various elements of the tube, such as plate voltage, screen grid voltage, and space charge grid voltage.

Meter Requirements

Ordinarily the plate resistance used in non-reactive amplifiers, such as those popularized by Loftin and White, are very high and usual current meters are not sensitive enough to measure the currents involved. Also, the exact value of the resistance may not be known. Hence it is difficult to obtain the voltage drop in the coupling resistance by measuring the current and applying Ohm's law.

The drop in the resistor can be measured directly with a vacuum tube voltmeter, and any other type of voltmeter is not applicable. The meter must not require any current for its operation because current would alter the voltages and the amplifier tube which is to be connected across the coupling resistor does not take any current when adjusted properly.

The circuit in Fig. 1 shows a hook-up for measuring the output voltage of a pentode tube working into a high resistance R4 by means of a vacuum tube voltmeter. This meter need not be calibrated to read voltage and it is not necessary to take a curve of the voltmeter tube beforehand because the measuring is done by the substitution method. The second tube and the milliammeter in the plate circuit are used only to indicate a balance.

How It Works

Suppose there is a current flowing in resistor R4. There will be a voltage drop in R4 which will make the grid of the second tube negative by an amount depending on the resistance R4 and the current flowing through it. We are to find what the drop is in volts. First throw the grid switch to the lower point so as to pick up the negative end of R3. There will be a certain reading on the milliammeter M. This current can be adjusted to any desired value by changing Rh. It is best to select a value which makes the needle of the meter point exactly to a division on the scale. This reading might be called the null reading because it is the reference point.

Now throw the grid switch to the top of R4. The reading on the meter M will change. Whether this will be an increase or a decrease depends on the voltage drop in R4 and the voltage drop in R2. The drop in R2 is determined by the voltage of E3, which may be a battery or a B supply unit. The drop in R4 will make the grid of the second tube more negative than it was when the grid switch was in the original position and the drop in R2 will make it more positive. If the voltage of E3 be changed so that the reading of M is the same as it was at first, that is, so that the needle is brought back to the null point, the voltage drop in R2 will be numerically equal to the voltage drop in R4, and this drop can be read on the voltmeter across R2. Hence to take a reading it is only necessary to adjust for the null point and read the voltmeter across R2. Such readings should be taken for different values of grid bias on the first tube as measured by meter V1.

It is important that there are no changes in the voltages applied to the various elements during a reading. To make certain that no changes have occurred the grid switch should be thrown back to the original position to see whether or not the null point has shifted. It is advisable to have several voltmeters which will indicate directly that no changes have occurred in the voltages and also to have a means for changing the voltages in case they have drifted. It is particularly important that the voltage E2, read on V2, does not change. This voltage should be kept constant during a complete run.

Varying Bucking Voltage

The method of varying the voltage across the used portion of R2 is indicated. R2 is a potentiometer and the slider is connected to the low end of R3. This method, unfortunately, introduces a slight shift in the null point since it introduces a change in the resistance in the plate circuit of the second tube. This change can be compensated for by switching back and changing Rh.

It is possible to do away with R2 entirely and vary the voltage across V3 in the same manner that that across R1 is varied. If this is done there will be no appreciable shift in the null point as the voltage across V3 is varied.

While B supply units may be used for supplying all the voltages in the circuit, more consistent results will be obtained if batteries are used. E4 is an exception. There is no reason at all why this should not be a B supply unit provided the null point is watched frequently for possible changes. E1 could also be supplied by a B supply unit, but since its voltage will be very small, comparatively, it is not worth while.

The object of R3 is only to supply a grid bias to the second tube and to ensure that no grid current will flow when the circuit is adjusted to the null point setting.

Since the vacuum tube voltmeter is only used at one current value in the plate circuit the range of the meter does not depend in any way on the characteristics of the second tube. Any tube can be used. A three-element filament type tube is shown, but a heater tube can be used as well. R3 in that case should be connected to the cathode. In case the voltmeter tube is of the three-element type and the filament is heated with alternating current, the grid bias, that is, the drop in R3, should be at least ¾ as great as the effective voltage across the filament. If the bias is less than this there may be a small grid current. For example, suppose the tube is a 171A. The effective filament voltage is 5 volts and the bias should be not less than 3.75 volts.

Estimating Bias

If the value of R3 is known the bias can be estimated, since at any time it is the product of the resistance of R3 and the current in amperes indicated by M. The resistance of Rh and the voltage of E4 might be such that the current is 6 milliamperes. Then in order that the bias should be 3.75 volts R3 should have a value of 625 ohms. Therefore, in this particular case, a

Use of Pentode in

(Concluded from precedng page)

lower end than the upper because only a comparatively low screen voltage will be needed for that tube. Hence the 12,000 ohm resistance may be made up of two resistors in series, one fixed and put on the positive side and one potentiometer placed at the negative end. This potentiometer may have a resistance of 5,000 ohms, which would make the fixed portion 7,000 ohms.

Another way would be to use two 25,000 ohm resistances in parallel, one being fixed and the other a potentiometer. Such resistors are available and are standard values. The return of the screen of the audio pentode would go, of course, to the slider on the potentiometer. The fact that two 25,000 ohm resistors in parallel gives a resistance of 12,500 ohms is of no consequence since 500 ohms is small in comparison with 12,000 ohms.

We now have to determine R7 so that the voltage drop in it is 70 volts. The current through it is approximately 18.6 milliamperes. Hence R7 should have a value of 3,760 ohms, or the nearest commercial resistor to that value.

Attention is called to the fact that voltage dividers having many taps are available and also voltage dividers with sliding taps. With such it is a simple matter to adjust the voltage divider to give the correct voltages. And attention also is called again that exact values are not needed for all of them.

for Loftin-White Circuits

ınd Constants Determined for Best Operation

Anderson

1,000 ohm resistor would be suitable. This value is especially convenient because the bias on the tube in volts would be equal numerically to the milliampere reading on the meter M. Thus Rh can be adjusted so that the reading is higher than 3.75 when the grid switch is connected to the low end of R3. This applies when the voltmeter tube is a 171A. For other tubes it is only necessary to use a different bias limit than 3.75 volts. For heater tubes it is only necessary to use about one-half volt, although higher voltages can be used. The 171A tube is especially suitable as voltmeter tube because it has a high mutual conductance. That means that for small changes in the voltage drop in R4 the change in the reading on M will be large. Hence more accurate settings are possible with this tube than with tubes having low mutual conductance.

Interesting Effects

Interesting effects will be noted when measuring the output voltages for different bias values on the screen grid or pentode tubes. For example, suppose the voltage on the control grid is first made zero. A certain voltage drop will be obtained in R4. Then the bias is increased, say by one-half volt. The voltage drop in R4 may still have the same value as before. This would indicate that a change of a half volt on the bias of the first tube produces no effect. If it does not the tube is dead in that region of bias. This condition is most likely to be met, especially if the value of R4 is large and the screen voltage is of the same order of magnitude as the plate voltage. Indeed, the stagnant condition of the tube may remain until the bias is as high as six or seven volts.

At a certain voltage on the grid a great change in the drop in R4 will be noticed, and the change will be sudden. Perhaps the voltage across R4 will change from maximum value to one-half that value in a grid voltage change of less than .1 volt. The tube will not function as an amplifier or as a detector until the grid bias is higher than that corresponding to the sudden jump in the output voltage. The stagnant condition of the tube obtains as long as the screen grid voltage is higher than effective voltage on the plate, that is, higher than the difference between the applied plate voltage and the voltage drop in the coupling resistor R4.

Making Tube Operable

In order to make a screen grid or pentode tube operate with low bias voltages it is necessary to ensure that the screen grid voltage is less than the effective voltage on the plate. This condition may be brought about in three different ways. First, to lower the screen grid voltage, keeping the plate load resistance and the applied plate voltage constant. Second, to increase the plate voltage, keeping the screen voltage and the plate load resistance constant. Third, decreasing the plate load resistance, keeping the voltages on the screen and applied plate voltages constant. Of course, the condition can also be brought about by combining these methods, or any two of them.

These facts are of special importance in connection with the Loftin-White non-reactive circuits. The coupling resistance must be high in order to get a high degree of amplification. The high resistance will cause a high drop in the voltage and therefore the effective voltage on the plate will be low. Thus in order to make the tube function the plate voltage may be increased, the screen voltage may be decreased, or the grid bias may be increased. But if the tube be adjusted by increasing the bias there will be a considerable amount of distortion of the wave form and a high proportion of second and third harmonic. Moreover, the amplification will be reduced. So the best way of bringing about the proper adjustment is not to increase the grid bias.

If the screen voltage is reduced the amplification also will be reduced, but so will the amount of distortion. Hence for a limited voltage available for the plate the best way of bringing the tube into adjustment is to reduce the screen voltage. If a high voltage is available for the plate it should be used, increasing the screen voltage proportionally, because increasing the plate voltage increases the amplification and at the same time reduces the harmonic content in the output voltage wave.

Pentodes Are Screen Grid Tubes

The pentode tubes available in this country are screen grid tubes, and therefore the above comments apply to them. However, the space charge grid decreases the internal plate resistance of the tube and for that reason makes it possible to extract a given percentage of the theoretical amplification with a lower plate coupling resistance. This means that the voltage drop will be some what less and all the adverse conditions mentioned will be correspondingly ameliorated.

Let us return to the circuit in Fig. 1 as an arrangement for taking characteristic curves. It is essential that the grid bias on the first tube be adjustable in small steps and that the voltage be easily controllable. The voltmeter V1 should have a range which is approximately the same as the grid bias range that is to be covered. If this range is fairly wide it is recommended that the meter be of the type which has two or more ranges.

The fine variation in the grid bias is effected by means of potentiometer P1. This should have a range of about 400 ohms. The voltage of the battery across this potentiometer should be slightly more than the smallest step of the main portion of E1. For example, if E1 can be varied in steps of 1.5 volts the battery across P1 should have a voltage of 3 volts. The entire battery E1 could well be made up of 7.5 volt grid batteries which are tapped at every cell. They are available in every radio store.

The values of R1 and P2 should be proportioned so that the space charge grid and the plate get the proper voltages. Suppose the total voltage across V2 is 250 volts and a voltage of 10 volts is required for the space charge grid. Then if the current through P2 is so large that any current diverted by the elements may be neglected R1 should be to 10 as P2 is to 240. Of P2 should be 240 times as large as R1. If then R1 is made 50 ohms, P2 should be 12,000 ohms. Since the current diverted by the space charge grid may not be negligible, even if the screen and plate currents are, in practice R1 would have to be made larger in order to get the 10 volts on the space charge grid.

V2 should be a high resistance voltmeter so that the voltages applied to all the elements can be measured accurately with it.

After the adjustment of the voltages have been made the meter may be put in the position indicated as a constant check on the voltage supplied by E2.

Saving Time

If a complete set of curves is not required on any screen grid or pentode tube, much time can be saved in arriving at operating adjustment. Suppose we have a given voltage for the plate and we wish to use a certain value of coupling resistor. We put the resistance in the circuit and adjust the plate voltage. If we are dealing with a pentode we also have to adjust the space charge voltage, but we are at liberty to select a certain voltage and stick to that, say 10 volts. Then for either tube all we have to do is to find the screen voltage which will be such that the tube will be operative near zero bias. Measure the voltage drop across R4 with the vacuum tube voltmeter and leave the adjustment. Then change grid bias on the tube under test by a small value, say one-quarter of a volt. Most likely this will not change the voltage drop across R4 as evidenced by the vacuum tube voltmeter. Now change the screen voltage downwards until there is a pronounced change.

When this has been done determine the value of the screen voltage for future reference and then leaving the adjustment of the screen voltage proceed to take readings for different values of the bias on grid. This curve plotted from the data obtained, grid bias against voltage across R4, will then show what the operating grid bias should be to give the best performance under the conditions given.

Present Receivers

It is assumed, of course, that the B supply unit is able to deliver at least 67.4 milliamperes and a voltage of 300 volts. This is not a severe requirement and should be met by nearly all supplies designed for 245 tubes.

Oscillation at Audio Frequency

The audio amplifier has an odd number of plate circuits, and for that reason it is relatively unstable. But the frequency of instability should be at a sufficiently high frequency to be controllable by means of large by-pass condensers, particularly electrolytic condensers. It is recommended that C10, C11, C12, C13, and C14 be of this type. All these condensers have been connected to the negative side so that a multi-section condenser may be used. Condensers C10 and C12 should be the largest, and each may be an 18 mfd. section of a 2-18, 2-8 condenser unit. C13, being the by-pass condenser for the power tube bias resistor should be one of the eights. Indeed, two eights may have to be used in this position. C11 and C14 do not have to be so large.

In case the power transformer does not have sufficient windings for the filaments, a separate filament transformer having three 2.5-volt windings is provided. The use of these windings is indicated. Note that the detector is put on a separate winding. The center taps of these windings should be connected to ground and not to B minus.

New Ideas From Experts

A Review of February Issue of Institute's "Proceedings"

By Edgar Price Preston

THE February, 1930, issue of "Proceedings of the Institute of Radio Engineers" is replete with interesting and important papers on various phases of radio. The papers cover both the theoretical and the practical phases of the subject, mathematical and experimental.

A paper of especial interest to those who delight in mathematical manipulation and the physical interpretations of the results of mathematical transformations will find pleasant, profitable reading in "A New Transformation in Alternating-Current Theory With Application to the Theory of Audition," by Balth. van der Pol, Physical Laboratory, Philips Incandescent Lamp Works, Eindhoven, Holland.

The transformations deal with the multiplication of impedances by powers of *j*, the square root of —1, or the imaginary unit. Ordinarily multiplication by this operator is interpreted as a rotation through 90 degrees of the vector impedance, or any vector that may be so treated. In van der Pol's paper the transformation is interpreted in a somewhat different manner. It leads to negative resistance, negative inductance, negative capacity, and to resistance resonance. These concepts in turn lead to new circuits which have important properties. Several examples of application of the new transformation are given.

Arthur E. Thiessen, General Radio Company, Cambridge, Mass., describes a method and an apparatus for "The Accurate Testing of Audio Amplifiers in Production." This paper is well worthy of a careful perusal by those interested in audio quality and the means by which it is measured in practice.

Noise Effects in Amplifiers

"A Study of Noise in Vacuum Tubes and Attached Circuits" is the title of a paper contributed by F. B. Llewellyn, Bell Telephone Laboratories, which deals with the noises originating in vacuum tubes and attached circuits, both from the theoretical and experimental points of view. It is treated under three headings: (1) shot effect with space charge, (2) thermal agitation of electricity in conductors, (3) noise from ions and secondary electrons produced within the tube.

The "shot effect," called "schroteffekt,' by Schottky, is due to irregularities in the stream of electrons from the filament to the plate in the absence of space charge, and is so called because of the analogy between the movement of electrons in the tube and the spattering of small shot fired from a shot gun. In the paper the shot effect is used to denote the noise whether there is a space charge in the tube or not.

Noise from thermal agitation is due to irregularities in the flow of current in conductors, or from the movement of electric charges within the conductor. As a result of the thermal agitation there will appear varying potential differences between any two points in a conductor, and these variations result in noises.

Noise From Shot Effect Eliminated

"The first requirement for a noiseless circuit," says Mr. Llewellyn, "is thus seen to be that the vacuum tubes employed contain filaments capable of operating at full temperature saturation, so that the shot effect noise is reduced to zero. The remaining noises must then come from ionization of gas within the tube, from the production of secondary electrons or ions, or from thermal agitation of electricity. This latter effect predominates in high vacuum tubes."

Experimental and theoretical curves are given for the various types of noise, showing how these vary in intensity with operating conditions. Methods for measuring the various noises are also given. The paper concludes with mathematical derivations of formulas for the shot effect in the presence of space charge and for the thermal noise of agitation of electricity.

H. A. Pidgeon and J. O. McNally, also of the Bell Laboratories, contribute "A Study of the Output Power Obtained From Vacuum Tubes of Different Types." The study is largely confined to tubes used in the Bell System, which have characteristics different from those of tubes available to radio experimenters and fans. However, the methods are applicable to all kinds of tubes. A feature of the curves is that they show the percent second and third harmonics that may be expected from the various tubes at different operating conditions. A careful study of this paper will help to give a better understanding of the characteristics of tubes, not only of those especially covered in the paper, but all kinds of tubes.

Humless Filament Supply

"Filament Supply for Radio Receiver From Rectified 25-Kilocycle Current" is an interesting paper contributed by Hugh A. Brown and Lloyd P. Morris, University of Illinois. The principle of the device is the generation of a 25-kilocycle alternating current by means of a standard tube oscillator operating at this frequency and then rectifying the high frequency current and filtering it at the high frequency before it is supplied to the filaments in the radio receiver. A dry type rectifier is used.

Among the advantages claimed for the new filament supply over the commercial AC supply are:

(1)—Use of an inexpensive long-life DC amplifier tube for all radio-frequency stages and for the detector.

(2)—Instant response of the radio receiver when the current is turned on.

(3)—Absence of any hum due to 60 cycles or of any of the harmonics of this frequency. Quietness of battery performance obtained without the vexations of battery maintenance.

This type of filament supply will undoubtedly be used in many future sets for the advantages claimed are obviously true. And other advantages could be cited.

Quartz Control for Oscillators

P. von Handel, K. Kruger, and H. Plendl of the German Research Laboratory for Aeronautics, report their experiments in stabilizing short wave reception and transmission from aircraft. While this paper is of no direct interest to broadcast listeners it is of great importance to all who work with short waves, whether for aircraft or other uses.

Paul O. Farnham, Radio Frequency Laboratory, Inc., Boonton, N. J., describes "A Broadcast Receiver for Use in Automobiles." Subjects specially treated are type of collector, ignition shielding, electrical characteristics of the receiver, physical structure of the receiver, power supply, and the reception results obtained. It is worthy to note that 224 type tubes are used in place of 222 because the direct current tubes were found to lack the sturdiness to withstand the shocks to which they would be subjected in an automobile.

Production Testing of Vacuum Tubes

K. S. Weaver and W. J. Jones, Westinghouse Lamp Company, Bloomfield, N. J., in a paper on "Production Testing of Vacuum Tubes," explain how large numbers of radio tubes are tested in the factory by automatic machinery. The machine rejects dead tubes or "duds", gassy tubes, low emission tubes, high and low plate current tubes, and accepts only those tubes which have passed all the electrical tests. Belt conveyors take the tubes ejected by the machine and carry them over to proper receptacles. A certain percentage of the good tubes are taken from the boxes and examined by inspectors for electrical and mechanical defects.

The paper is illustrated by many line cuts of circuits used in the various tests to which the tubes are subjected and by photographs of the automatic machines with which some of the tests are made in large quantity.

Cross Modulation

"Cross Modulation in RF Amplifiers" is the title of a short paper by Sylvan Harris, Engineering Department, F. A. D. Andrea, Inc., covering the interference of one station with another when the frequencies of these stations are relatively far apart. The effect is shown to be due to detection by the amplifier tubes. The remedy for the cross talk is to make the input to the first tube, as well as to succeeding tubes, selective enough to eliminate one of the carriers.

The subject of cross-modulaton, as the author points out, is one of importance in the design of highly sensitive receivers, particularly of the tuned radio frequency type, usng screen grid tubes. Listeners are familiar enough with repeat tuning in some superheterodynes, but are baffled at cross-talk in TRF receivers, and repeat tuning as well, when in most respects the receiver is highly selective, as well as sensitive. Mr. Harris, in bringing up the subject, has rendered the industry a service. It is obliging of him to point out the results of his own experimenting.

Yasusi Wanatabe, Professor of Electrical Engineering, Tohoku Imperial University, Japan, discusses the characteristics of the multivibrator invented by Abraham and Bloch. He gives the formulas for the period of oscillation as developed by Armagnat and Brillouin and Balth. van der Pol and points out that these formulas do not quite agree with experimental results. The writer develops a theory of his own and gives the formula for the frequency of oscillation and that of the mutual conductance.

The multivibrator is a two-tube resistance-capacity coupled amplifier in which the output of the second tube is connected to the input of the first and the output of the first to the input of the second. This circuit oscillates when the coupling resistance and the voltages have the proper values, and the wave of the generated current is very rich in harmonics. That is, the wave form is very poor. The instrument is useful in laboratories where it is necessary to produce a wave rich in harmonics for measurement purposes. Incidentally, the oscillation of the multivibrator is very much like the oscillation in a two stage resistance-coupled amplifier in which there is considerable common impedance between the two plate circuits.

There's Money in Radio

Solid Engineering Foundation and Practical Knowledge Required

By Austin C. Lescarboura

THE main thing which was uncovered in a recent investigation into radio occupational opportunities is that radio is no longer a plaything. Nor is it an experiment or again a hobby, so far as the industry itself is concerned. Rather, it is a very serious piece of business, calling for very serious workers. This discovery, briefly, explains why some so-called radio workers are disappointed in their radio career, and why others, properly trained, are satisfied.

The writer recalls his early struggles in the budding radio art, back in 1908, when one man's guess was just as good as the next with regard to any radio problem. There were no radio engineers or radiotricians in those days. There were, however, plenty of tinkerers. And the best tinkerer—the fellow with the greatest amount of ingenuity and patience—generally carried the day. By painful and costly cut-and-try methods the basic principles of radio engineering were being formulated and correlated for those who were to follow.

Know the Basic Principles

Today the basic principles of radio are positively established. Furthermore, the principles of electricity are carefully meshed with those of radio. It is possible for a real engineer to figure out how many turns of wire to place on a given tubing for a certain value of inductance, and what that inductance value, in combination with a given variable condenser, will provide by way of frequency or wavelength range.

There is no guessing, no fretting, no tiresome tinkering. With the ubiquitous slide rule, the radio engineer solves no end of probelms at his desk, in a few moments' time, which formerly would have called for days and weeks of hay-wire work.

The positive technique which is the very foundation of present-day radio is too often ignored by would-be radio engineers. Perhaps the trouble is traceable to the term "engineer." We handle that term in a most lackadaisical manner. We speak of an apartment house engineer, a bug exterminating engineer, an automobile greasing engineer, and other varieties, with great abandon. Indeed, it is positively a distinction these days not to be an engineer of one kind or another.

Nevertheless, a radio engineer is a fellow who knows his electrical and radio principles, and how to apply them. Many would-be radio engineers fail to appreciate that present-day radio engineering is based on a foundation of positive knowledge.

They do not realize that the radio industry has neither time nor patience to dig down below the foundation of its established knowledge.

It expects a radio engineer to know thoroughly the established knowledge and to build up from that foundation. It expects the radio engineer to solve routine problems by means of formulae and slide rule, rather than by the experimental, tinkering, cut-and-try method. Nevertheless, from the foundation upwards, no end of ingenuity, patience and willingness to try new ideas, even in haywire or breadboard form, are expected of the engineer. By all means, however, let us not waste time by indulging in the costly trial-and-error method in those principles long since established.

What Is Needed

The radio industry is much in need of radio engineers. It calls for men grounded in the necessary fundamental knowledge. These men should have a thorough grasp of electrical principles and mathematics, for after all, radio is little more than a refined and highly specialized branch of electrical engineering. There has been much criticism of salaries paid so-called radio engineers, but on inquiry, we learn that many of the complaints are by gentlemen likely to take Ohm's Law as another legal step to hamper their personal freedom, rather than as a basic principle of electrical conduct. There are plenty of soldering iron engineers about, but all too few radio engineers.

For an engineering position in the radio industry, an engineering training is essential. Various engineering schools are now providing a radio engineering course, which includes the usual electrical course together with a specialized radio touch. Some colleges and universities provide a communication engineering course, which takes in telegraphy and telephony as well as radio.

It is interesting to note that an appreciable proportion of the students of radio correspondence and radio resident schools are electrical engineers or students, anxious to specialize in radio. As an example of what this means by way of preparation, Rudolph L. Duncan, president of the RCA Institutes, reports that an electrical engineering student of New York University recently completed a radio course and qualified for his commercial operator's license in six weeks! This is probably a record.

However, it should be noted that the student was fully conversant with radio engineering principles through his electrical work, and, therefore, could concentrate on the radio code.

J. E. Smith, president of the National Radio Institute, also reports many electrical engineering students and graduates among his correspondence course students.

Practical Men Most Important

Let us distinguish well between radio engineering positions and other positions. An engineering position requires considerable training, which may be obtained best at a university or college, at least so far as the electrical and mathematical foundation is concerned. The radio end may be obtained through a radio school.

But the radio industry has need for practical radio men, just as much and even more so than for radio engineers. While engineers are expected to provide the vast store of established knowledge in the planning of undertakings, the practical radio man is the one who must carry on. The relationship is not unlike the West Point graduate now commissioned officer in the Army, and the non-commissioned officer. The commissioned officer may do the heavy thinking, but the "non-com" does most of the actual work.

It is in the practical end that radio presents the greatest opportunities to the multitude. The average man, denied the privileges of higher education, may find the desired opportunity in practical radio work. The training for such work may be found in the radio courses offered by resident and correspondence schools. A planned training, through the medium of a radio school, is the most desirable method of preparing for a radio career, for it saves much time, effort and patience.

The practical radio man not infrequently commands a greater salary than the radio engineer. Furthermore, the practical radio man is often found working side by side with the radio engineer in the research laboratory, drafting room, factory, radio station and so on. In fact, the tendency is more and more to consider real initiative and ability rather than a college degree. Lack of a college education is no longer the great handicap that it used to be. What's in a name? Very little, after all is said and done. It's the work that counts.

It is interesting to note that a college training, so far as radio is concerned, is generally an invitation to the proud possessor of the sheepskin to start learning something useful. Some of the larger radio organizations require trained radio men to fill important positions, but these men are trained by the organization.

"In the Radio Operations Department," we are told by an outstanding manufacturer, "we employ about 75 men. Almost the whole of our New England plant is devoted to manufacture of radio equipment, while at our main plant we have many different kinds of radio laboratories and a radio engineering department, in which trained radio engineers are employed.

"After trained men (electrical engineers) come to us, we train them further in our methods. Many college graduates come into our organization with the intention of taking up radio engineering. These study and work in the various radio departments of the company for a period of a year, which is known as the Graduate Student Course in Radio Engineering. After this, these men are assigned positions in the work they desire.

"The wage scale or salaries for trained radio men is from $150 to $300 a month, depending upon length of service, initiative, ability and general qualifications of the man.

"The suggestion we have to offer for training more efficient radio men is that more of them take electrical or radio engineering in colleges before they start in actual radio work."

Where Practical Men Are Found

Frankly, we believe that the radio engineer is not as much in demand as the practical radio man, who is closer to the sales end, and that is the end that usually pays the big income in any line or industry. Often the practical radio man, who knows his wiring and general principles and soldering iron, earns as much as the radio engineer, even in the same department or organization. The practical man is the fellow who translates the slide rule calculations of radio engineers into haywire or breadboard layouts and then proceeds to apply the final touch for the staff.

The practical radio man is found today in the engineering department, in the research laboratory, in the production end, in the radio jobbing and retailing fields, and out in the field servicing radio products.

Resolved That Multi-Tu

Affirmative

By Martin Force

THE trend in modern radio design has been toward increasing the number of tubes used as well as the power of those tubes. Is this trend in the right direction? Can better results be obtained with many tubes in the receiver than with only a small number? Are there really any advantages in using more than five tubes, excluding the rectifier?

One group of persons versed in radio contends that it is not necessary to use more than four or five tubes and that the use of a higher number invariably results in a waste of power, which is unwarranted. Another group is equally certain that only a multi-tube receiver can yield the results that one has a right to expect from up-to-date broadcasting. The battle rages and it seems that those who clamor for more tubes are in the ascendency.

While there are good arguments on both sides, it must be conceded that the modern receiver is superior to the receiver in vogue only two years ago, and is vastly superior to that in vogue five years ago.

Points of Superiority

When it comes to making DX records it may be that the old squealer with a multiplicity of controls of a few years ago may show up better than a modern single-control receiver of today. But DX is not now in style. A very small percentage of the radio population will sit up until every broadcast station in the country has signed off just to be able to hear a faint squeak that may with a large amount of imagination be identified with some distant station. The thrill experienced by searchers for distant stations when they heard the call letters of a station a few thousand miles away is now far outweighed by the thrill experienced by listening by the hour to classic music of the highest quality emanating from a local station. After a musical feast of this nature the thrill experienced when turning to a distant station is indeed mild, and it may in fact be a feeling of disgust rather than emotional exhileration.

But cannot the local stations be brought in just as well with a receiver having just half as many tubes as most modern receivers have? Is it necessary to have a multitube receiver for bringing in local stations and a receiver of only a few tubes for bringing in the feeble signals of the distant stations? It is conceded that the local stations can be brought in with a set of fewer tubes, and it is even asserted that it can be brought in with better quality.

Uniqueness of Reception

But let no one jump on that admission and on that assertion as a point in favor of the modest receiver. One of the prime requisites of any receiver is its exclusiveness. The quality of the simple, unselective receiver may be excellent so long as there is only one station on the air, but of what value is the excellency of the quality when the receiver brings in a dozen other programs on top of the one desired? A modern, highly selective receiver insures uniqueness of reception, that is, reception of the station desired to the exclusion of all other stations. The low and modest receiver insures no exclusiveness. A modern receiver provides the comfort and exclusiveness of a limousine while the modest receiver offers no greater comfort and convenience than a crowded subway train.

Who wants, for example, to hear a blatant jazz orchestra when a noted preacher is delivering a sacred sermon? Who wants to have a preacher intrude with his sermon when jazz and dancing are the order of the hour? Who wants to hear cooking recipes from an affected superior female when Galli Curci is singing? Who wants to hear a political harangue when a noted scientist expounds some vital phase of his science? None.

Uniqueness of reception is the first requisite of any radio receiver, and the modest receiver of only a few tubes is not capable of meeting this requirement.

Exclusiveness With Regeneration

But a high order of selectivity can be obtained with regeneration and only one or two tuners. When then is it necessary to use many tubes and many tuners in order to insure exclusiveness? It is not necessary to use many tubes if we are willing to have all the disadvantages of regeneration, squealing, interference with neighbors, distortion of quality. Neither is it necessary to have many tubes if we are willing to have a multiplicity of controls on the receiver, if we have one or two controls for each of the tuners, one for the filament of each tube, one for the antenna coupler, and half a dozen others to bring the modest receiver up to the acme of its capability.

Comfort and convenience demand simplicity of operation. There must not be more than one control for the tuning and one for the volume, if any. This demand usually imposes several tubes as radio frequency amplifiers and several well-coordinated tuned circuits. [It] is a well-known fact that as soon as two tunded circuits are controll[ed] by the same knob simultaneously the modest receiver loses its sens[i]tivity. It is no longer capable of either sensitivity or selectivit[y]. It is just for this reason that more tubes and more tuners have be[en] added to receivers.

Elimination of Antenna

The simple receiver with which DX records were established in th[e] early days of broadcasting invariably used a good outside antenn[a]. One was an essential part of the receiver, and in almost every ca[se] when a receiver lacked sensitivity the recommendation was made [to] look to the antenna—make certain that it complied with all the we[ll] established principles of antenna construction. And one of the co[n]ditions for success even with the best of antenna was that it [be] exposed to the incoming wave. This requirement often impos[ed] conditions of construction of the antenna which could not be met.

Suppose, for example, that 100 families live in the same apartme[nt] house, which is a common condition in the larger cities. Furthe[r] assume that each one of these families has a receiver. Each has be[en] told to put up a good antenna on the roof, keeping it free from [all] power wires, all other antennas, and if that were impossible, to r[un] it at right angles. Since we live in a three-dimensional space, it [is] impossible to put more than three antennas at right angles, mutuall[y]. The other 97 antennas would either have to be run parallel to one [of] the three or at some other angle that would violate the injunction [to] maintain the orthogonal relation.

In the country, of course, the situation is different, as there it [is] easy to obey all the rules for the erection of a good outdoor antenn[a]. But even there the multi-tube receiver is not out of place, for to g[et] dependable receptions at all seasons and at all hours of the day, t[he] receiver must be highly sensitive.

Convenience of Indoor Antenna

In the city conditions impose the use of an indoor antenna in mo[st] instances, and in the country the use of such an antenna is no le[ss] convenient and desirable.

A small indoor antenna does not pick up as much from broadca[st] stations as a good outdoor antenna, and this lack of pick-up must [be] compensated for by amplification, which means that more tubes mu[st] be used. Now there are very few people, indeed, who would rathe[r] not have a receiver of many tubes capable of operating satisfactori[ly] on a small indoor antenna than one that would require a long, car[e]fully constructed outdoor antenna. Imagine the plight of a man wh[o] would have to climb out on the roof on a cold night when a blizza[rd] is blowing to repair the antenna or else forego a radio program [to] which he has been looking forward for months.

At this point a bright boy suggested that on a night so wind[y] there would be no need to repair the antenna, no matter how impo[r]tant the program, because the air would be so full of SOS calls th[at] all the broadcasting stations would be shut down anyway. Of cours[e] this boy had got his brightness by living near the coast all his rad[io] life. Most broadcast stations would be going right ahead with t[he] program, SOS or not, and on that night there would be a great[er] need to repair the antenna if this were located in the coastal are[a]. He simply would have to get his cherished program from the interio[r]. The man with the multi-tube set would simply turn the dial a[nd] keep dry and warm. The fellow with the outdoor antenna wou[ld] have to climb the roof, get wet and cold, and return just in tin[e] to hear the obsequies of the special program, provided he did n[ot] slip off the roof.

Cost of Maintenance

The high cost of maintenance of a multi-tube receiver is one [of] the objections against this type of receiver. If this cost really adde[d] an appreciable amount to the monthly electric bill this indeed wou[ld] be a potent argument against the use of a dozen or so tubes. B[ut] just how much does the receiver add to the bill every month? Th[e] power required to operate such a set seldom exceeds 75 watts. Su[p]pose the set is operated on an average of four hours a day. Th[at] would be 120 hours a month. The energy required every mont[h], then, would be 75x120 watt hours, or 9 kilowatt-hours. At 7.5 cen[ts] per kilowatt-hour, the monthly cost of operating this receiver wou[ld] be 67.5 cents. This is a small amount to pay for a whole month['s] radio entertainment and instruction, considering the great convenien[ce] of the multi-tube receiver.

Some multi-tube sets may require as much as 100 watts and, [of] course, these would cost a little more to operate. But the amou[nt] added to the bill in this case would still only be 90 cents.

Obviously, it would not be fair to charge the entire operating co[st] against the multi-tube receiver, for it costs some to operate the s[et] of fewer tubes also. Only the difference should be charged again[st] the multi-tube set. The cost of operating any receiver is approx[i]mately proportional to the number of tubes. A 9-tube receiver wou[ld] cost only about 30 cents more than a 6-tube set.

e Sets Are Worth While

Negative

By E. Jasper Connaught

MANY excuses have been offered by protagonists of multi-tube receivers why these sets do not perform any better than receivers having one-half or one-third the number of tubes. None of these will stand up under impartial analysis. Any one who has had practical experience with receivers, commercial and home constructed, having from one to twenty tubes, is entirely immune to any argumetns in favor of using fore than six tubes, excluding the rectifier, in any receiver. All the arguments are only subterfuges and evasions of the facts.

Why, for example, is it necessary to use half a dozen screen grid tubes in a receiver when greater sensitivity can be obtained with a single three-element tube as radio frequency amplifier and a similar regenerative detector? Because, say the protagonists of multi-tube receivers, it is not true that as great sensitivity can be obtained with the simple regenerative circuit. Their bold statement would possibly carry conviction if one did not happen to know the facts in the case—if one did not have two receivers of the different types side by side and found by actual test that the smaller receiver outperforms the other. Only in the absence of experience will the claim for the multi-tube receiver carry conviction, and then it does it only because of ingenuous credulity.

Losing the Selectivity

The multi-tube receiver adherent points to the number of tuned circuits and uses them as an argument for greater selectivity. Why, he says, it is pure nonsense to think that two tuners can give as high selectivity as half a dozen of them. No sane man can have the temerity to make such a claim. Is not the selectivity proportional to the number of tuners?

Only a man who does not know what he is talking about can have the temerity to claim that the selectivity is proportional to the number of tuned circuits. It is nothing of the kind. If it were true, a receiver having six tuners should be six times as selective as the receiver having one tuner, and three times as selective as the receiver having two tuners. Selectivity means the ability of the receiver to discriminate among stations of different frequencies. That is just what the two-tuner, regenerative receiver is capable of. The receiver with six tuners in nine cases out of ten is tuned to six different frequencies, and in many cases to as many different stations. There can be no real selectivity when that condition obtains.

Scores on Sensitivity

The principal argument in favor of the multi-tube receiver is that it is vastly more sensitive than the less pretentious receiver. Who has ever made any DX records with multi-tube receivers of the modern type? Nobody. All records are made with simple receivers having only a reasonable number of tubes.

How can the multi-tube receiver be sensitive when it is out of tune most of the time, with no means for bringing the multiplicity of tuned circuits into resonance with the same frequency simultaneously? The multi-tube receivers are made that way in order to make them at all manageable. How can this receiver be sensitive when every tuned circuit is surrounded by shields the only purpose of which is to kill off the sensitivity?

The real reason for putting in many tubes in a receiver is to make that receiver as impressive as possible to the uninitiated. Ah, this receiver has ten tubes, and half of them are screen grid tubes! This is the most sensitive, the most selective receiver that has ever been built. More than that, it is the "most perfect" receiver! In practice this "most perfect" receiver turns out to be something less than mediocre. The proud possessor of this receiver may not know it, but the caller whom he is trying to impress with his wonderful set may regard it as a dud. Courtesy alone prevents him from saying so. The caller may mention hearing regularly distant stations on his inexpensive receiver, stations which the multi-tube set never brings in. The defense for the expensive set is that the location is poor.

Gain and Loss

In order to be able to handle a multi-tube receiver at all it is necessary to introduce losses to offset the amplification. A tube is put in to amplify the signals. Then a losser of some kind, often a shield, is added to reduce the amplification. Then another tube is added to get some more amplification, and this is followed by the addition of another losser. This process goes on until the receiver has a sufficient number of tuners and tubes to make a deep impression on the uninitiated, or until it has a greater number of tuners and tubes than the receiver put out by some competitor of the manufacturer.

We have been told that screen grid tubes amplify enormously more than three-element tubes. Therefore, screen grid tube receivers are pointed out as being superior from the point of view of sensitivity. Indeed, we are told just how many million times the receiver amplifies. The number expressing the amplification is so great that if it were really true that the set amplified so greatly, there would not be a station on the face of the earth which that receiver would not bring in with loudspeaker volume, using nothing but a hairpin for an antenna. Yet that receiver has difficulty in bringing in stations a thousand miles away. There is a surprisingly large number of poor locations when such receivers are operated.

Noise in Receivers

One of the disadvantages of a multi-tube receiver not often mentioned is the tube and circuit noises. These noises increase with the number of tubes used, and they are often so great that it is impossible to hear clearly any station requiring a moderate degree of amplification. "Static" is the explanation for any hissing and roaring noise that may be heard in the receiver. Multi-tube receivers are often operated in such manner that the tube and circuit noises are greater than they are in receivers having fewer tubes.

Probably more than 99 per cent of listeners-in are content to listen to local stations and only a few want occasionally to tune in a distant station, not for the entertainment that may be obtained from that station but simply out of curiosity. Why then is it necessary to have a receiver which is so sensitive as to receive stations across the country? It is not necessary, whether the receiver have few or many tubes. And when curiosity is so strong as to make the dial twister fish for the distance station is it not better to have a receiver of few tuners and few tubes when such a receiver is more likely to bring in the station?

The greater convenience of the indoor antenna made possible by multi-tube sets is not forbidden to the man with the simple set. He, too, can bring in distant stations with an indoor antenna. Perhaps not with an antenna of a few inches in length, but certainly with an antenna which can be erected inside the house and put out of sight without any trouble. A good ground is as important as a good antenna, and a ground is just as easily provided for the inexpensive set as for the more costly set.

Operate Set Without Squealing

One argument against the regenerative receiver is that it squeals a lot and interferes with the neighbor's enjoyment of radio. This argument is not so potent as it seems to be. The man who has a regenerative set does not like squeals any more than his neighbor does, and he knows how to prevent the squealing. He cannot get any distant stations while his set is oscillating. Neither does the regenerative set interfere any more than a multi-tube receiver that squeals. And where is there a receiver which does not squeal? Practically every multi-tube receiver squeals, and as a rule there is no provision for controlling the squealing.

One of the strongest indictments against the multi-tube receivers is the opinion service men and home constructors have of them. "When I want real DX reception," one says, "I turn to my old DX-dyne. It beats every multi-tube set that I have tried, and I have tried many." This opinion is typical of those of thousands of set builders and experimenters. They know the relative merits of different receivers, and their opinions is worth more than the stereotyped claims of manufacturers. No experimenter will say that any receiver is "most perfect."

Difference In Investment

It may be argued that the cost of maintaining a multi-tube receiver is only negligibly higher than the cost of maintaining the less pretentious. This may be relatively true. But whatever the greater cost may be, it is unnecessary expense in view of the fact that no better results can be obtained by adding a lot of more tubes. Then we must not forget the difference between original costs, the interest on the investment, and the rate of depreciation.

The multi-tube receiver may cost several times that of the simple receiver. Hence the interest on the investment will be correspondingly higher. This must be added to the cost of maintenance. Moreover, the rate of depreciation is much greater for the expensive set than for the modest set. This, too, must be charged against the multi-tube set.

All the added costs of the multi-tube receiver would be worth the outlay, provided that the results were any better than the results with a receiver having only four to six tubes. Is the quality any better? No. Is the selectivity any better? No. Is the sensitivity any better? No. Is the volume handling capacity any greater? Usually not. Does the multi-tube set present a better appearance? Not necessarily. The appearance has nothing to do with the number of tubes. Does the multi-tube set insure greater convenience? It may be a little easier to tune. Does it produce less undesired sounds? No; more.

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Affirmative

By Martin Force

THE trend in modern radio design has been toward increasing the number of tubes used as well as the power of those tubes. Is this trend in the right direction? Can better results be obtained with many tubes in the receiver than with only a small number? Are there really any advantages in using more than five tubes, excluding the rectifier?

One group of persons versed in radio contends that it is not necessary to use more than four or five tubes and that the use of a higher number invariably results in a waste of power, which is unwarranted. Another group is equally certain that only a multi-tube receiver can yield the results that one has a right to expect from up-to-date broadcasting. The battle rages and it seems that those who clamor for more tubes are in the ascendency.

While there are good arguments on both sides, it must be conceded that the modern receiver is superior to the receiver in vogue only two years ago, and is vastly superior to that in vogue five years ago.

Points of Superiority

When it comes to making DX records it may be that the old squealer with a multiplicity of controls of a few years ago may show up better than a modern single-control receiver of today. But DX is not now in style. A very small percentage of the radio population will sit up until every broadcast station in the country has signed off just to be able to hear a faint squeak that may with a large amount of imagination be identified with some distant station. The thrill experienced by searchers for distant stations when they heard the call letters of a station a few thousand miles away is now far outweighed by the thrill experienced by listening by the hour to classic music of the highest quality emanating from a local station. After a musical feast of this nature the thrill experienced when turning to a distant station is indeed mild, and it may in fact be a feeling of disgust rather than emotional exhileration.

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Uniqueness of Reception

But let no one jump on that admission and on that assertion as a point in favor of the modest receiver. One of the prime requisites of any receiver is its exclusiveness. The quality of the simple, unselective receiver may be excellent so long as there is only one station on the air, but of what value is the excellency of the quality when the receiver brings in a dozen other programs on top of the one desired? A modern, highly selective receiver insures uniqueness of reception, that is, reception of the station desired to the exclusion of all other stations. The low and modest receiver insures no exclusiveness. A modern receiver provides the comfort and exclusiveness of a limousine while the modest receiver offers no greater comfort and convenience than a crowded subway train.

Who wants, for example, to hear a blatant jazz orchestra when a noted preacher is delivering a sacred sermon? Who wants to have a preacher intrude with his sermon when jazz and dancing are the order of the hour? Who wants to hear cooking recipes from an affected superior female when Galli Curci is singing? Who wants to hear a political harangue when a noted scientist expounds some vital phase of his science? None.

Uniqueness of reception is the first requisite of any radio receiver, and the modest receiver of only a few tubes is not capable of meeting this requirement.

Exclusiveness With Regeneration

But a high order of selectivity can be obtained with regeneration and only one or two tuners. When then is it necessary to use many tubes and many tuners in order to insure exclusiveness? It is not necessary to use many tubes if we are willing to have all the disadvantages of regeneration, squealing, interference with neighbors, distortion of quality. Neither is it necessary to have many tubes if we are willing to have a multiplicity of controls on the receiver, if we have one or two controls for each of the tuners, one for the filament of each tube, one for the antenna coupler, and half a dozen others to bring the modest receiver up to the acme of its capability.

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How can the multi-tube receiver be sensitive when it is out of tune most of the time, with no means for bringing the multiplicity of tuned circuits into resonance with the same frequency simultaneously? The multi-tube receivers are made that way in order to make them at all manageable. How can this receiver be sensitive when every tuned circuit is surrounded by shields the only purpose of which is to kill off the sensitivity?

The real reason for putting in many tubes in a receiver is to make that receiver as impressive as possible to the uninitiated. Ah, this receiver has ten tubes, and half of them are screen grid tubes! This is the most sensitive, the most selective receiver that has ever been built. More than that, it is the "most perfect" receiver! In practice this "most perfect" receiver turns out to be something less than mediocre. The proud possessor of this receiver may not know it, but the caller whom he is trying to impress with his wonderful set may regard it as a dud. Courtesy alone prevents him from saying so. The caller may mention hearing regularly distant stations on his inexpensive receiver, stations which the multi-tube set never brings in. The defense for the expensive set is that the location is poor.

Gain and Loss

In order to be able to handle a multi-tube receiver at all it is necessary to introduce losses to offset the amplification. A tube is put in to amplify the signals. Then a losser of some kind, often a shield, is added to reduce the amplification. Then another tube is added to get some more amplification, and this is followed by the addition of another losser. This process goes on until the receiver has a sufficient number of tuners and tubes to make a deep impression on the uninitiated, or until it has a greater number of tuners and tubes than the receiver put out by some competitor of the manufacturer.

We have been told that screen grid tubes amplify enormously more than three-element tubes. Therefore, screen grid tube receivers are pointed out as being superior from the point of view of sensitivity. Indeed, we are told just how many million times the receiver amplifies. The number expressing the amplification is so great that if it were really true that the set amplified so greatly, there would not be a station on the face of the earth which that receiver would not bring in with loudspeaker volume, using nothing but a hairpin for an antenna. Yet that receiver has difficulty in bringing in stations a thousand miles away. There is a surprisingly large number of poor locations when such receivers are operated.

Noise in Receivers

One of the disadvantages of a multi-tube receiver not often mentioned is the tube and circuit noises. These noises increase with the number of tubes used, and they are often so great that it is impossible to hear clearly any station requiring a moderate degree of amplification. "Static" is the explanation for any hissing and roaring noise that may be heard in the receiver. Multi-tube receivers are often operated in such manner that the tube and circuit noises are greater than they are in receivers having fewer tubes.

Probably more than 99 per cent of listeners-in are content to listen to local stations and only a few want occasionally to tune in a distant station, not for the entertainment that may be obtained from that station but simply out of curiosity. Why then is it necessary to have a receiver which is so sensitive as to receive stations across the country? It is not necessary, whether the receiver have few or many tubes. And when curiosity is so strong as to make the dial twister fish for the distance station is it not better to have a receiver of few tuners and few tubes when such a receiver is more likely to bring in the station?

The greater convenience of the indoor antenna made possible by multi-tube sets is not forbidden to the man with the simple set. He, too, can bring in distant stations with an indoor antenna. Perhaps not with an antenna of a few inches in length, but certainly with an antenna which can be erected inside the house and put out of sight without any trouble. A good ground is as important as a good antenna, and a ground is just as easily provided for the inexpensive set as for the more costly set.

Operate Set Without Squealing

One argument against the regenerative receiver is that it squeals a lot and interferes with the neighbor's enjoyment of radio. This argument is not so potent as it seems to be. The man who has a regenerative set does not like squeals any more than his neighbor does, and he knows how to prevent the squealing. He cannot get any distant stations while his set is oscillating. Neither does the regenerative set interfere any more than a multi-tube receiver that squeals. And where is there a receiver which does not squeal? Practically every multi-tube receiver squeals, and as a rule there is no provision for controlling the squealing.

One of the strongest indictments against the multi-tube receivers is the opinion service men and home constructors have of them. "When I want real DX reception," one says, "I turn to my old DX-dyne. It beats every multi-tube set that I have tried, and I have tried many." This opinion is typical of those of thousands of set builders and experimenters. They know the relative merits of different receivers, and their opinions is worth more than the stereotyped claims of manufacturers. No experimenter will say that any receiver is "most perfect."

Difference In Investment

It may be argued that the cost of maintaining a multi-tube receiver is only negligibly higher than the cost of maintaining the less pretentious. This may be relatively true. But whatever the greater cost may be, it is unnecessary expense in view of the fact that no better results can be obtained by adding a lot of more tubes. Then we must not forget the difference between original costs, the interest on the investment, and the rate of depreciation.

The multi-tube receiver may cost several times that of the simple receiver. Hence the interest on the investment will be correspondingly higher. This must be added to the cost of maintenance. Moreover, the rate of depreciation is much greater for the expensive set than for the modest set. This, too, must be charged against the multi-tube set.

All the added costs of the multi-tube receiver would be worth the outlay, provided that the results were any better than the results with a receiver having only four to six tubes. Is the quality any better? No. Is the selectivity any better? No. Is the sensitivity any better? No. Is the volume handling capacity any greater? Usually not. Does the multi-tube set present a better appearance? Not necessarily. The appearance has nothing to do with the number of tubes. Does the multi-tube set insure greater convenience? It may be a little easier to tune. Does it produce less undesired sounds? No; more.

Resolved That Multi-Tu

Affirmative

By Martin Force

THE trend in modern radio design has been toward increasing the number of tubes used as well as the power of those tubes. Is this trend in the right direction? Can better results be obtained with many tubes in the receiver than with only a small number? Are there really any advantages in using more than five tubes, excluding the rectifier?

One group of persons versed in radio contends that it is not necessary to use more than four or five tubes and that the use of a higher number invariably results in a waste of power, which is unwarranted. Another group is equally certain that only a multi-tube receiver can yield the results that one has a right to expect from up-to-date broadcasting. The battle rages and it seems that those who clamor for more tubes are in the ascendency.

While there are good arguments on both sides, it must be conceded that the modern receiver is superior to the receiver in vogue only two years ago, and is vastly superior to that in vogue five years ago.

Points of Superiority

When it comes to making DX records it may be that the old squealer with a multiplicity of controls of a few years ago may show up better than a modern single-control receiver of today. But DX is not now in style. A very small percentage of the radio population will sit up until every broadcast station in the country has signed off just to be able to hear a faint squeak that may with a large amount of imagination be identified with some distant station. The thrill experienced by searchers for distant stations when they heard the call letters of a station a few thousand miles away is now far outweighed by the thrill experienced by listening by the hour to classic music of the highest quality emanating from a local station. After a musical feast of this nature the thrill experienced when turning to a distant station is indeed mild, and it may in fact be a feeling of disgust rather than emotional exhileration.

But cannot the local stations be brought in just as well with a receiver having just half as many tubes as most modern receivers have? Is it necessary to have a multitube receiver for bringing in local stations and a receiver of only a few tubes for bringing in the feeble signals of the distant stations? It is conceded that the local stations can be brought in with a set of fewer tubes, and it is even asserted that it can be brought in with better quality.

Uniqueness of Reception

But let no one jump on that admission and on that assertion as a point in favor of the modest receiver. One of the prime requisites of any receiver is its exclusiveness. The quality of the simple, unselective receiver may be excellent so long as there is only one station on the air, but of what value is the excellency of the quality when the receiver brings in a dozen other programs on top of the one desired? A modern, highly selective receiver insures uniqueness of reception, that is, reception of the station desired to the exclusion of all other stations. The low and modest receiver insures no exclusiveness. A modern receiver provides the comfort and exclusiveness of a limousine while the modest receiver offers no greater comfort and convenience than a crowded subway train.

Who wants, for example, to hear a blatant jazz orchestra when a noted preacher is delivering a sacred sermon? Who wants to have a preacher intrude with his sermon when jazz and dancing are the order of the hour? Who wants to hear cooking recipes from an affected superior female when Galli Curci is singing? Who wants to hear a political harangue when a noted scientist expounds some vital phase of his science? None.

Uniqueness of reception is the first requisite of any radio receiver, and the modest receiver of only a few tubes is not capable of meeting this requirement.

Exclusiveness With Regeneration

But a high order of selectivity can be obtained with regeneration and only one or two tuners. When then is it necessary to use many tubes and many tuners in order to insure exclusiveness? It is not necessary to use many tubes if we are willing to have all the disadvantages of regeneration, squealing, interference with neighbors, distortion of quality. Neither is it necessary to have many tubes if we are willing to have a multiplicity of controls on the receiver, if we have one or two controls for each of the tuners, one for the filament of each tube, one for the antenna coupler, and half a dozen others to bring the modest receiver up to the acme of its capability.

Comfort and convenience demand simplicity of operation. There must not be more than one control for the tuning and one for the volume, if any. This demand usually imposes several tubes as radio frequency amplifiers and several well-coordinated tuned circuits. is a well-known fact that as soon as two tunded circuits are controll by the same knob simultaneously the modest receiver loses its sen tivity. It is no longer capable of either sensitivity or selectivi It is just for this reason that more tubes and more tuners have be added to receivers.

Elimination of Antenna

The simple receiver with which DX records were established in t early days of broadcasting invariably used a good outside anten One was an essential part of the receiver, and in almost every ca when a receiver lacked sensitivity the recommendation was made look to the antenna—make certain that it complied with all the we established principles of antenna construction. And one of the co ditions for success even with the best of antenna was that it exposed to the incoming wave. This requirement often impos conditions of construction of the antenna which could not be met.

Suppose, for example, that 100 families live in the same apartme house, which is a common condition in the larger cities. Furth assume that each one of these families has a receiver. Each has be told to put up a good antenna on the roof, keeping it free from power wires, all other antennas, and if that were impossible, to r it at right angles. Since we live in a three-dimensional space, it impossible to put more than three antennas at right angles, mutual The other 97 antennas would either have to be run parallel to one the three or at some other angle that would violate the injunction maintain the orthogonal relation.

In the country, of course, the situation is different, as there it easy to obey all the rules for the erection of a good outdoor anten But even there the multi-tube receiver is not out of place, for to dependable receptions at all seasons and at all hours of the day, receiver must be highly sensitive.

Convenience of Indoor Antenna

In the city conditions impose the use of an indoor antenna in m instances, and in the country the use of such an antenna is no l convenient and desirable.

A small indoor antenna does not pick up as much from broadc stations as a good outdoor antenna, and this lack of pick-up must compensated for by amplification, which means that more tubes m be used. Now there are very few people, indeed, who would rath not have a receiver of many tubes capable of operating satisfactor on a small indoor antenna than one that would require a long, ca fully constructed outdoor antenna. Imagine the plight of a man w would have to climb out on the roof on a cold night when a blizza is blowing to repair the antenna or else forego a radio program which he has been looking forward for months.

At this point a bright boy suggested that on a night so win there would be no need to repair the antenna, no matter how imp tant the program, because the air would be so full of SOS calls t all the broadcasting stations would be shut down anyway. Of cour this boy had got his brightness by living near the coast all his ra life. Most broadcast stations would be going right ahead with program, SOS or not, and on that night there would be a grea need to repair the antenna if this were located in the coastal ar He simply would have to get his cherished program from the inter The man with the multi-tube set would simply turn the dial a keep dry and warm. The fellow with the outdoor antenna wo have to climb the roof, get wet and cold, and return just in ti to hear the obsequies of the special program, provided he did slip off the roof.

Cost of Maintenance

The high cost of maintenance of a multi-tube receiver is one the objections against this type of receiver. If this cost really ad an appreciable amount to the monthly electric bill this indeed wo be a potent argument against the use of a dozen or so tubes. just how much does the receiver add to the bill every month? power required to operate such a set seldom exceeds 75 watts. S pose the set is operated on an average of four hours a day. T would be 120 hours a month. The energy required every mon then, would be 75x120 watt hours, or 9 kilowatt-hours. At 7.5 ce per kilowatt-hour, the monthly cost of operating this receiver wo be 67.5 cents. This is a small amount to pay for a whole mon radio entertainment and instruction, considering the great convenie of the multi-tube receiver.

Some multi-tube sets may require as much as 100 watts and, course, these would cost a little more to operate. But the amo added to the bill in this case would still only be 90 cents.

Obviously, it would not be fair to charge the entire operating c against the multi-tube receiver, for it costs some to operate the of fewer tubes also. Only the difference should be charged agai the multi-tube set. The cost of operating any receiver is appro imately proportional to the number of tubes. A 9-tube receiver wo cost only about 30 cents more than a 6-tube set.

e Sets Are Worth While

Negative

By E. Jasper Connaught

MANY excuses have been offered by protagonists of multi-tube receivers why these sets do not perform any better than receivers having one-half or one-third the number of tubes. None of these will stand up under impartial analysis. Any one who has had practical experience with receivers, commercial and home constructed, having from one to twenty tubes, is entirely immune to any argumetns in favor of using fore than six tubes, excluding the rectifier, in any receiver. All the arguments are only subterfuges and evasions of the facts.

Why, for example, is it necessary to use half a dozen screen grid tubes in a receiver when greater sensitivity can be obtained with a single three-element tube as radio frequency amplifier and a similar regenerative detector? Because, say the protagonists of multi-tube receivers, it is not true that as great sensitivity can be obtained with the simple regenerative circuit. Their bold statement would possibly carry conviction if one did not happen to know the facts in the case—if one did not have two receivers of the different types side by side and found by actual test that the smaller receiver outperforms the other. Only in the absence of experience will the claim for the multi-tube receiver carry conviction, and then it does it only because of ingenuous credulity.

Losing the Selectivity

The multi-tube receiver adherent points to the number of tuned circuits and uses them as an argument for greater selectivity. Why, he says, it is pure nonsense to think that two tuners can give as high selectivity as half a dozen of them. No sane man can have the temerity to make such a claim. Is not the selectivity proportional to the number of tuners?

Only a man who does not know what he is talking about can have the temerity to claim that the selectivity is proportional to the number of tuned circuits. It is nothing of the kind. If it were true, a receiver having six tuners should be six times as selective as the receiver having one tuner, and three times as selective as the receiver having two tuners. Selectivity means the ability of the receiver to discriminate among stations of different frequencies. That is just what the two-tuner, regenerative receiver is capable of. The receiver with six tuners in nine cases out of ten is tuned to six different frequencies, and in many cases to as many different stations. There can be no real selectivity when that condition obtains.

Scores on Sensitivity

The principal argument in favor of the multi-tube receiver is that it is vastly more sensitive than the less pretentious receiver. Who has ever made any DX records with multi-tube receivers of the modern type? Nobody. All records are made with simple receivers having only a reasonable number of tubes.

How can the multi-tube receiver be sensitive when it is out of tune most of the time, with no means for bringing the multiplicity of tuned circuits into resonance with the same frequency simultaneously? The multi-tube receivers are made that way in order to make them at all manageable. How can this receiver be sensitive when every tuned circuit is surrounded by shields the only purpose of which is to kill off the sensitivity?

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Gain and Loss

In order to be able to handle a multi-tube receiver at all it is necessary to introduce losses to offset the amplification. A tube is put in to amplify the signals. Then a losser of some kind, often a shield, is added to reduce the amplification. Then another tube is added to get some more amplification, and this is followed by the addition of another losser. This process goes on until the receiver has a sufficient number of tuners and tubes to make a deep impression on the uninitiated, or until it has a greater number of tuners and tubes than the receiver put out by some competitor of the manufacturer.

We have been told that screen grid tubes amplify enormously more than three-element tubes. Therefore, screen grid tube receivers are pointed out as being superior from the point of view of sensitivity. Indeed, we are told just how many million times the receiver amplifies. The number expressing the amplification is so great that if it were really true that the set amplified so greatly, there would not be a station on the face of the earth which that receiver would not bring in with loudspeaker volume, using nothing but a hairpin for an antenna. Yet that receiver has difficulty in bringing in stations a thousand miles away. There is a surprisingly large number of poor locations when such receivers are operated.

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One of the disadvantages of a multi-tube receiver not often mentioned is the tube and circuit noises. These noises increase with the number of tubes used, and they are often so great that it is impossible to hear clearly any station requiring a moderate degree of amplification. "Static" is the explanation for any hissing and roaring noise that may be heard in the receiver. Multi-tube receivers are often operated in such manner that the tube and circuit noises are greater than they are in receivers having fewer tubes.

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Operate Set Without Squealing

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BOARD REVEALS SHIFTS TO STOP BAD CROSS-TALK

28 STATIONS ON CLEAR CHANNEL TO ALTER WAVE

Washington.

Changes in the assignments of 28 stations which operate on 13 of the 40 cleared channels set aside for the exclusive use of high-powered or "national" stations during evening hours, are proposed by the Federal Radio Commission, in a plan offered as a means of alleviating "cross-talk" interference caused by insufficient frequency and geographical separation between the stations.

Contemplated as the first sweeping revision of assignments of large stations since the nation-wide reallocation was effected in November, 1928, the Commission has addressed letters to each of the stations involved asking its cooperation. The letters, which are identical, are accompanied by the proposed plan, and state that it should work to the mutual benefit of stations and listeners.

Interference Detected

Under the 1928 reallocation, 40 cleared channels were set aside for high-powered stations, with the view to providing adequate service for rural listeners.

Since then, it was explained, the Commission has been observing closely the operation of these stations, and has detected the cross-talk interference, resulting from close geographical separation between stations on adjacent channels, and also due to the fact that certain stations have made improvements in their equipment which extended their service areas, thus causing the interchannel interference.

In soliciting the stations, the Commission explains it believes that the plan can be made effective by mutual agreement among all stations, and that no serious objection will result. If this can be done it will not be necessary to hold public hearings, it was explained.

18 Changes March 2d

On the 13 cleared channels 17 stations are assigned on a "national" basis, utilizing power ranging from 5,000 to the maximum of 50,000 watts. In addition, there are 11 limited time or daylight operation stations involved. The plan was worked out, it was stated, at the direction of the Commission's Acting Chief Engineer, Capt. Guy Hill, who assigned George O. Sutton, broadcast engineer, to it last Fall.

At the same time the Commission announced that because of cross-talk interference existing on eight non-cleared channels in the upper portion of the spectrum, that, effective Sunday, March 2d, the assignments of 18 stations operating on these channels will be changed.

These changes are being made without consulting the stations involved, and upon recommendation of the engineering division. It is a part of the general project to eliminate cross-talk interference occasioned by lack of geographical and frequency separation between stations.

As to the cleared channel plan, the Commission points out that under the existing allocation there are eight instances where the mileage separation between stations on adjacent channels is less than 400 miles, whereas it is believed necessary to have from at least 400 to 600 miles between clear channel stations on adjacent channels.

Under the proposed plan one instance occurs where the separation is 400 miles and one instance where it is 580 miles, while all others exceed this distance. The average mileage separation will be increased from 552 to 1,117 miles.

The 17 main stations, and the 13 channels involved in the realignment are as follows, says "The United States Daily":

	Present	Proposed
WHAS, Louisville, Ky.	820	1,020
KYW, Chicago	1,020	1,140
KTHS, Hot Springts, Ark., KRLD, Dallas, Tex.	1,040	1,070
WTAM, Cleveland	1,070	1,080
WBT, Charlotte, N. C.	1,080	1,040
KMOX, St. Louis, Mo.	1,090	1,110
WRVA, Richmond, Va.	1,110	1,150
KSL, Salt Lake City, Utah	1,130	1,090
WAPI, Birmingham, Ala., KVOO, Tulsa, Okla.	1,140	1,130
WHAM, Rochester, N. Y.	1,150	1,160
WOWO, Fort Wayne, Ind., WWVA, Wheeling, W. Va.	1,160	1,180
WCAU, Philadelphia	1,170	820
KOB, State College, N. Mex., KEX, Portland, Oreg.	1,180	1,170

In addition to these stations, those limited time and day stations involved, are as follows:

	Present	Proposed
WMBI, Chicago, WCBD, Zion City	1,080	1,040
WHDI, Minneapolis, WDGY, Minneapolis	1,180	1,170
WJJD, Mooseheart, Ill.	1,130	1,090
WKEN, Grand Island, N. Y.	1,040	1,160
WKAR, Lansing, Mich.	1,040	830
WCAZ, Carthage, Ill., WDZ, Tuscola, Ill.	1,070	No change
KSOO, Sioux Falls, S. Dak.	1,110	1,100
KTNT, Muscatine, Iowa	1,170	1,160

Calls Plan Most Feasible

In its letter the Commission stated that for several months it has given the proposed change consideration, and had decided upon the plan as the most feasible method.

"In order to accomplish these results it is necessary to change the frequency assignment of several stations," continues the letter. "The minimum number of changes required to relieve the interference is specified in this plan. In certain cases it has been necessary to change the assignment of a particular station not because that station was causing cross-talk interference, but in order to effect a better frequency separation between other stations on adjacent channels where close geographical separation exists.

"The frequency assignment proposed for any of these stations will not in any way limit their service, and due to the general public good resulting from the entire plan, such changes becomes imperative." The changes in frequencies, it was explained to the stations, are so interrelated that it is necessary for the whole plan to be put in operation at one time. "Therefore," states the letter, "the Commission desires to know how much time each station will require before making the specified change in frequency.

"The existing interference in some cases is serious and the Commission, therefore, suggests that you give the plan consideration at your earliest convenience so that an agreement can be reached and the interference corrected as soon as practicable."

In the plan itself the Commission states:

"There are 13 channels involved in this rearrangement. On 9 of the 13 frequencies stations are now suffering from and causing cross-talk to stations on adjacent channels. This interference is mainly due to insufficient frequency separation for the geographical separation between the stations.

"In some cases the interference has been aggravated by one station installing the most modern equipment and thus extending its service area while the stations on adjacent channels made no change in equipment.

"The stations cannot be moved to another city to alleviate the interference. Therefore, the only course which the Commission can pursue in relieving the existing cross-talk is to change the frequency assignment of the necessary number of stations and gain greater frequency separation between the interfering stations.

Mileage Separation Discussed

"It will be noticed that under the existing allocation there are eight instances where the mileage separation between stations on adjacent channels is less than 600 miles and four instances where the separation is less than 400 miles. The Commission believes that it is necessary to have from at least 400 to 600 miles between clear channel stations on adjacent channels. Under the proposed plan one instance occurs where the separation is 400 miles and one instance where the separation is 580 miles. All others exceed this amount. The average mileage separation between the clear channel stations involved will be increased from 522 miles to 1,117 miles.

"There are several stations which are suffering from cross-talk from stations on an adjacent channel where one station has installed modern equipment and increased power during the last year.

"In each of the cases the Commission feels that this is due to the close frequency separation for the mileage between the stations.

Expects Better Service

"A careful study of the foregoing table will reveal the fact that an intolerable condition would result between stations 200 ot 300 miles apart if the power ratio was 10 to 1 and on adjacent channels. Applications are now before the Commission which, if granted, would bring this about.

"The purpose, therefore, in proposing this change is to alleviate the present cross-talk between certain channels by gaining better frequency separation, and preventing more of this in the future by gaining greater frequency separation where stations have small mileage separation.

"The Commission feels this plan when inaugurated will bring this about and allow the stations involved to render better service to the public thereby, being in the general public interest, convenience and necessity."

French Train Has Radio with Phones

The French State Railway has announced the first train in France equipped with radio, according to a report received in the Department of Commerce from Commercial Attache F. W. Allport, Paris.

This train, which will operate between Paris and Havre, will be fitted out with individual earphones for each passenger. Coaches provided with similar equipment are soon expected to be put into service on other lines of the State Railway.

REDUCED TIME SHOWN AS BIG DENT IN INCOME

Washington.

WLS, at Chicago, operated by "The Prairie Farmer," agricultural publication, partly owned by Sears, Roebuck & Co., will appeal from a decision of the Court of Appeals of the District of Columbia, curtailing its broadcasting time in favor of WENR, also at Chicago, operated by the Insull power interests, Harry E. Kelly, attorney for the station, has announced.

Mr. Kelly and Edgar L. Bill, director of the station, appeared before the Commission in executive session to contest an immediate reduction in broadcasting time on the ground that such action would result in substantial loss in revenue.

Wants Month's Time

They asked for a postponement of 30 days to allow WLS to rearrange its advertising contracts with the least possible monetary loss. Mr. Bill explained that approximately $250,000 in advertising contracts would be interfered with if the half-time sharing arrangement became effective immediately. These contracts include 43 accounts which run in terms varying from three months to one year.

"There would be an upheaval of our advertising business," Mr. Bill declared. "We pointed out to the Commission that under the mandate of the court no date for the division of time on an equal basis by the stations is specified. In view of this we asked for 30 days in which to straighten out as many of the contracts as possible, so that we could have as little loss as possible."

Cites Deprivation

Mr. Kelly said that the new appeal would be based on the ground of deprivation of property rights, involving the constitutionality of the action as a direct violation of the Fifth Amendment, which guarantees due process of law before confiscation.

WLS now uses 5,000 watts, but has a construction permit to erect a station using the maximum of 50,000 watts. WENR now uses 50,000 watts.

Radio-Victor Plant To Cost $11,420,000

An expansion program involving the expenditure of more than $7,500,000 during 1930 is to be undertaken by the RCA Victor Company, said Edward E. Shumaker, president of the company. More than $5,500,000 of this amount will be spent for the construction of a new building and mechanical equipment, including machine tools, small tools, conveyors and other important items.

The new building is to be used for the manufacture of radio parts for radio assembly and shipping. In addition to this, more than $2,000,000 worth of equipment is being brought to Camden from the General Electric and Westinghouse plants for use in radio production in the RCA Victor plant. Combined with the appropriation of $3,820,000, which was authorized last year and which is still being expended, the RCA Victor Company by the end of 1930 will have made an outlay of $11,420,000 for plant expansion and development.

157 Minute Men Check Lawmakers

The Radio Manufacturers Association is entering active opposition to unfair curtailment of radio activities.

C. C. Colby, chairman of the legislative committee, reported there are enrolled in this legislative work 157 men, spread over thirty-one states. Organization in other states is being completed.

Daily reports regarding radio legislation introduced anywhere are received by Frank D. Scott, of Washington, D. C., legislative counsel of the RMA. Prompt action is taken to protect radio interests against harmful or unfair legislation calculated to injure sales.

Chairman Colby reported an anti-radio proposal which would have placed an 11 p. m. curfew on the use of all radio sets and introduce other drastic limitations. This proposed ordinance was killed in committee.

A similar bill in the New York Legislature also is having attention, as is a bill in the South Carolina Legislature to tax receiving sets.

In Massachusetts there is being opposed a plan to ban receiving sets from automobiles.

HOLLAND OFF AIR, U. S. WAITED

Bernard C. J. Loder, first Chief Justice of the World Court, was to have addressed an anxious American audience on a recent Sunday afternoon, through the kindness of short-wave transmission from Holland, pickup on the Atlantic seaboard, and a rebroadcast over not only the National Broadcasting Chain, but also over WOR, Newark, N. J., which had been done the courtesy of being linked in.

A good instrumental musical program was on the air, so-called high-brow stuff, and it was evident that the National Broadcasting Company was fully prepared to spend the entire afternoon giving adequate entertainment from its own studio, even if nothing was heard from The Voice of the World.

Phillips Carlin, the announcer, at the time that the speech from Holland was to be heard, announced regretfully that word had been received from the Holland station that mechanical trouble had developed, but that it was expected this would be remedied in two hours, so that at least some time in the afternoon the program being rendered would be interrupted to permit broadcasting the big feature.

Well, the afternoon wore on and on, and finally there was a hopeless announcement there would be nothing doing that time. So the feature was postponed a week.

Several million persons, already educated to an appetite for hearing the other side of the Atlantic by radio, were listening in, and if during all the suspense and consequent disappointment, any one managed to remember the name of even one of the musical pieces played from the NBC studio that afternoon, will he so notify the company, at 711 Fifth avenue, New York City?

Motto for round-the-world features: "Better Luck Next Time."

SPEED TUBES LICENSED

The Cable Radio Tube Corporation, maker of Speed tubes, has been licensed by RCA, General Electric, and Westinghouse.

40 PERCENT OF FACTORIES BAD OFF ON MONEY

The radio industry is receiving many reports of improved business conditions. At a meeting of the Radio Manufacturers Association's board of directors there were numerous reports of better business during January, and also prospects were reported encouraging.

Effects of last year's over-production of radio receiving sets, according to industry reports, are almost past. The era of cut prices, due largely to distress merchandise, is about over, it is said, and with reduced production, normal manufacturing schedules and distribution soon will be reached.

40% Are In Trouble

H. B. Richmond, of Cambridge, Mass., president of the RMA, told of the encouraging trade reports and outlook. President Richmond and Major H. H. Frost, chairman of the Association's merchandising committee, reported that liquidation of excess production, contrary to past predictions, was about over and probably would be completed in a few weeks instead of in a few months, as originally expected.

Referring to the industry difficulties last year, President Richmond stated that 25 per cent. of the manufacturers have maintained price levels, 35 per cent. cut prices, and 40 per cent. have become involved in financial difficulties.

Distress Stocks Lowered

This, however, reduced the number of manufacturing units, President Richmond said, with production schedules now approaching reasonable prospective demand.

Chairman Frost of the merchandising committee reported that distress stocks were not large and had been reduced greatly since December 15th, with only a few more weeks of liquidation in prospect.

Chairman Leslie F. Muter of the credit committee also reported substantial improvement in industry credit conditions.

New AC Meter Reads Plus or Minus 2 Cycles

A new frequency meter of the indicating type has been developed by the Westinghouse Electric and Manufacturing Company in Newark, New Jersey. The design of this type frequency meter permits the production of instruments having a scale range of plus or minus 2 cycles for 60 cycle work, with operating torques at least equal to those used in corresponding voltmeters, and with a remarkable freedom from temperature or voltage error effects.

The earlier forms of frequency meters operating on the ratio principle used a divided electrical circuit, one branch being wound as non-inductively as possible, while the other side was made purposely as inductive as possible. As the frequency varied, the ratio between the currents in the divided circuit varied, and this allowed the instrument to be calibrated in terms of frequency.

The scale range of from 25% below to 25% above normal frequency was about the limit for such instruments making most of the scale range practically useless on modern systems, the frequency of which is maintained within close limits.

RADIO WORLD

The First and Only National Radio Weekly
Eighth 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, business manager and managing editor; J. E. Anderson, technical editor.

Strange Bedfellows

BROADCASTING is like politics in the strange bedfellows that it makes. WMCA and WNYC, both of New York City, have been at loggerheads ever since the November 11th, 1928, reallocation, because they were assigned to the same channel, 570 kc (526 meters). This time-sharing never did work out to the satisfaction of either. Perhaps it is not too much to say that no time sharing ever works out to the satisfaction of any "victim" of the system, since the station that has to pass judgment on itself has to admit it is entitled to full time and a cleared channel.

The squabble got to be so bad that at times both WNYC and WMCA were on the air simultaneously, so that receivers tuned to their common wave heard uncommon commingling of programs. WNYC, operated by the City of New York, if broadcasting some event of "historical importance," like Grover Whalen receiving some distinguished guest, would feel impelled to continue with the good work beyond the allotted time. Then an explanation would come forth that the event overlapped only a short time on the other station's share, and was of such importance, etc. However, that arrogant weakness did not convince the Federal Radio Commission, and both stations were warned to behave or there would be something doing.

Then the Commission lifted WGBS, also of New York City, to a new position in the metropolitan galaxy, on 600 kc. (500 meters), a channel not used by any other station in that part of the country, and after both WMCA and WNYC and a disagreeable host of others, had been informed an infinite number of times that there were no more channels available in the First Zone that New York City stations could possibly obtain, due to over-congestion already existing, and that 50 kc. separation between stations was im- other station in the New York district, between WGBS and WMCA-WNYC.

Here was an opportunity for both WNYC and WMCA to take the same side: Federal Radio Commission, Gentlemen: Please kick WGBS off that plum position.

Protests of this sort were promptly filed with the Commission.

It is nice to have two quarreling stations agree on something.

Programs by Conference

BY popular vote alone the stations can not well select their programs. Some have tried it, hoping that some form of presentation would be devoid of harsh reaction, but numerically large numbers of persons, albeit a small percentage, will find excruciating fault. Complainants seem to be chronic listeners.

There are too many of us, as political voters or as consumers of cabbage, shoelaces or programs, to make Athenian democracy possible. Stations choose conference boards of one form or another, the larger chains having the benefit of leaders of specialized branches of thought—science, art and philosophy. While these conferees are susceptible to the effects of expressed public opinion, nevertheless they reach their conclusions without too much regard for the fault-finders.

It is noteworthy what a large and growing consideration is being given to education as the result of program apportionment as laid out by such expert conferees. Informatory and educational features for adults, as well as courses for children, are included.

While radio is today primarily entertainment by voice and instrument, and may be predominatingly such forever, it should offend no adult that he is given an opportunity of peeking into abodes of thought far removed from those that surround him in his daily tasks of bread-winning, and that the horizon of his brain should be broadened.

Programs by conference have diversified and extended the scope of the world's most lavish means of communication.

The Short-Wave Furor

TWO authors, in last week's issue, debated the proposition, "Resolved, That Distance Reception is Worth While." Without intending to judge the result of the debate, it is obvious that hearing far-off stations, particularly those in remote foreign countries, holds a strong fascination. Behold the furor now raging in the short-wave field, which offers distance as its attraction.

One of the largest parts manufacturers reports that most of his business is in parts for short-wave reception. It is obvious, from such results, that not only has the short-wave fever seized the radio experimenter, but that many not technically versed in radio, who have never built a set, are trying their hand at this deft pastime, concentrating on the completion of a worth-while short-wave receiver.

Others, finding no short-wave receivers made by the large set manufacturers, or within easy purchasing reach, are buying short-wave receivers assembled by workmen in radio stores. Thus the rage for short-wave reception is edging in on the layman. There is a wide field of opportunity here, both for manufacturers and for the public, with no problems of over-production yet in sight.

Short waves now can be tuned in on AC sets as well as on battery-operated sets, with equal clarity. Some adapters are worth while, too.

Some listeners are so accustomed to receiving great distances with their short-wave devices that they regularly tune for some foreign station, say 5SW, Chelmsford, England, and while listening to it begin to criticize the modulation, or apply some other comparison with regular broadcast reception, which is one of the best signs.

High Voltage Required

Loftin-White circuits now command the attention of most radio experimenters in broadcast reception. Many of the "boys" will be tempted to "get by" with the apparatus they have.

For example, they may have a B supply delivering 400 volts and they may assemble a Loftin-White amplifier demanding 750 volts. Those who yield to the temptation will later complain that the volume is weak and that the distortion is strong. The trouble is that the temptation to disregard advice was too strong.

LITERATURE WANTED

C. Bowden, 2334 N. Marshall St., Phila., Pa.
C. R. Morgan, 401 1st St., Brooklyn, N. Y.
A. J. Plezia, 7840 McGraw, Detroit, Mich.

M. R. Pekarsky, 410 Marion Pl., Grand Rapids, Mich.
H. L. Anderson, 19th St. & Floral Ave., Fort Dodge, Iowa.
C. C. Faupel, 110 E. Constitution St., Victoria, Tex.

Forum

The Spirit of Progress

R. Henkin, in Forum of the February Henkin, in forum of the February 1st issue, in which he would have you to "cut out the educational part of your magazine," I wonder what we would do for a technical radio education if all the radio magazine editors were of that same opinion?

We should not be content with merely assembling a new circuit and finding that it works; but we must know why it works.

I wonder who would criticize an editor for discussing the N. R. circuit of Messrs. Loftin and White? To the student who will study with thought this is one of the most interesting subjects being discussed, just as was the Band Pass filter system of tuning, a few months ago.

If it happens that a student, studying these articles, is handicapped by lack of knowledge of mathematics, this will inspire him to get the required mathematical knowledge so he can proceed to study such articles in an intelligent manner providing that he is a true student and thirsty for knowledge.

I quote from experience.

I came out of school in the 5th year, and just five years ago I couldn't add common fractions. At which time I started trying to understand a few articles on the technical fundamentals of radio. It was right there I saw my deficiency. This caused me to start studying and to-day I have a good knowledge of algebra, geometry and trigonometry. Of course this cost me many sleepless hours, and staying in at night, but the reward was worth it, as I have been able to master a mechanical, electrical and radio engineering course, as well as being able to understand technical discussions by such authorities as Rider, Silver, Anderson, Bernard, Oram, Morecroft and others. So, in all, I believe I am voicing the opinion of the majority of your readers when I say if you withhold your technical knowledge from us, where are we going to get our food for thought and what could be a better way to impart that knowledge to us, than through the medium of such a periodical as RADIO WORLD, backed by its staff of engineers who know their stuff, have the necessary education, and years of experience?

So go to it, fellows. I am subscribing for your magazine, for the purpose of learning the technique of radio engineering, and if we read, or shall I say study, enough of such articles, we will, in time, be classed as radio engineers. We must continue to learn as long as we live. We cannot stop. We cannot stand still. We either go up by learning, or go backward by trying to come to a standstill.

T. C. Raynes,
Braman, Okla.

Let Each Be Iself!

AS I am constantly reading RADIO WORLD, I naturally think it the best radio magazine I ever got hold of. As it is full of interesting reading, with diagrams and hook-ups of all kinds, so I think it O. K. So do not let anybody magazine, and a newspaper be a newspaper, as I see some are advising you to do. They are not interested in radio building, anyway. No, I should say not, by so doing RADIO WORLD will hurt itself. Let a radio magazine be a radio magazine, and a newspaper, be a newspaper.

S. S. Jacobs.
Glenburn, N. Dakota.

NEW SELENIUM CELL IS CALLED EPOCH-MAKING

Request for an experimental license for two channels in the continental band have been asked of the Radio Commission by United Research Corporation, of Long Island, N. Y., a subsidiary of Brunswick-Balke-Collender Co., for testing out a new photo-electric cell, said to be a revolutionary development in light sensitive cells.

Device Explained

The new device, it was explained to the Commission, is the Hart selenium cell, invented by Russell Hart, of Los Angeles. Selenium cells had been tried by others for television purposes, but their characteristics were such as to be unsuitable, and for that reason engineers generally had discarded these cells. The new Hart cell, however, is said to overcome the disadvantages of the old selenium cell.

The new cell was explained to the Commission by Dr. Ellsworth DeWitt, chief engineer of the United Research Corporation, and Dr. Arthur W. Carpenter, engineer in charge of television and photo-electric experiments. They appeared, with Bethuel M. Webster, Jr., and Paul M. Segal, counsel, on behalf of the application for authority to erect a television transmitting station in furtherance of the experiments with the new cell. They asked for channels between 2,100 and 2,300 and between 2,750 and 2,950 kilocycles.

Superior Cell

"The cell is infinitely superior to anything in cells heretofore made," declared Dr. Carpenter. "Up to the present we have used it in the development of talking pictures, but it has a direct bearing on television, and we want to continue the development along that line."

Now Sponsorship Even Invades Radiovision!

The first sponsored talking radiovision program was recently transmitted by the Jenkins Television Corporation, Jersey City, N. J. The program was sponsored by the DeForest Radio Company of Passaic, N. J., and consisted of a speech by Dr. DeForest, together with his animated image.

The technical means employed for the transmission was highly ingenious. The subject had been recorded on film and disc records. The picture values, taken from the film by means of a special pick-up machine in the Jenkins' television studios in Jersey City and transmitted on the 139 meter wave of the Jenkins' television station, W2XCR. The sound values, taken from a disc record, were sent by wire to the DeForest radiophone transmitter, W2XCD at Passaic, and broadcast on 187 meters.

Auto Set Distributed

The entire sales and service of the new Delco Automotive Radio, manufactured by General Motors, is to be handled by the national organization of United Motors Service.

There are control branches in 27 cities of the United States and Canada and approximately 3,000 authorized service stations covering the entire country.

Girl of Five Thrills Amid Big-Timers

Rose Marie, five-year-old radio artist, has been added to the group of entertainers under contract to the Artists' Service of the National Broadcasting Company. Her first appearance on the network was on February 13th in the R-K-O Hour, and she made a most pronounced hit.

The little girl got a hand from the studio audience second to none on the program, and must have made a remarkable impression on the radio audience with her "blues" type of singing, as expressive and adroit as the most finished adult's.

"If Rose Marie can do all this at five," said the announcer, "we hesitate to prophesy what she will do when she's all of seven years old."

RADIO TALKIES SHOW FEATURE

Radio talkies, or combined and synchronized sight and sound broadcasting, were demonstrated to the public at the Hudson County Radio Dealers' Exposition in Jersey City, N. J. Complete radio presentations, with living pictures of radio performers accompanied by their voices, similar to the usual talking pictures, were given under typical home conditions.

The radio talkies are broadcast simultaneously through two transmitters. The programs originate in the Jenkins Television Corporation studio at Jersey City, in the form of special motion picture films with synchronized disk recordings. The picture signals are sent to the television transmitter, W2XCR, on the roof of the Jenkins plant, and broadcast on 139 meters, while the sound signals are sent by direct wire to the DeForest experimental radio-phone transmitter, W2XCD, at Passaic, N. J., and broadcast on 187 meters.

The usual broadcast receiver can tune in the radio-phone signals at the lower end of the tuning dial. The television signals are intercepted by means of a short-wave receiver and radiovisor. The loudspeaker rendition and the radiovisor pictures are matched for the illusion of a living reproduction.

Patent Suit Stops Universal Licenses

Washington.

Universal Wireless Communications Co., Inc., has filed with the Federal Radio Commission applications for renewals of five licenses for experimental operation within the United States with portable transmitters.

It was explained to the Commission that these stations are being used in testing locations for permanent radiotelegraph stations. The company, under its grant from the Commission, must connect for point-to-point radiotelegraph service, 110 cities by 1932. Fourteen of these stations are completed and ready for commercial operation, it was stated, but the Commission has not yet issued licenses for them because of a recent order of the Court of Appeals, which the Commission believes prevents it from taking that action. This order was for a temporary injunction on a patent suit by RCA.

AIR BLACKLISTS MANY PHRASES TO AVOID SLIPS

There are words and phrases it's best not to use on the air, according to announcers and production men of the National Broadcasting Co.

They are not naughty words, either. The ban is not a question of morals but of diction.

Known as "bad air words," it is part of the radio director's job to find substitutes, if possible, for them when he prepares a script for broadcasting. And in such commonplace "scripts" as the daily stock market reports come some of the trickiest and hardest words to enunciate before a microphone.

Slip of Tongue

For example the combination of sounds resulting in "general railway signal" causes many announcers to hesitate. Someone has to read it every day during the stock reports but every so often it reaches the listener as "genwal wailway signal." The reason for the difficulty in keeping it as written is that the tongue must perform certain acrobatic movements in order clearly to enunciate every syllable. Tongues will slip.

Words with what are known as "explosive" consonants are hard air words. For example, "indubitably," not easy to handle under any given condition, makes the sensitive galvanometer needle jump all over the dial, indicating that it has certain qualities found not best for broadcasting. "Apathetic" is another and "peep," simple and inoffensive as it may seem in print, often causes trouble. Any combination of letters that cause "pops"—say "pop" aloud to get the meaning of this—are difficult to handle.

Hissing Sounds Are Hard

Sibilants, too, at times are not pleasing, though a person who has good diction does not find them very troublesome. Any actor with the slightest trace of a lisp or a hiss in his voice just goes all to pieces over such a phrase as "sixty-sixth in a series of serious sessions." The word "Oscillation" all by itself has been known to stump some would-be radio actors.

NBC continuity writers know many of these words and manage to keep most of them out of the scripts that reach the actors. When it is impossible to find substitute words, the director watches for them and takes time out to give the actor with the handicap lines plenty of time to master them.

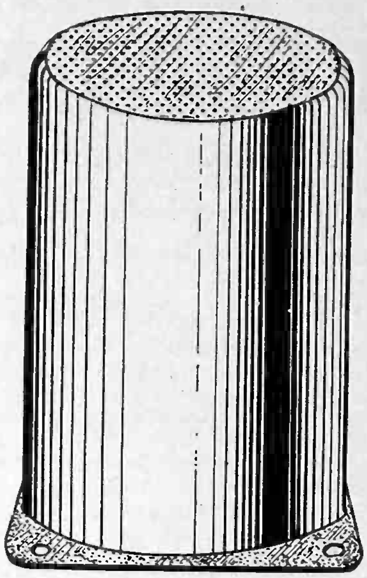
Zenith Turns January Loss Into 1930 Profit

The Zenith Radio Corporation, through Paul B. Klugh, vice-president and general manager, reports that net profits for the three months ending January 31st, 1930, after reserves, royalties and charge-offs, but before Federal taxes, was $58,662. For the nine months ending on the same date the net profit was $130,256, he says.

Mr. Klugh reports that the unsettling conditions which affected the earnings of the corporation prior to January have been successfully met and that the month of January was the largest January in the company's history. Net profits for January were $57,502 as compared with a loss of $27,273 for the same month a year ago.

The Latest in Tuning Equipment

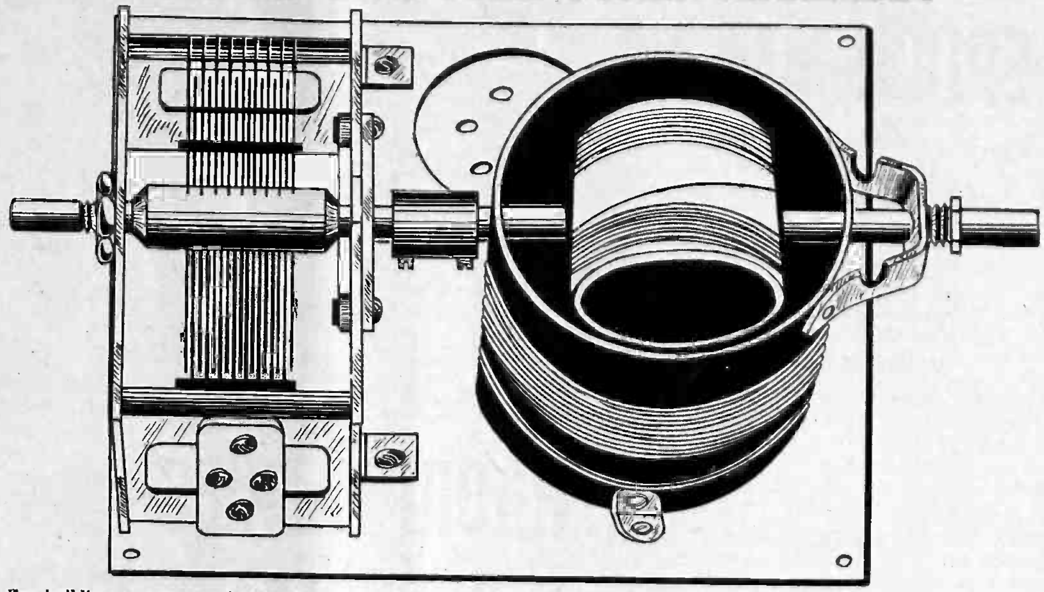
SHIELDED COIL



RF transformer in aluminum shield 2¾" square at bottom, 3¾" high. If metal subpanel is used no extra base is needed.
Coils have brackets on. You must assemble in shield yourself and solder winding terminals to built-in lugs. For all circuits and stages, including screen grid tubes.

Cat. No. SH3 for .00035 mfd. $0.95
Cat. No. SH5 for .0005 mfd. $1.00
Cat. SHB (extra base) $0.10

BERNARD TWO-TUBE TUNER ASSEMBLY



For building a tuner consisting of a stage of screen grid radio frequency amplification and a detector, AC or battery-operated, use the Bernard two-tube tuner assembly. Suitable for single control with one drum dial or separately tuned stages with two flat-type dials. The assembly consists of antenna stage (BTL-AC or BTL-DC), having Bernard Tuner BT3A, a .00035 mfd. condenser, socket, link and aluminum base. The detector input stage (BTR-AC or BTR-DC) consists of the same parts, but the coil has a tuned primary with untuned input to detector. Assemblies are unwired but are erected.

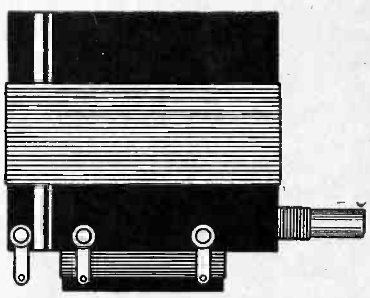
The condenser has shaft protruding at rear, so if two dials are used coil is put at front panel in either instance and condenser at front panel for the other.

For AC operation, 224 RF and 224, 227 or 228 detector, order Cat. No. BTL-AC and BTR-AC at $6.00 for both.

For battery operation of filaments, 222 RF and 222, 240, 201A or 112A detector, order Cat. No. BTL-DC and BTR-DC at $6.00 for both.

[Note: for drum dial single control an 80 mmfd. equalizing condenser is necessary. This is extra at $0.35. Order Cat. EQ-80.]

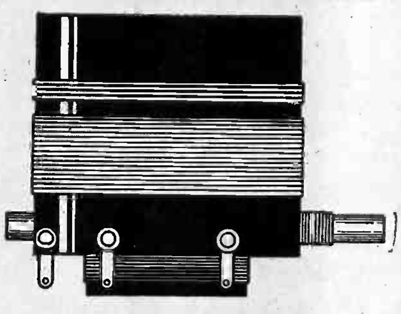
ANTENNA COUPLER



Cat. No. VA5—$0.85
FOR .0005 MFD. CONDENSER

Moving primary and fixed secondary, for antenna coupling. Serves as volume control.
Cat. No. VA3 for .00035 mfd. $0.90

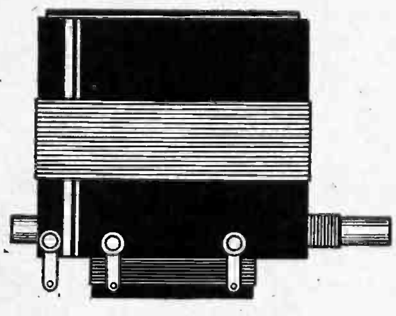
BERNARD TUNERS



Cat. No. BT5A—$1.35
FOR .0005 MFD. CONDENSERS

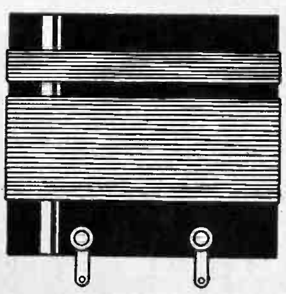
Bernard Tuner BT5A for .0005 mfd. for antenna coupling, the primary being fixed and the secondary tuned. This coil is used as input to the first screen grid radio frequency tube. Secondary has moving coil.
Cat. No. BT3A for .00035 mfd. ..$1.35

Bernard Tuner BT5B for .0005 mfd. for working out of a screen grid tube, tuned primary, untuned secondary. Primary has moving coil.
Cat. BT3B for .00035 mfd. ..$1.35



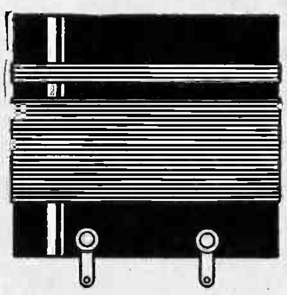
Cat. No. BT5B—$1.35
FOR .0005 MFD. CONDENSER

SG TRANSFORMER



Cat. No. SGS5—$0.60
FOR .0005 MFD. CONDENSER

Interstage radio frequency transformer, to work out of a screen grid tube, primary untuned.
Cat. No. SGS3 for .00035 mfd. $0.65



Cat. No. RF5—$0.60
FOR .0005 MFD. CONDENSER

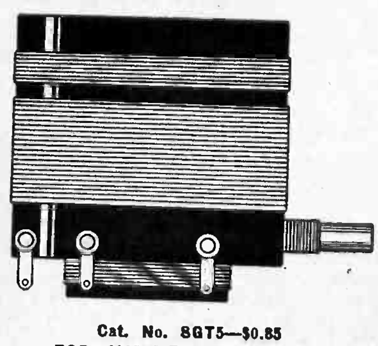
DIAMOND PAIR

Cat. No. RF5—$0.60
FOR .0005 MFD. CONDENSER

Antenna coil for any standard circuit, and one of the two coils constituting the Diamond Pair.
Cat. No. RF3 for .00035 .$0.65

Cat. No. SGT5—$0.85
FOR .0005 MFD. CONDENSER

Interstage 3-circuit coil for any hookup where an untuned primary is in the plate circuit of a screen grid tube.
SGT3 for .00035 mfd...$0.90

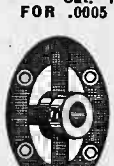


Cat. No. SGT5—$0.85
FOR .0005 MFD. CONDENSER

Order the Diamond Pair, Cat. DP5 for .0005 mfd. at $1.45

Order the Diamond Pair, Cat. DP3 for .00035 mfd. at $1.55

[Note: These same coils are for AC or battery circuit.]



FL4 $0.30
Flexible insulated coupler for uniting coil or condenser shafts.
Order Cat. FL4 at $0.30
Equalizing condenser, 80 mmfd., for connection across any tuning condenser where ganging is resorted to, or for equalizing independently tuned circuits to make dials track.
Order Cat. EQ80 at $0.35

Screen Grid Coil Company,
143 West 45th Street,
New York, N. Y. (Just East of Broadway.)

Please ship at once C. O. D.:

☐ Cat. No. .... at $ ....
☐ Cat. No. .... at $ ....
☐ Cat. No. .... at $ ....

Name ....

Address ....

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

The standard three-circuit tuner is used with primary in the plate circuit of any RF tube, AC or battery type, excepting only screen grid tube.

For .0005 mfd. order T5 at $0.85

For .00035 order Cat. T3 at $0.90

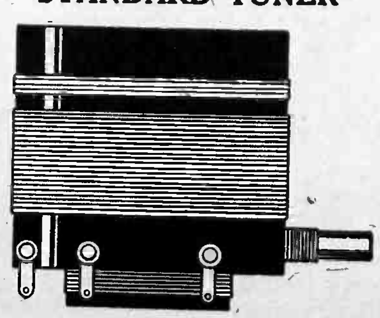
All coils have 2½" diameter, except the shielded coil, which is wound on 1¾".

The coils are wound by machine on a bakelite form, and the tuned windings have identical inductance for a given capacity condenser, i. e., .0005 mfd. or .00035 mfd. Full coverage of the wave band is assured.

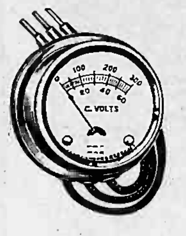
All coils with a moving coil have single hole panel mounting fixture. All others have base mounting provision. The coils should be used with connection lugs at bottom, to shorten leads.

Only the Bernard Tuners have a shaft extending from rear. This feature is necesary so that physical coupling to tuning condenser shaft may be accomplished by the insulated link.

STANDARD TUNER



0-60,0-300
HIGH RESISTANCE
DC VOLTMETER
With three 28" tipped leads built in



J-246 Voltmeter, for measuring all direct current voltages, including B eliminators. 0-60, 0-300 (double range).

A portable type, high resistance meter. 2½" outside diameter, for close reading of direct current voltages up to 60 volts, and for reading DC voltages up to 300 volts. Three vari-colored 28" insulated leads, with jack tips, are built in. Black is minus, yellow is 60 volts maximum and red is 300 volts maximum. These voltages are marked at the meter outlets. Cat. J-246. Net price, $2.28.

Multiplier, with jack terminals, to increase range 0-300 range to 0-600. Cat. J-106JT (with jack terminals), net price, $1.18.

Order One C. O. D.

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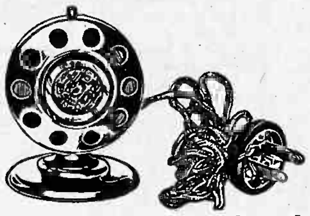
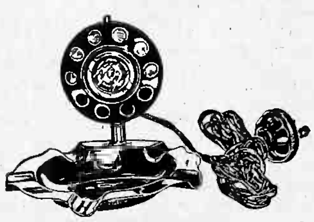
143 West 45th St., N. Y. City

MICROPHONE LIGHTERS

for cigars or cigarettes, with button switch at top. Press the switch and light up!



Model A lighter, microphone design, with 5-ft. AC cable and plug. Works on 110 volts, AC any frequency and on direct current. ....Price $1.00



Model B lighter, microphone design, on tray, with 5-ft AC cable and plug. Works on 110 volt AC, any frequency, and on direct current. Exactly the same lighter as the other, only tray is added. Price..............$1.50

This lighter is instantaneous. Hold button down only long enough to light a cigar or cigarette. The two models are furnished in attractive sprayed finish. Both are very compact! For instance, the tray is only 4½" in diameter. Use these lighters in your home and for holiday gifts.

he heater element is renewable. Price 35 cents.

RADIO WORLD, 145 West 45th St., N. Y. City
☐ Please send me Model A Microphone Lighter at $1.00.
☐ Please send me Model B at $1.50.
Please ship C. O. D.

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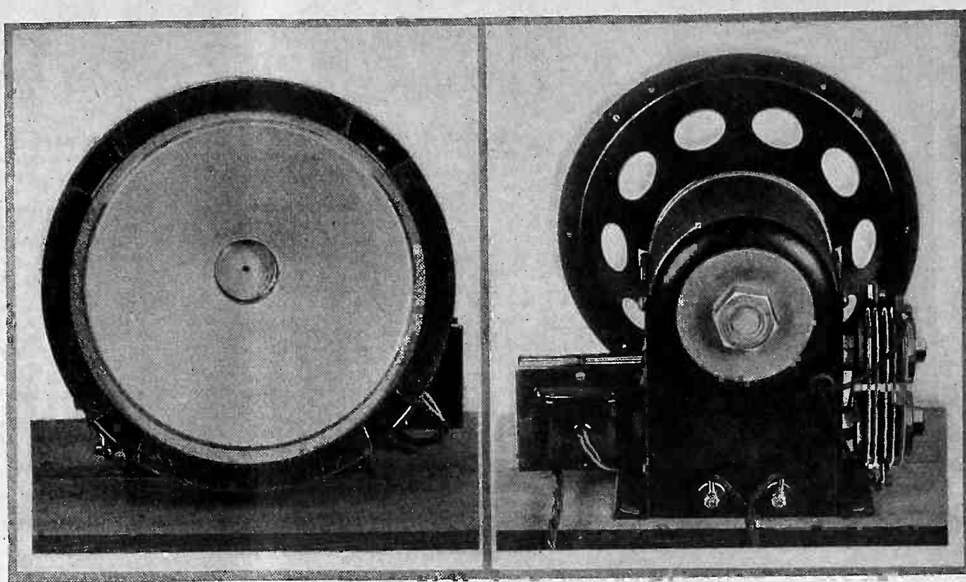
City.............................. State..................

RADIO WORLD'S BOOK SERVICE has been found of great value not only by radio fans, constructors, etc., but also by radio and other technical schools throughout the country. See the radio books advertisements in this issue.

Nothing Finer Than This Dynamic in Tone Quality!



Try This AC Dynamic Erla—No Matter on What Set and You Will Verify These Facts: Tone Unexcelled, sensitivity most remarkable

TO WORK this speaker, put plug into AC wall socket, lamp socket or convenience outlet of set, connect speaker tips to output posts of set, and tune in.

Here are the technical data on the AC dynamic Erla:
10 feet long power leads with plug
10 feet long speaker leads with one-inch terminal tips
Outside diameter of cone, 9 inches
Depth of speaker, 8 inches
Overall width of speaker, 9.5 inches
Mounting board, detachable, 10¾x12¾x⅞ inches
Burtex cone
Diameter of central magnet pole, 1.5 inches
Flexible spring mounting of tip of cone, and moving coil
Moving coil accurately center-mounted
Depth of magnet structure, 4.5 inches
Outside diameter of magnet structure, 4.5 inches
Built-in full wave, dry rectifier
Husky output transformer built in; heavy core, shielded
Superior workmanship
Thick felt buffers on front of cone edges
Built-in power transformer for rectifier
Will stand output of 250 tubes in push-pull and work superbly in any tubes, single or push-pull
Tone quality is unsurpassed

$12.50

Our Guaranty!

We have had considerable experience with AC dynamic chasses, and it is our firm conviction this is the best one we have offered so far.

So convinced are we that you will be overjoyed from the reproduction afforded by this Erla chassis that we ask you to buy it at no risk to yourself whatsoever. Order one shipped C.O.D. Try it for five days. If for any reason you desire to return it in that time, do so and we will refund your purchase price and expressage you laid out. This widest guaranty applies only to the Erla chassis.

Acoustical Engineering Associates
143 West 45th Street New York, N. Y.
Please ship at once, express C.O.D., one Erla dynamic chassis, 110 volt AC, 50-60 cycles, as advertised, at $12.50, on a five-day guaranty or money-back if not completely satisfied, including cartage money, which applies to the Erla offer only.
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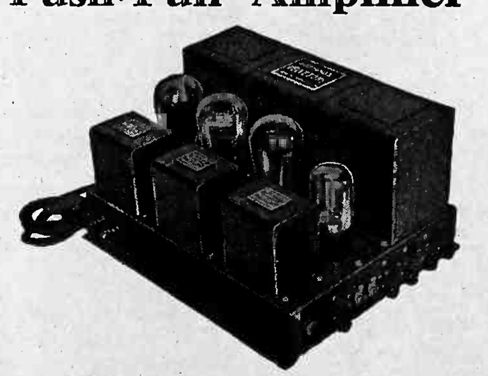
MB-29

AC TUNER — WRITE FOR WHOLESALE PRICES!

Push-Pull Amplifier

The National Velvetone Push-Pull Power Amplifier (shown at right) consists of an AC-operated filament-plate supply, with two stage transformer audio amplifier and output transformer built in. Made only for 110-V., 50-60 cycles. Sold only in completely wired form, licensed under RCA patents.

The new Power Amplifier has been developed and built to get the very most out of the MB-29. It is a combination power supply and audio amplifier, using a 280 tube for a rectifier, one stage of transformer audio with a 227 tube and a stage of push pull amplification with two 245s. It furnishes all power for itself and for the MB-29, as well as the audio channel. Order catalog PPPA, list price, completely wired and equipped with phonograph jack, (less tubes) $97.50. Your price. **WRITE FOR WHOLESALE PRICES**



View of National Velvetone Push-Pull Power Amplifier, an expertly made A, B and C supply and audio amplifier, producing marvelous tone quality.

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Attention... Radio Service Men

Radio-Craft *for the* Professional-Serviceman-Radiotrician

is compiling an international list of names of qualified service men throughout the United States and Canada, as well as in foreign countries.

This list, which RADIO-CRAFT is trying to make the most complete one in the world, will be a connecting link between the radio manufacturer and the radio service man.

RADIO-CRAFT is continuously being solicited by radio manufacturers for the names of competent service men; and it is for this purpose only that this list is being compiled. There is no charge for this service to either radio service men or radio manufacturers.

We are asking every reader of this magazine who is a professional service man to fill out the blank printed below or (if he prefers not to cut the page of this magazine) to put the same information on his letterhead or that of his firm, and send it in to RADIO-CRAFT. The data thus obtained will be arranged in systematic form and will constitute an official list of radio service men, throughout the United States and foreign countries, available to radio manufacturers. This list makes possible increased cooperation for the benefit of the industry and all concerned in the betterment of the radio trade.

NATIONAL LIST OF SERVICE MEN,
c/o RADIO-CRAFT, 98 Park Place, New York, N. Y.

Please enter the undersigned in the files of your National List of Radio Service Men. My qualifications are as set forth below:

Name (please print) ....

Address .... (City) .... (State) ....

Firm Name and Address .... *(If in business for self, please so state)*

Age .... Years' Experience in Radio Construction? ....

Years in Professional Servicing? ....

Have You Agency for Commercial Sets? .... (What Makes?) ....

....

What Tubes Do You Recommend? ....

Custom Builder .... (What Specialties?) ....

Study Courses Taken in Radio Work from Following Institutions

....

Specialized in Servicing Following Makes ....

....

What Testing Equipment Do You Own? ....

What Other Trades or Professions? ....

Educational and Other Qualifications? ....

Comments .... (Signed) ....

(RW. 31)

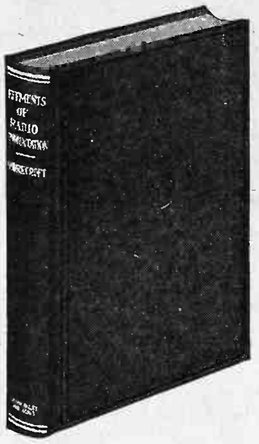
RADIO WORLD BOOK SERVICE

AS the first and only national radio weekly, now in its eighth year, RADIO WORLD publishes the most timely, up-to-date news of radio circuits and events in the set-building and broadcasting fields. Technical accuracy second to none. Get a copy at your news-stand today, 15c. RADIO WORLD advises impartially on all radio topics, including what text books to buy, and helps you to read the books properly. Every book advertised on this page is essential to your radio library.

Five New Volumes Offer Short-Cut to Knowledge!

MORECROFT

"Elements of Radio Communication"



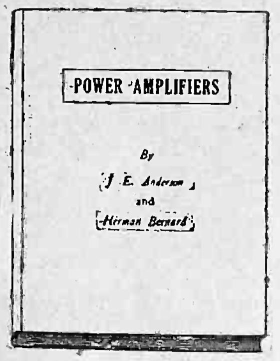
The latest book by Prof. John H. Morecroft, of the Engineering Department of Columbia University, and past president of the Institute of Radio Engineers, is his "Elements of Radio Communication," a book for the novice to enjoy. We regard this as the best elementary book to inform you authoritatively on the technical phases of radio in plain language, without requirement of mathematical knowledge. The book is a complete course on the elements of radio, containing much material never before published. It has 226 pages, 170 illustrations and a complete index. Just out, it is the book of the year in radio. Cloth bound. Order Cat. ME @ $3.00

By the same author: "Principles of Radio Communication," second (new) edition. This book is for advanced students. It is the standard of excellence in its field. It covers much the same ground as the later book, only much more fully and more technically. Contains 1,001 pages, 831 illustrations. Cloth bound. Order Cat. MP @................ $7.50

ANDERSON and BERNARD

"Power Amplifiers"

Here is the *first* book to be published on the subject of "Power Amplifiers." Now printing, it is certain to fill a void in radio literature. The whole subject is fully covered in a masterful theoretical discussion of audio amplifiers and power supplies, supplemented by constructional chapters, with complete wiring diagrams and specification of parts. Learn while you build! J. E. Anderson, M. A., technical editor of RADIO WORLD, and Herman Bernard, LL. B., managing editor of RADIO WORLD, both of the Institute of Radio Engineers, have explained fully the phenomena of power amplifiers. Learn all about motorboating and its cures, push-pull theory and practice, grid bias methods and effects, vacuum tubes in audio circuits, AC and battery type AF amplifiers, phase relationships, common impedance, filter systems, by-pass condenser effects, necessities for tone quality, values of coupling constants, and a host of other topics associated with power amplification, including speech amplifiers and "talkie" installations.



More than 200 pages and more than 100 illustrations are devoted to an analysis of this outstanding radio subject. "Power Amplifiers" is authoritative, original and comprehensive. It is free from the traditional errors that have crept into this subject. The theoretical part of the book can be understood by most novices, while the constructional part, that capitalizes the previously imparted knowledge, is thoroughly understandable by anybody. There is virtually no mathematics in the book. Cloth bound. Order Cat. PAM @..$3.50

MOYER and WOSTREL

"Radio Receiving Tubes"

The need for an elementary book on radio tubes that answers all the important questions has been filled by James A. Moyer, Director of University Extension, Massachusetts Department of Education, and John F. Wostrel, Instructor in Radio Engineering, Division of University Extension, Massachusetts Department of Education.

This new book is a complete discussion of tube principles, functions and uses, thoroughly up-to-date. In this book 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

By the same authors:

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

"Practical Radio Construction and Repairing," 319 pages, a companion volume. Order Cat. MWPRC @.............$2.00

[NOTE: *The standard book on tubes for advanced students is "The Thermionic Vacuum Tube," by Hendrik Van der Bijl. Order Cat. VDB @*.................................$5.00]

RIDER

"Service Man's Manual"

Two new books by John F. Rider, R. E., Member, Institute of Radio Engineers, constitute the series grouped by him under the heading "Service Man's Manual." Part I is "Mathematics of Radio." Part II is "Trouble Shooter's Manual."

The value of one of these books is more than doubled by the possession of the other.

"The Mathematics of Radio," 128 pages, 8½x11", 119 illustrations, bridges the gap between the novice and the college professor. It gives a theoretical background so necessary for a proper understanding of radio and audio circuits and their servicing. Flexible cover. Order Cat. MOR @....$2.00

The first comprehensive volume devoted exclusively to the topic uppermost in every service man's mind is "Trouble Shooter's Manual," just published. It is not only a treatise for service men, telling them how to overcome their most serious problems, and fully diagramming the solutions, but it is a course in how to become a service man. It gives all the details of servicing as they have never been given before. Finding the right mode of attack, applying the remedy promptly and obtaining the actual factory-drawn diagrams of receivers always have been a big load on the service man's chest. But no more. Rider, expert on trouble shooting, has produced the outstanding volume on servicing, and has taken the load off the service man's chest!

This book is worth hundreds of dollars to any one who shoots trouble in receivers—whether they be factory-made, custom-built or home-made receivers. The home experimenter, the radio engineer, the custom set-builder, the teacher, the student—all will find this new book immensely informative and absolutely authoritative.

MORE THAN 100 WIRING DIAGRAMS OF RECEIVERS MADE BY MORE THAN FORTY DIFFERENT SET MANUFACTURERS ARE PUBLISHED IN THIS BOOK, INCLUDING OLD MODELS AND LATEST MODELS! RCA, ATWATER KENT, CROSLEY, MAJESTIC, ZENITH, STROMBERG CARLSON, KOLSTER, FEDERAL, FADA, Etc. 240 pages, size 8½x11"; 200 illustrations. Imitation leather cover. Order Cat. TSM @..$3.50

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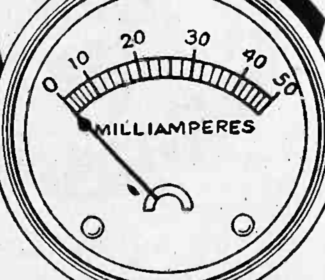

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RADIO WORLD, a weekly paper published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y. Vol. XVI, No. 24. Whole No. 414. March 1st, 1930. 15c per copy, $6.00 per year. [Entered as second-class matter, March, 1922, at the Post Office at New York, N. Y., under act of March, 1879.] Roland Burke Hennessy, president and treasurer; M. B. Hennessy, vice-president; Herman Bernard, business manager and managing editor; J. E. Anderson, technical editor.

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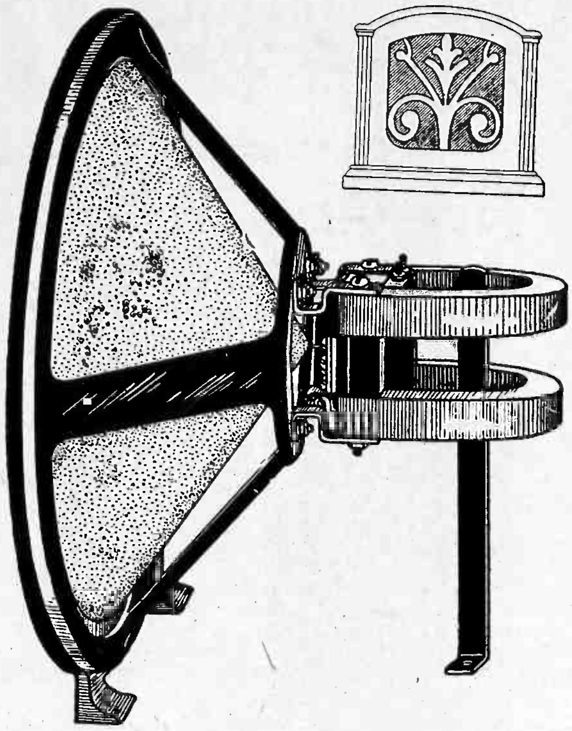
T-E-M-P-L-E F-A-R-R-A-N-D

Temple AC Dynamic Model 10, in a beautiful cabinet. The speaker chassis is one of the finest made. There are an output transformer and dry rectifier built in. The cabinet has decorated walnut front and back, with carved grille ornament. An AC switch is accessible underneath cabinet. Rear is removable for adjustment of resistor knob to match the impedance of your receiver's output tube. Connect plugged AC cable to 110 volts AC, 50 to 60 cycles, and connect tipped cords to speaker post of receiver. This remarkable speaker Cat. TEM-10 at only.. **$15.34**



Farrand Inductor Chassis, consisting of the unit, cone, spider, bracket, assembled, but not in a cabinet.

Model 6-G, 10" extreme diameter of cone front rim	**$8.00**
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Velvet B Eliminator $16.13

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Latest Model National Velvet-B, Type 8580 in handsome crackle finish black metal casing, for use with sets up to and including six tubes. Input 105-120 volts AC, 50 to 60 cycles. Output 180 volts maximum at 35 milliamperes. Three variable output intermediate voltages. (Det., RF AF) Eliminator has excellent filter system to eliminate hum, including 30 henry choke and 18 mfd Mershon condenser. No motorboating! (Eliminator Licensed under patents of the Radio Corporation of America and associated companies.)

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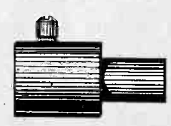

Here is a handy aid to salvaging condensers and coils that have 1/4" diameter shafts not long enough for your purpose. Fits on 1/4" shaft and provides 5/8" extension, still at 1/4". Price 10c net.

RADIO WORLD
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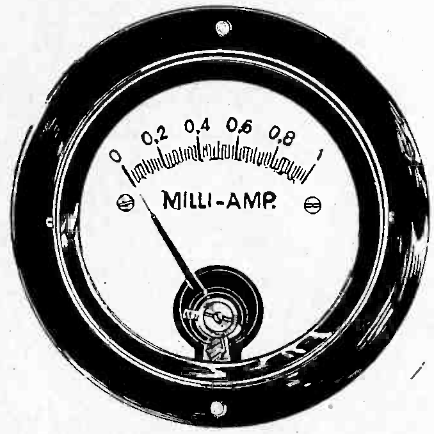

Here is a 0-1 milliammeter, accurate to plus or minus 1% clearly legible to two-one hundredths of a milliampere at any reading (20 microamperes). This expertly made precision instrument is offered at the lowest price so far for a 0-1 ma. Order Cat. FO-1 at $5.95. C. O. D.

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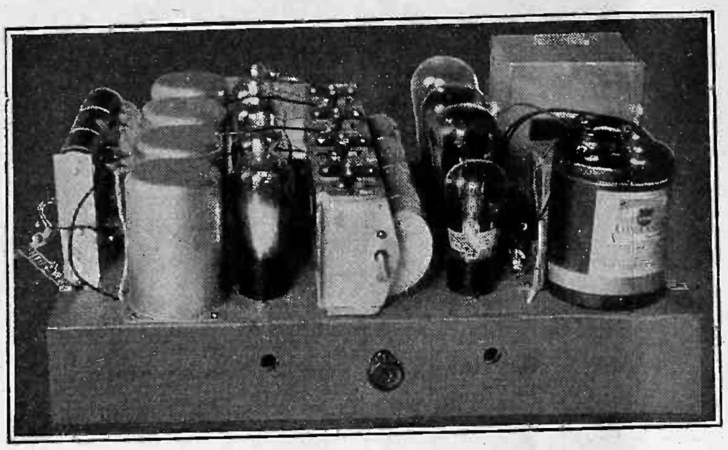
High Gain at Low Cost

HB44 - - - $45.35



The HB44, assembled, presents in compact form, on a 17½ x 11½" steel chassis, a completely AC operated shielded receiver, using four 224 screen grid tubes, one 227, two 245s in push-pull, and a 280 rectifier, eight tubes all told. Here is the circuit that will bring 'em in from all over the country—and at a price you can afford—$45.59. This price includes EVERYTHING except speaker, cabinet and tubes.

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☐ R3—One Lynch 5.0 meg. metallized grid leak, with mounting	.40
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☐ Ch—One double filter choke coil, 30 henrys each section, 100 ma.	3.71
☐ SW—One pendant AC switch with 12 ft. cable	.80
☐ PL—One 2.5 volt pilot lamp and bracket	.70
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☐ One subpanel 17½" x 11½", with five UY and three UX sockets	3.00
☐ One vernier dial	.50
☐ Four National grid clips	.24
☐ All parts (less cabinet, tubes and speaker)	$45.35
☐ Tubes: four 224, one 227, two 245, one 280	9.51

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☐ Please ship all parts for HB44 @ $45.59
☐ Eight tubes for HB44 .... 9.51
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☐ Enclosed find $........... remittance.
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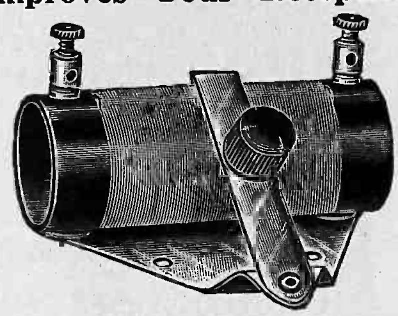

Remove aerial lead from set. Connect aerial instead to one of the binding posts of the Aerial Tuner. Connect the other binding post of the Aerial Tuner to antenna post of your set. Then move the lever of the Aerial Tuner until any weak station comes in loudest. The lever need not be moved for every different frequency tuned in. The Aerial Tuner acts as an antenna loading coil and puts the antenna's frequency at any frequency in the broadcast band that you desire to build up. Price, 85c.

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Use this speaker on any set, battery-operated or AC, and you'll be delighted.

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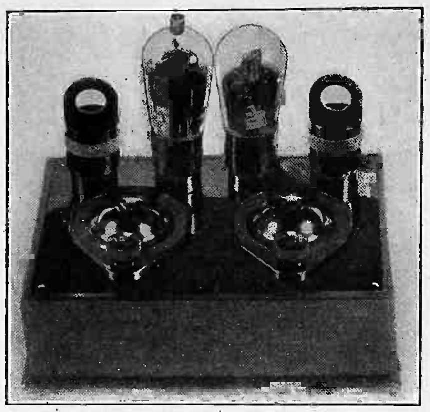

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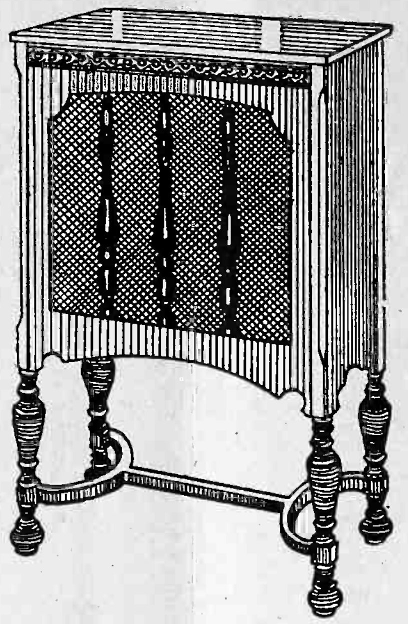

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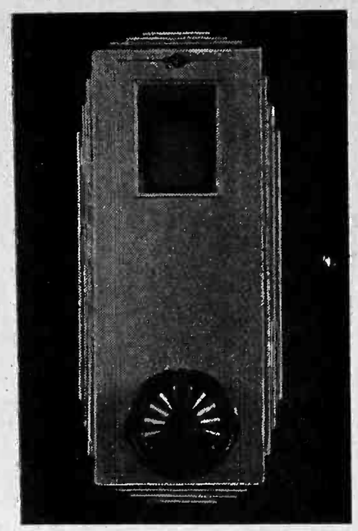

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