

NOV. 9TH
1929

A BIG KICK

15
CENTS

IN 5-TUBE PUSH-PULL SET!

RADIO

REG. U.S. PAT. OFF.

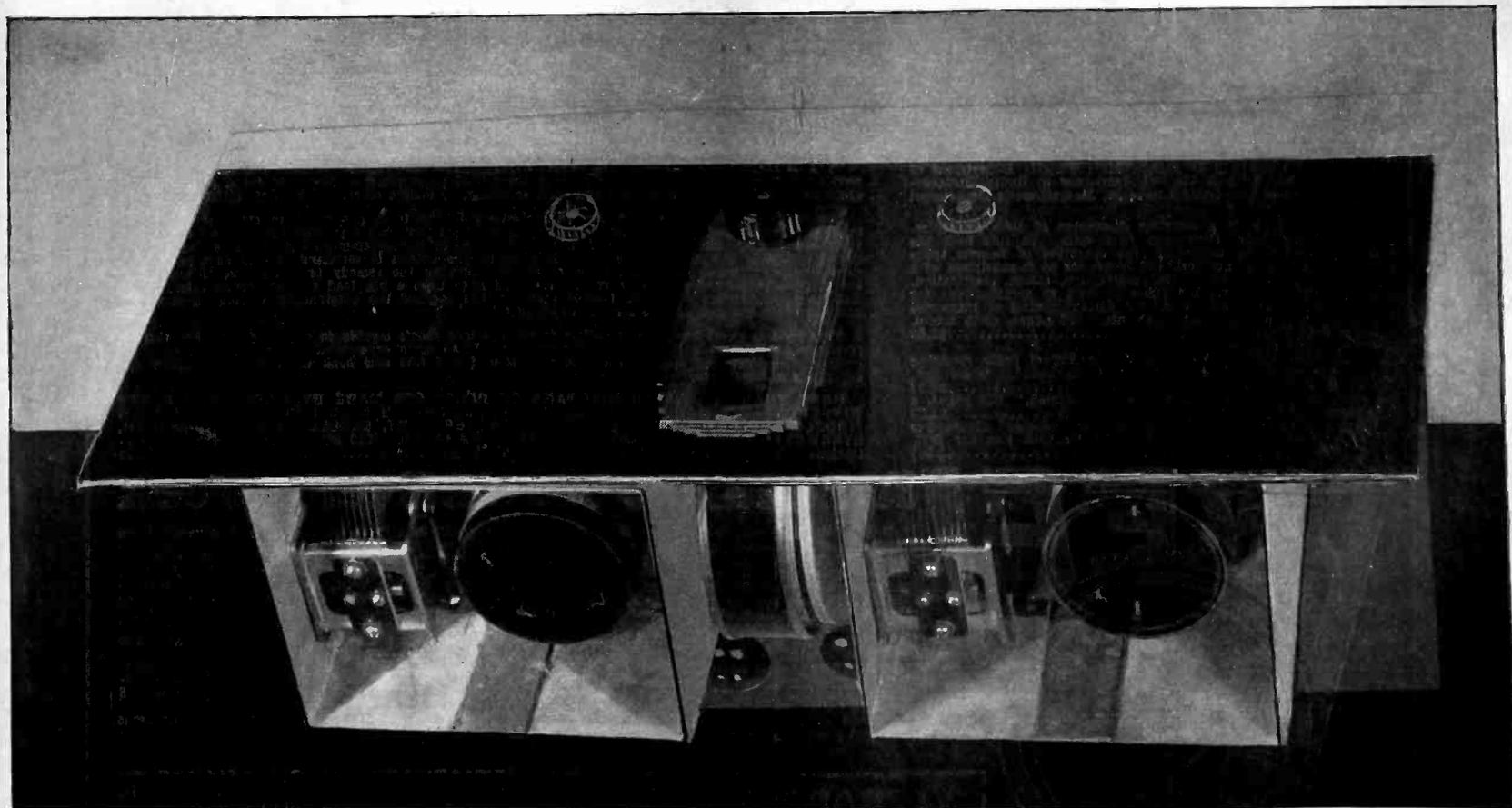
WORLD

The First and Only National Radio Weekly
398th Consecutive Issue—EIGHTH YEAR

Three SG RF
Battery Model Tuner

Amplification
After Detection

HB22, SCREEN GRID SHIELDED CIRCUIT!



A Battery-Operated Circuit That Lifts the Performance of a Five-Tube Design to New Heights,
With a Big Kick, and Push-Pull, is Shown Above. See Page 5

HOW TO CONSTRUCT INTERMEDIATE AMPLIFIERS

Rider Lifts a BIG Load Off the Service Man's Chest!

In New Book Noted Radio Engineer Devotes 240 Pages to Trouble Shooting in All Receivers and Gives the Wiring Diagrams of Factory-Made Sets in 200 Illustrations—You Can Carry This Book Around With You—No More Torture Tracing Out Circuits.

“Trouble Shooter’s Manual” *By John F. Rider* JUST OUT!

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 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.



JOHN F. RIDER
Member, Institute of Radio Engineers

Wiring Diagrams of All These Receivers!

Besides 22 chapters covering thoroughly the field of trouble shooting, this volume contains the wiring diagrams of models, as obtained direct from the factory, a wealth of hitherto confidential wiring information released for the first time in the interest of producing better results from receivers. You will find these diagrams alone well

- | | | |
|---|---|--|
| R. C. A.
60, 62, 20, 64, 80
105, 51, 16, 32, 50,
25 A.C., 28 A.C., 41,
Receptor S.P.U., 17,
18, 33.
FEDERAL
Type F series filament,
Type E series filament,
Type D series filament,
Model K, Model H. | ZENITH
39, 39A, 392, 392A,
40A, 35PX, 35APX,
352PX, 352APX, 37A,
35P, 35AP, 352P,
352AP, 34P, 342P, 33,
34, 35, 35A, 342, 352,
352A, 362, 31, 32, 333,
353A, power supply
ZEL7, power supply
ZEL2. | FADA
50/80A receivers, 460A
Fada 10, 11, 30, 31,
10Z, 11Z, 30Z, 31Z,
16, 17, 32, 16Z, 32Z,
18, special, 192A-192B
and 192B8 units,
R80A, 480A, and SF
50/80A receivers, 460A
receiver and R60 unit,
7 A.C. receiver, 475
UA or CA and SP45-
75 UA or CA, 50, 70,
71, 72, C electric unit
for special and 7 A.C.
receivers, ABC 6 volt
tube supply, 86V and
82W, E180Z power
plant and E 420 power
plant. |
| ATWATER-KENT
10B, 12, 20, 30, 35,
45, 32, 33, 49, 38, 36,
37, 40, 42, 52, 50, 44,
43, 41 power units for
87, 88, 44, 43, 41. | MAJESTIC
70, 70B, 180, power
pack 7BP3, 7P6, 7P3
(old wiring) 8P3,
8P6, 7BP6. | FREED-EISEMANN
NR5, FE18, NR70,
470, NR57, 457,
NR11, NR40 DC. |
| CROSLEY
XJ, Trirayn SRS, 601,
401, 401A, 608, 704,
B and C supply for
704, 704A, 704B, 705,
706. | FRESHMAN
Masterpieces, equaphase,
G, G-60-S power sup-
ply, L and LS, Q15,
K, K-60-S power
supply. | |

worth the price of the book. The wiring diagrams are of new and old models, of receivers and accessories, and as to some of the set manufacturers, all the models they ever produced are shown in wiring diagrams! Here is the list of receivers, etc., diagrams of which are published in this most important and valuable book:

- | | | |
|---|--|---|
| STEWART-WARNER
300, 305, 310, 315,
320, 325, 500, 520,
525, 700, 705, 710,
715, 720, 530, 535,
750, 801, 802, 806. | STROMBERG-CARLSON
1A, 2B, 501, 502, 523,
524, 635, 636, 403AA
power plant, 404 RA
power plant. | COLONIAL
26, 31 A.C., 31 D.C. |
| GREBE
MU1, MU2, synchro-
phase 5, synchrophase
A C 6
AC7, Deluxe 428. | ALL-AMERICAN
6 tube electric, 8 tube
80, 83, 84, 85, 86, 88,
6 tube 6C, 61, 62, 65,
66, 6 and 3 tube A.C.
power pack. | WORKRITE
4 tube chassis, 6 tube
chassis. |
| PHILCO
Philco-electric, 82, 86. | DAY FAN
OEM7, 4 tube, 5-5
tube 1925 model, Day
Fan 8 A.C., power
supply for 6 tube
A.C., B power supply
5524 and 5525, motor
generator and filter, 6
tube motor generator
tube set, 6 tube 110 volt
D.C. set, 6 tube 32
volt D.C. set. | AMRAD
70, 7100, 7191 power
unit. |
| KOLSTER
4-tube chassis used in
6 tube sets, tuning
chassis for 7 tube sets,
power amplifier, 7 tube
power pack and ampli-
fier, 8 tube power
pack and amplifier,
rectifier unit K23. | | SPARTON
A.C. 89. |
| | | MISCELLANEOUS
DeForest F5, D10,
D17, Super Zenith
Magnavox dial, Ther-
myodyne, Grimes 4DL
inverse duplex, Garod
neurodyne, Garod EA,
Ware 7 tube, Ware
type T, Federal 103
special, Federal 59,
Kennedy 220, Operadio
portable, Sleeper BX1,
Armad Industrol. |

Here are the 22 chapter headings:

- | | |
|-------------------------------------|---|
| SERVICE PROCEDURE | TROUBLE SHOOTING IN "B" BATTERY ELIMINATORS |
| PRACTICAL APPLICATION OF ANALYSIS | SPEAKERS AND TYPES |
| VACUUM TUBES | AUDIO AMPLIFIERS |
| OPERATING SYSTEMS | TROUBLE SHOOTING IN AUDIO AMPLIFIERS |
| AERIAL SYSTEMS | TROUBLES IN DETECTOR SYSTEMS |
| "A" BATTERY ELIMINATORS | RADIO FREQUENCY AMPLIFIERS |
| TROUBLES IN "A" ELIMINATORS | TROUBLE SHOOTING IN RF AMPLIFIERS |
| TROUBLE SHOOTING IN "A" ELIMINATORS | SERIES FILAMENT RECEIVERS |
| "B" BATTERY ELIMINATORS | TESTING, AND TESTING DEVICES |
| TROUBLES IN "B" BATTERY ELIMINATORS | TROUBLES IN DC SETS |
| | TROUBLES IN AC SETS |

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

Enclosed please find:

\$3.50 for which please send me postpaid "Trouble Shooter's Manual," by John F. Rider, being Part II of "Service Man's Manual," 240 pages, 8 1/2 x 11", more than 200 illustrations, including wiring diagrams of commercial receivers as advertised; imitation leather cover, gold lettering.

\$2.00 for which please send me postpaid "Mathematics of Radio," by John F. Rider, 128 pages, 8 1/2 x 11", 119 illustrations, flexible cover, this being Part I of "Service Man's Manual."

NAME

ADDRESS

CITY STATE

Some of the Questions Settled in Book:

Securing information from the receiver owner, list of questions, practical chart system of repairs, circuits and operating conditions. Repairs in the home, method of operation, spare tubes, the process of elimination, recognizing symptoms, examples of practical application, tracing distortion, tracing electrical disturbances; vacuum tube tests; neutralizing systems, filament circuits, grid circuits, methods of securing grid bias, plate circuits; long aerials, short aerials, selectivity, imperfect contact, directional qualities, grounds; "A" battery eliminator types, design, operating limitations, requirements for perfect operation, AC eliminators, DC eliminators; "A" eliminator hum, reasons, voltage, reasons, noise; full wave, half wave, B battery eliminators, filament rectifiers, gaseous rectifier, dry disc rectifier, wiring, parts used, design, voltage regulation, operating limitations, requirements for perfect operation, combination filament and plate voltage eliminators, AC and DC types; B battery eliminator output current and voltage, excessive hum, dead eliminator, poor design, reasons for defects, motorboating, punctured condensers, shorted chokes, voltage regulator tubes, function of filter system, C bias voltages, voltage divider systems, filter condensers, by-pass condensers, voltages in the system; determining voltages in B eliminators, AC, DC, voltage drop, effect of shorted filter system, defective rectifiers, defective transformer, defective chokes, defective by-pass condenser, design of filter system, defective voltage divider network, relation between hum and output voltage, isolation of troubles, external filters, noise filters; cone, dynamic, exponential speakers, troubles, dead, weak output, distorted output, rattle, continuity testing, windings, magnets, frequency filters, testing, chokes, condensers, hum elimination; audio amplifier types, transformer, resistance, impedance, auto-transformer, combinations, requirements for perfect operation, operating limitations, tubes, forms of coupling, plate voltage, grid voltage, filament voltage, isolating condensers, voltage reducing resistances, noises, analysis of trouble, plate current, grid current.

"The Mathematics of Radio"

John F. Rider wrote two companion books grouped under the title "Service Man's Manual." The first was "Mathematics of Radio," the second "Trouble Shooter's Manual." The value of one of these books is more than double that of the possession of the other.

"The Mathematics of Radio," 128 pages, 8 1/2 x 11", 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.



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Technical Accuracy Second to None
 Latest Circuits and News
EIGHTH YEAR

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High Gain with HB22

Shielded Tuner Uses SG Tube—Push-Pull Output

By Herman Bernard

Managing Editor

A SHIELDED tuner, using a screen grid tube as radio frequency amplifier, a standard detector, and two stages of transformer-coupled audio, the output in push-pull, makes as good a receiver for general home use as one would desire. There are adequate reasons for using only one radio frequency stage: simplicity and economy, both consistent with good results. The audio channel is certainly no less than would be found in any other receiver designed for general home use, and especially does the push-pull output meet the popular demand.

What a circuit is worth, or what it is like, depends essentially on the design. So much more can be accomplished with a simple tuner than is ordinarily set forth that one is encouraged to present a design capable of more than a mere glance at the diagram would intimate.

THE FAVORITE OF OTHER DAYS

When two stages of general purpose tubes in radio frequency amplification hookup, a detector, and two plain stages of audio constituted the popular five-tube tuned radio frequency receiver, it was generally accepted that such was sufficient for home use. Persons who had a hankering for exceptional sensitivity or were so circumstanced that abnormal selectivity was required, used more elaborate circuits, and these same individuals certainly will lean toward more elaborate circuits than the present one. But in the absence of this special hankering, the five-tube design presented now will more than fill the bill.

The use of shielding permits high sensitivity without instability, so one point is gained. The input to the radio frequency amplifier is standard, but the type of coil used is the dynamic tuner, here included so that the tuning of the first stage will be just like that of the second, an absolute requirement because of single tuning control.

The plate circuit of the radio frequency amplifier is tuned. That builds up the sensitivity. Coupling to the detector is made by means of an untuned secondary. Close coupling is used.

WHY THIS SECONDARY IS NOT TUNED

Under such circumstances sensitivity is high, and it is not advisable to tune this particular secondary, because to make that practical, loose coupling would be required, and there would be a sacrifice in sensitivity on that account alone, if on no other.

Grid leak and condenser detection are highly suitable, as the radio frequency amplification is not too high to affect quality adversely because of detector overload. Even so, more volume than is comfortable will be obtained on most stations, therefore the volume control is put in a handy position. It is a rheostat of 75 ohms in the negative filament leg of the screen grid tube.

Standard practice is followed in the audio channel under a well-established system that gives most gain with the type of tubes used.

ASSEMBLY NOVELTY

The novelty of the assembly lies in the shielded tuner. Two shields are used, and each one contains coil, tuning condenser, coupling link, bypass condenser, socket and four binding posts. One shield supports the switched rheostat.

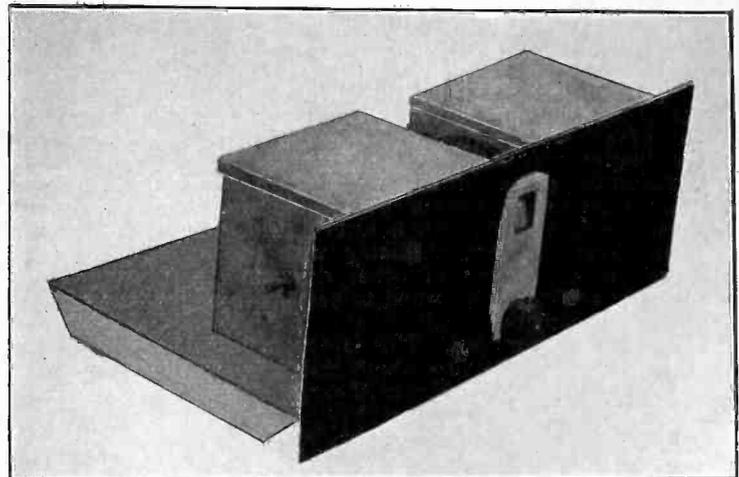


FIG. 1

ANGULAR FRONT VIEW OF THE ASSEMBLY WHEN A SEPARATE FRONT PANEL IS USED, WHICH IS NECESSARY IF YOU ERECT YOUR OWN SHIELDS. THE SWITCH RHEOSTAT IS AT LEFT, A DUMMY SHAFT AND KNOB AT RIGHT.

These shields are specially constructed to accommodate the new modernistic National drum dial, with color wheel feature that causes different colors to flood the telescopic screen of the dial as the knob is turned. The dial has the pilot light and bracket as part of its assembly, and one of the shields is specially contrived to prevent obstruction to the lamp bracket. A 1-inch diameter hole furnishes this means of safeguarding against a short circuit.

As the dial will receive a shaft on both sides, it is used as the means of coupling two circuits mechanically.

The dynamic tuners are so constructed that a link causes the same motion to turn the tuning condenser and the moving segment of the tuned winding. In the RF stage this tuned winding is the secondary, but in the interstage circuit the tuned winding is the primary. The tuning is equalized by means of a small adjustable condenser of 80 mfd., which is in the first shield and set once, preferably at when a low wavelength station is tuned in.

The moving coil feature is necessary, because the capacity effect present when high amplification is used by tuning the plate circuit is so great that the tuning condenser, if unaided, would escape covering the entire band of wavelengths with any fixed coil.

If you put more turns on a fixed coil, the highest wavelength stations would be tuned in, but the lowest wavelengths, say from 250 meters or even 275 meters down, would not come in at all. If turns were removed to bring them in, then the highest wavelengths, say from 500 meters up, would not be reached. Therefore some system is necessary that changes the effective

A Striking Screen Grid Ci

Fine Results Obtained Economically in Five-Tube

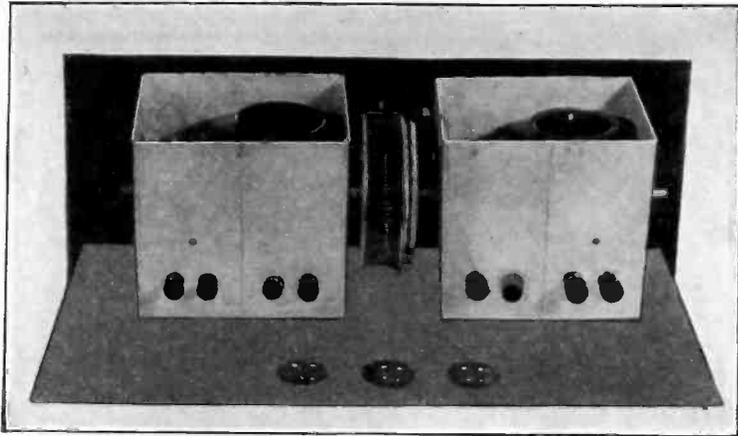


FIG. 2
REAR VIEW, WITH AUDIO PARTS OMITTED, SO AS TO PRESENT FULL VIEW OF SHIELDS AND BINDING POSTS THEREON. HOW THE DRUM COUPLES THE SHAFTS IN ONE SHIELD WITH THOSE IN THE OTHER IS SHOWN.

inductance in the right direction, making it higher for the higher wavelengths and lower for the lower wavelengths. This the dynamic tuner accomplishes fully.

Besides, it operates, in two stages as used here, in such a way as to increase the amplification at the higher wavelengths, where it is needed most, and thus helps to overcome the short-coming of tuned radio frequency amplification—higher amplification at lower wavelengths, with greatly diminished sensitivity on the higher wavelengths. The sensitivity is approximately equal throughout the broadcast scale of wavelengths by the present special tuning system, used as shown.

By using this system with a screen grid tube the sensitivity is far in excess of that obtaining with the favorite five-tube radio frequency receiver of other days, and besides the fifth tube may be regarded as turned to better use as the second output tube to permit push-pull.

Each shield is grounded. This is accomplished by connecting the ground post to the first stage shield, by putting it through the switch to the shield. Hence the ground post must be insulated.

SECOND SHIELD'S GROUNDING

Then the grounding is effectuated in the second shield through the tuning condenser, drum bushing and the second shield's coil shaft. In the present instance, in both shields, the coupling link that unites coil shaft with condenser shaft is not insulated, but is a metal bushing, to pass $\frac{1}{4}$ " rod, and having two set-screws in it. One screw fastens to the coil shaft and the other to the condenser shaft.

Therefore since the condenser frame in each instance is attached to the shield itself, automatically making electrical connection, and as the dial bushing is likewise automatically used to unite the two, the second shield is grounded.

FIXED CONDENSER COMPLETES CIRCUIT

Because the second shield is grounded, and the tuning condenser frame, representing the rotor, is likewise, the coil in the screen grid tube's plate circuit can not be connected to the same point, since the coil takes a B plus connection, at 135 volts, and a short circuit would result. But a fixed condenser of relatively large capacity as compared with the tuning condenser could be connected from the "low" end of the coil to the shield. The tuning condenser is .00035 mfd., and a capacity of .006 mfd. would be suitable, yet to make assurances triply sure a condenser of .01 mfd. is used, and this completes the tuned circuit and utterly preserves the integrity of the tuning system.

NEED 7 x 18" FRONT FOR OWN SHIELDS

Besides the 1" diameter cut-out for passing the lamp bracket on the right-hand shield, there is a small cut-out on the left-hand shield to permit mounting this shield very close to the drum receptacle. Hence compactness results, and the over-all

width is such that the assembly will fit into a small steel cabinet.

The shield assemblies are commercially obtainable, but if you desire to make your own shields you may do so from directions published in last week's issue of *RADIO WORLD*, dated November 2d. The 1" cut-out should be provided in only one side of one shield, for this is to pass the pilot bracket and there is only one such bracket. It will not be necessary to provide the second opening, for pushing the first shield closer to the drum, because with the knockdown type of shield, of your own make, 7 x 18" front panel and standard cabinet are required.

The commercial shields referred to have one-piece sides all around, the top is removable by lifting, while the bottom is bolted on.

WHAT IS ON BINDING POSTS

On each shield are four binding posts. The first shield's posts are for antenna, grounded A minus (this post also is insulated), B plus 45 volts for the G lug of socket, and P for the plate. The second shield's four insulated posts are for plate of first tube, B plus 135, A plus and plate of detector tube. The commercial product has the binding posts in proper position, properly marked, and the leads connected thereto, so that the soldered wiring to be made to the first socket consists of connecting the A plus post of the second shield to the 6.5 ohms filament resistor, and the other side of this resistor to the F plus lug of the first socket (tube 1), while A minus, B minus and C plus go through the switch to the shield. A flexible lead and grid clip are inside the first shield.

In the case of the second shield the soldered wiring you have to do consists of connecting one side of the pilot lamp bracket to the shield, by soldering to a lug that is at hand, and running a lead from the other side of the pilot lamp bracket, through a hole in the shield already provided, to the lug of the A plus binding post of that shield.

The other connections to these shielded circuits are made by wires connected by friction to the binding posts, for instance, antenna connected to one post, ground, A minus and B minus to another, detector plate, etc. There is little to wire except the audio stages, although whatever wiring has to be done in the shielded stages is necessary to make the circuit operative.

The rheostat and the switch, a unit, are mounted on the first shield.

WHAT CIRCUIT DOES

You will get plenty of distance with this circuit and will be surprised at the performance, unless you have had experience with this kind of circuit. It is not enough to say that there is only one radio frequency stage, and assume that not much can be expected of that. One should bear in mind that a screen grid tube is used, that the best known means of achieving highest amplification from this tube at radio frequencies also is utilized, and that shielding is resorted to for stability and incidentally for sharpening the selectivity somewhat. The tuning condenser, coil and socket are in each shield, therefore even the tube is shielded.

A long antenna may be used with this circuit without fear, as the selectivity is high enough for that. The volume will be very considerable, also more than you might expect from mere examination of the diagram.

CONNECT MOVING COILS PROPERLY

There is only one thing that will defeat good results and that is, if you build your own shield and make your own assembly, the moving coils may not be connected correctly. The coils to use are BT3A and BT3B of the Screen Grid Coil Company. Both dynamic segments must be so positioned that when the condenser capacity in use is maximum, the moving coils aid the fixed coils with which they are series connected.

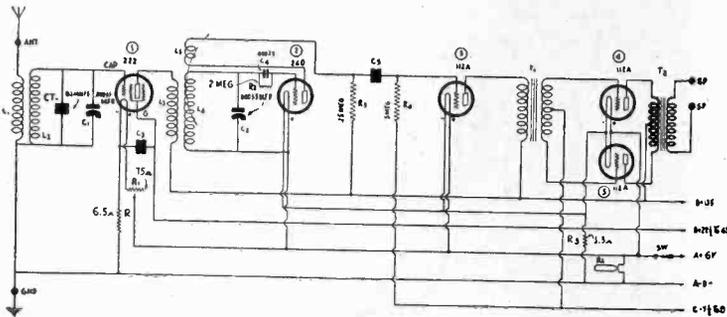
An easy way to test for this is to position the two moving coils so that they are physically parallel with the fixed winding when the plates of the condensers are totally enmeshed. Then tune in some stations. If volume is unbelievably weak, turn one of the moving coils around 180 degrees, that is, half a circle. You may have to loosen some set-screws to do this. Now you will find volume aplenty, and everything is all right unless you can't tune in the highest wavelength stations. If that shortcoming prevails, turn around both moving coils half a circle and the trick has been turned. Retighten any set-screws, adjust the equalizing condenser to maximum sensitivity at some low wavelength.

In the factory-assembled shielded stages the coils are in place

Types of Circuits and Lo

Requirements for Use of High Mu

By J. E. Anderson



A HIGH MU DETECTOR TUBE (2) IS USED WITH A RESISTOR IN THE PLATE CIRCUIT. PUSH-PULL INPUT AND OUTPUT TRANSFORMERS ARE SHOWN AT RIGHT.

[This is the third instalment of "Radio for Schoolboys." The first and second instalments were published in the October 26th and November 2nd issues. Next week another article in the series will be printed.—Editor.]

CHAPTER III.

Amplification After Detection

ONCE detection has taken place interest in radio frequencies ceases and attention is confined exclusively to audio frequencies.

It was desirable to keep radio frequencies out of the audio amplifier, and to aid this elimination a bypass condenser of small capacity, not exceeding .001 mfd., was connected from detector plate to some grounded conductor, as A minus or plus, or filament minus or plus. Sometimes in addition a radio frequency choke coil is used to help in this result, and sometimes a combination of radio frequency choke and two condensers, to form a filter circuit.

A filter circuit is one that either eliminates or passes a certain frequency or band of frequencies, and in this instance it is an eliminating filter, since it is directed toward the exclusion of radio frequencies.

When the audio frequency is delivered from the output of the detector circuit it is not audible but is in such a state that it can be rendered audible by connecting a suitable reproducing device in the circuit. The currents and voltages would actuate earphones, because the diaphragms of the earphones would respond to the variations that are at frequencies within the audible range.

OVERALL GAIN OF AF AMPLIFIER

The use of earphones for listening in has declined greatly, as the popular demand is for operation of a loudspeaker. To gain this higher end it is necessary to magnify the voltages resulting from detection, and to do so without injuring quality. The degree of gain will depend on the types of coupling used, the number of stages and the B and C voltages applied to the tubes. The amount of magnification which the audio amplifier produces is known as its overall gain, and is represented by a figure showing how many times greater is the output signal voltage compared with the voltage originally impressed on the input of the audio amplifier. From input to last plate circuit the gain nowadays is usually at least 400, and in receivers that have strong audio amplifiers, with suitably large capacity output power tubes, the gain may be several times 400.

Everywhere in radio—at radio frequencies or audio frequencies—the voltages and currents must have some unit on which they can work. At the output of the detector either a coil or a resistor is connected in circuit. If a coil is used, it may be a single winding, constituting what has been termed an impedance coil, and if so it will have an iron or steel or other magnetic metal core, thus distinguishing it from a tuning coil, which has only an air core.

HOW COILS BEHAVE

If a two-winding coil is used, then both windings are on one core. One winding, the primary, is connected in the plate circuit of the detector, and the other winding, the secondary, is connected in the grid circuit of the first audio frequency amplifying tube. The coupling then is achieved magnetically, the fields of

both coils varying as the audio frequencies vary. This phenomenon is exactly the same as the one existing in a tuning coil and is due to the presence of magnetism when current is passed through the coil. If this current were steady it would be useless, but it is unsteady in two directions, and is considered as alternating current.

The two-winding coil with iron core is called an audio transformer. There are some variations of the separate-winding transformer, as, for example, a single winding tapped so that part of the winding is in the plate circuit and all of the winding is in the next grid circuit. This is called an auto-transformer, and it has a step-up ratio, also, but requires a condenser to keep the positive plate voltage of the detector off the grid of the first audio tube, which grid must be negative.

If a resistor is used there is no magnetic field, but the variations take place in the plate current flowing through the resistor. The plate current in any event is continuously unsteady by the signal variations.

Here, too, a condenser is used to keep the first audio tube's grid negative, since a condenser as used here will not pass direct current. When a condenser does pass direct current it is due to leakage, and is not only accidental or unintentional but may be detrimental.

SERIES AND PARALLEL

Hence in resistance audio the coupling resistor is the one in the plate circuit. The signal voltage fluctuates across this resistor, which constitutes the signal's operating medium or path of activity. The condenser does not couple.

In the next circuit there is a higher resistor, usually of the order of millions of ohms. A million ohms are one megohm, and if the grid resistor, here too called a leak, is 2,000,000 ohms it is abbreviated 2 meg.

The circuit consisting of the grid leak and the isolating condenser is a series-connected circuit, because the parts, called constants, are connected with the end of one to the end of the other, and the voltage impressed on the otherwise free terminals. The other type of connection is parallel, which consists of the two terminals of one unit connected to the two terminals of another unit. Any combination of a series connection and a parallel connection is called series-parallel. Therefore we have a plate resistor in the detector circuit, which we may consider as one unit, and a series circuit, comprising a condenser and a grid leak. If we inspect the connection closely we find that the plate resistor has the series circuit connected in parallel with it. Another way of viewing the situation is that the condenser and the plate resistor form a series circuit, connected in parallel with the grid leak.

Whenever constants are connected in series, the result is a greater value than the value of any one of the components, with the single exception of the connection of capacities, where the opposite holds true. Whenever constants are connected in parallel, excepting only the example of condensers, the result is a value lower than that of any one of the components. So if a low value of plate resistor is used, with a high value of grid leak, in the resistance coupled circuit, the total resistance of the parallel-united circuit is less than the resistance of the plate resistor. The plate resistor and the grid leak are in parallel.

ALTERNATING CURRENT RESISTANCE

So far we have regarded resistance as the opposition offered to the flow of steady current, known as direct current. If the direct current resistance is 4 ohms it is always 4 ohms, no matter how much direct current is passed through it. Direct current has zero frequency.

But where alternating current is concerned, the AC resistance of a coil increases with frequency. This opposition offered by a coil to the flow of alternating current is called its AC resistance. But even to alternating current, providing the frequencies are within the audio range, the AC resistance of a pure resistor is the same as its DC resistance. Practically, there are no pure resistors used in radio. The commercial resistors have inductance or capacity in addition to resistance.

So when we insert a constant in the plate circuit of the detector tube, we not only provide a place in which the moving electric forces can work, but we provide one that has AC resistance. We call this resistance the impedance of the load on the circuit.

When the load is the primary of an audio transformer, or an auto-transformer, we use the primary to receive the detector tube's output, and the secondary to deliver to the next tube an

Ads for Audio Amplifiers

Tubes—Push-Pull Output Explained

and Herman Bernard

enlarged copy of this output. It is something like taking a negative to a photographer and have him furnish an enlarged print. The same picture is there, and if the enlargement is clearly made, we say that there is no distortion. If it is blurred, or seems to make the view bend away at the corners, or has other defects, we say it is distorted.

STEP-UP RATIO

Therefore the audio transformer that has secondary with more turns than the primary, steps up the voltage, and the proportion of step-up is the proportion of the number of turns of wire. If there are 400 turns on the primary and 1,600 on the secondary the step-up ratio is 1 to 4. Therefore a given AC voltage impressed on the primary will be four times as great in the secondary.

Whatever the step-up ratio, the inductance used in the primary in the plate circuit of the detector should be large. This would constitute a high impedance load, and it makes for better detection. With some special types of tubes, an extraordinarily high impedance load in the plate circuit is required for high amplification. Such tubes are known as high mu tubes because they are capable of high magnification. The magnification capability of the tube alone is called its amplification constant or mu. Examples of high mu tubes are the 240 and 222 for battery operation of filaments, 224 and 228 for AC operation of the filaments. The 222 and 224 have four elements, the fourth being a special, extra grid, known as the screen grid, and these two tubes therefore are called screen grid tubes.

SUITING THE LOAD TO THE TUBE

While general purpose tubes may be used advisedly with audio transformers, special purpose tubes should be used with audio impedance coils (called choke coils, too) or with resistors in the plate circuits, because there is no transformer in the second instance to step up the voltage. The special purpose tube will increase the voltage when the proper circuit is hooked up to that tube. If a transformer has a high impedance primary, it is not satisfactory even then to use a special purpose tube like the 240 or 222 or 228 or 224, because these tubes require an extraordinarily high plate load impedance, and if the special tubes are used with transformers the volume will not be increased over what would result from general purpose tubes, but will be less than that, and the quality will suffer.

Having a suitable load on the detector plate, consistent with the type of tube used, the load on the grid circuit that follows is always higher in practice.

While the unit in the detector plate circuit is connected to positive B, the one in the next grid circuit is connected to C minus, as it is necessary to have a negative grid bias to prevent distortion. Also, this negative bias reduces the plate current drain at any given plate voltage, as compared to what the current would be at lesser negative bias, or at no bias whatever.

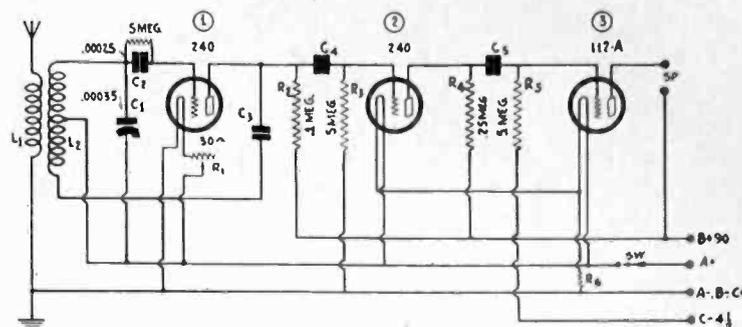
AMOUNT OF AMPLIFICATION

The plate circuit of the first audio tube is circuited the same as the detector plate, except for omission of the bypass condenser. Usually two stages of audio frequency amplification are used, but if there is enormous gain at radio frequencies, one stage may be sufficient, while for extraordinary volume three stages may be used with an average tuner. Each succeeding audio stage is usually a repetition of the preceding audio stage as to circuit formation.

How much audio amplification is to be used depends on what the designer intends shall be accomplished in volume and quality. As the number of audio stages is increased, the problems of maintaining stability in the audio amplifier and producing an undistorted result become greater. Instability would evidence itself as howling, constant squealing, popping, or "motorboating," in every instance an example of oscillation at audio frequencies. Distortion would change the wave form or make reproduced frequencies differ from the original frequencies.

SPEAKER CONNECTIONS

When the output tube is reached, the loudspeaker may be connected directly in the plate circuit, so that one tipped cord of the speaker would go to the plate (a binding post usually marked Speaker Minus) and the other to the maximum B plus voltage (a binding post usually Speaker Plus). Such a connec-



THE SPEAKER IS TO BE CONNECTED DIRECTLY IN THE PLATE CIRCUIT OF THE LAST TUBE (3) IN THIS RECEIVER. TWO RESISTANCE-AUDIO STAGES ARE SHOWN.

tion causes the plate current to pass through the windings of the speaker's coils, which is good practice if the current does not exceed 15 milliamperes. If more current is flowing in the plate circuit an output filter should be used, where an extra coil carrying the direct current is built huskily enough to endure this current, and only the signal voltages (alternating current) are communicated to the loudspeaker windings. The most familiar type of such speaker output filter consists of an audio choke coil and a condenser.

PUSH-PULL

The output, instead of consisting of a single tube, may consist of two tubes connected in a special manner, constituting a push-pull circuit. Thus the work of handling the signal is divided equally between the two tubes, which are series connected. The equality of service, however, is not simultaneous in all ways, as the tubes function half a voltage cycle apart. When the maximum positive voltage of a cycle is handled by one tube, the maximum negative voltage of the same cycle is handled by the other tube at the same instant. So, as the signal voltages and currents in the two tubes are equal and opposite, they are said to be 180 degrees out of phase.

If a circle be drawn, and a diameter imposed thereon, with pointer at the two extremes, and this double needle be turned around as freely as desired, every time one pointer is at any given number of degrees of the circle, the other pointer is 180 degrees away. The word "phase" is used to represent this displacement. If one imagines simply as an illustration that the signal is travelling around the circle in a clockwise direction, and that a horizontal diameter is the zero line of the signal, the upper semi-circle positive, the lower negative, the action of push-pull may be represented by the rapid rotation of the double-pointer, as if it were spun by a motor.

PUSH-PULL OUTPUT

When push-pull is used a special type of transformer feeds the two tubes, at the input, and a special type of coupling device is used for exhausting the push-pull tubes. The input transformer has a center-tapped secondary, the output transformer has a center-tapped primary. Instead of an output transformer a double-choke coil, consisting of one winding center-tapped, may be used, plates to extremes, center tap to B plus, and the speaker connected directly to the plates without any direct current passing through the speaker windings. This unusual situation of direct current absence from the speaker windings is due to the plate current in each half of the double choke coil being equal but opposite in phase. So if the voltage is plus 20 at one plate, it is minus 20 on the other plate at the same instant, and the arithmetic difference is zero. So no direct current is fed to the speaker. However, the audio frequencies do fluctuate across the speaker winding, so the signal is heard.

Some types of speakers, particularly dynamics, have transformers built in, so that connection made to a circuit like the one shown above results in keeping the direct plate current out of the speaker magnet coils. The reason for the precaution in any instance is to protect the speaker from injury or ruin, and in some instances tone quality is protected also.

The Limit in Keeness

Battery-Operated Tuner as Sensitive and Selective as Practical

By H. B. Herman

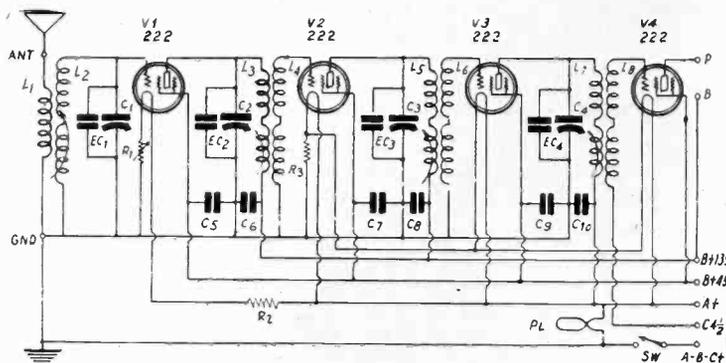


FIG. 1

DESIGN OF A HIGHLY SENSITIVE BATTERY-OPERATED SINGLE CONTROL TUNER. EACH STAGE IS INDIVIDUALLY SHIELDED. A POWER DETECTOR IS USED. ALL TUBES ARE 222 SCREEN GRID.

A HIGHLY sensitive screen grid tuner for battery operation is given an advance showing this week, in circuit form and general layout, preparatory to the publication next week of the constructional article.

There are four shields, one for each of the stages; three steps of tuned radio frequency amplification and a tuned input to the power detector. All tubes are 222 screen grid.

With this outfit it is necessary to have an audio amplifier and power for the filaments, plates and screen grids. The filament power may be derived from a storage battery. The plate power may be taken from B batteries or from a B eliminator. The B voltages for the tuner are shown, but those for the audio amplifier will depend on the type of amplifier and tubes used therein.

In general practice a power amplifier will be used in conjunction with a tuner such as this. Two stages of audio should be used, but a precaution must be taken. The load on the detector plate should be a resistor, therefore if the power amplifier is transformer coupled, the first audio stage should be changed, to use a resistor in the detector plate circuit, a condenser of .01 mfd. or larger capacity between detector plate and first audio grid, while the audio transformer secondary or a 5 meg. grid leak may be used in the first audio grid circuit.

MEETS HIGH SENSITIVITY DEMAND

Many who build receivers are especially keen for a highly sensitive receiver, one with a high order of selectivity as well. The present circuit will meet that demand fully.

The construction is simplified by the use of unit shields with the parts mounted therein, with few leads to be soldered, as the principal ones already are brought out to the binding posts on the back of the shields.

The first two stages are familiar to readers of RADIO WORLD as to assembly and appearance, as they duplicate those in simpler circuits previously published. But the extra pair of stages constitutes a new feature. The mechanical coupling of the driving shafts of the extra two is established by means of two

LIST OF PARTS

Shielded antenna stage, consisting of Bernard tuner BT3A, tuning condenser .00035 mfd., 75-ohm switch rheostat with knob, equalizing condenser, grid clip with flexible lead, socket, fixed condenser .01 mfd., link and four binding posts, all parts in shield.

Three shielded interstage, consisting of Bernard tuner BT3B, tuning condenser .00035 mfd., equalizing condenser, grid clip with flexible lead, socket, fixed condenser .01 mfd., link and four binding posts, all parts in shield.

Dummy knob, shaft, bushing.

R2—6.5-ohm filament resistor.

R3—10-ohm filament resistor.

National modernistic dial with pilot light.

Cabinet, front panel, subpanel.

Two pulleys with belt.

pulleys and a belt. This feature is disclosed in the general plan diagram.

By using three stages of tuned RF the sensitivity is so high that it approaches the noise level, but does not quite reach it. This is about as far as any one dares to go in the design of a receiver, since there is a technical limit to sensitivity, just as there is to selectivity.

On the one hand sensitivity can not be pressed to such a degree that the strays that abound, but which are not heard on receivers of ordinary sensitivity, become fearsome doses of static, while on the other hand selectivity is limited by the precaution against attenuation of sidebands.

In the present design both vices have been avoided, and the circuit design has caused the progress and advance to stop at those crossroads where peril exists.

Extreme neatness, indeed handsomeness, of appearance results from the use of the cadmium-plated steel shields. Their thickness is more than ample, so that shielding is made very effective. Besides, steel is a better magnetic shield than aluminum and partakes of none of the frailness of aluminum. The rigidity is excellent. No pillar construction is resorted to, but the sides are one piece, fashioned permanently in a die, and so constructed as to permit the easy affixing of the bottom, by use of nuts and bolts, while the top is removable, to afford access to tubes.

The socket is built onto the bottom piece, and fits snugly into the allotted space. The bottom and top are already in position in the factory-assembled layout, and the wiring to be done is not considerable, as has been stated, but is necessary to make the outfit workable.

FEARLESSLY HIGH AMPLIFICATION

What can be received on this tuner in any particular location can not be foretold. The same frank statement applies to every receiver design ever promulgated. It is certain, however, that extremely favorable conditions can be circumvented, residents of semi-dead spot areas will delight in the possession of this tuner, and the many thousands who have a strong hankering for reception of far-distant stations will have their hearts filled with delight, perhaps as never before.

This is a tuner most extraordinary, because it uses the tuned plate system of loading up to the fullest degree the plate circuits of the screen grid tubes, for highest amplification, highest sensitivity and best response consistent with maximum allowable selectivity.

A custom has arisen to use the screen grid tube at less than its maximum capability. This is an easy way out of the difficulty of oscillation, but it does not permit reaping the full reward that anybody ought to have the right to expect.

Relatively small primaries are used habitually, but here the primary in each plate circuit is tuned, so that infinite impedance exists in the plate circuit, while the input to the succeeding tube is always an untuned winding. There is a step-up. There is a step-up ratio between primary and secondary, and this further enhances the sensitivity. The volume from the detector is so great that no form of detection save power detection is even thinkable. It is possible to obtain fair speaker volume with only one stage of resistance-coupled audio, but this is not recommended. An extra stage should be used, either resistance-coupled or transformer coupled, with tubes to match.

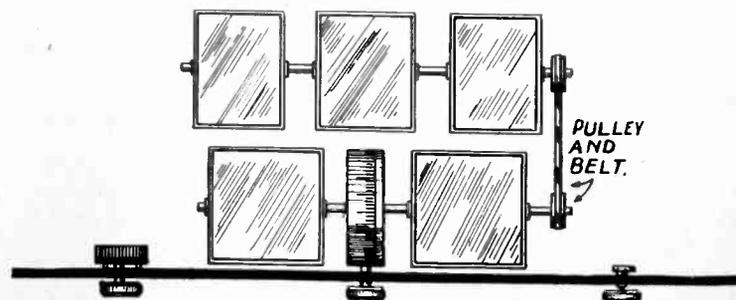


FIG. 2

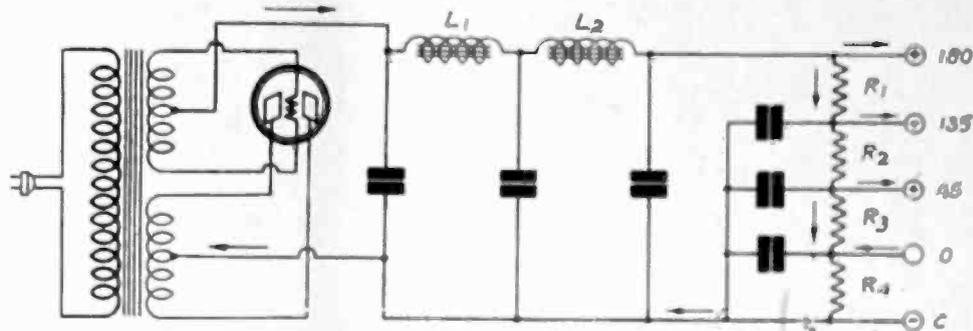
GENERAL PLAN OF THE LAYOUT OF PARTS. THE DIAL TURNS SHAFTS OF THE FIRST TWO COILS AND CONDENSERS AND A PAIR OF PULLEYS AND A BELT COMMUNICATE THIS MOTION TO THE NEXT TWO STAGES.

Strangeness Familiarized

Analogies Make the Incomprehensible Easy to Understand

By Herbert E. Hayden

DIFFERENCE OF POTENTIAL MAKES WATER FLOW. SO CURRENT FLOWS IN A CIRCUIT. ARROWS SHOW DIRECTIONS OF CURRENT IN A B SUPPLY.



THERE are many phenomena in radio which seem to some fans absolutely beyond comprehension, yet which are only special cases of general phenomena with which it is already well familiar.

Consider, for example, Ohm's law and the fall of potential in a conductor. This law is the essence of simplicity, and still many fall down on it, perhaps for no other reason than they think it difficult and abstract.

Of course there are reasons for this mental attitude. It involves electric potential, current and resistance. In order to understand Ohm's law it is necessary to have clear conceptions what these things are, which are not so easy to form. Electric potential is not something which can be felt or tasted or seen or heard. Current is even more beyond the human senses. And resistance does not tie in very well with anything that we can perceive. All three of these quantities must be conceived rather than perceived.

THE WATER ANALOGY

Well, whenever we are faced with a problem like this we have to resort to analogies with something within the realm of the senses. But these analogies depend largely on how well someone else has conceived the abstract problem. The purpose of the analogy is to help anyone who understands the concrete problem to form the same conception of the abstract as the one who gives the analogy.

The analogy usually given to explain Ohm's law is that of water in a pipe subjected to a hydrostatic pressure. The pressure difference between the ends of the pipe corresponds to the electrical difference of potential between the ends of a conductor. The flow of water in the pipe between these points corresponds to the electric current, and the resistance to the flow of water corresponds to the electric resistance. The resistance in the pipe to the flow of water is largely friction in the pipe. Likewise, the resistance to the flow of electric current is largely friction.

RAPID VARIATION OF PRESSURE

It is not known what the friction is, but that should be no bar to the understanding of the problem, for we do not really know what the friction in the water pipe is either. If we drag a weight over rough ground we have some idea of what friction is, and it is undoubtedly of a similar nature whether it is in a water pipe or an electrical conductor.

We know that if there is much resistance to the flow of water in a pipe the pressure in the pipe varies rapidly from point to point, provided that water is flowing. Likewise, if there is much resistance to the flow of electrical current in a conductor the potential drops rapidly from point to point. Ohm's law states that the fall of potential along the wire is directly proportional to the current flowing and to the resistance.

The total fall of potential in a given conductor, or the difference of potential between the ends of the conductor, is proportional to the total resistance in the wire multiplied by the current flowing. The factor of proportionality becomes unity when we use volts, amperes and ohms as the units of measuring the potential difference, the current and the resistance, respectively.

EXAMPLES OF WATER AND GAS

We all have observed that when a radio set, or a washing machine, or a toaster is turned on the lights in the house suddenly dim a little, and that they grow brighter when the same device is turned off. If the hydraulic analogy holds for the electrical circuit, there should be a similar effect in the water supply system. That is, when one tap is opened while water is flowing from other taps, the rate

of flow from those already on should suddenly decrease, and vice versa when one of several taps is closed. Of course, that is true, and everybody has observed it.

The same phenomenon takes place in the gas supply system, and many a pot of stew has been burned because of it. The flame may be adjusted while most other gas jets in the same supply are burning, and shortly after the good cook has left the stove, someone turns off a jet and forthwith the jet which had been adjusted just so begins to burn hotter because the pressure of the gas has increased.

A very similar phenomenon occurs around the antenna that is serving the set if there are many antennas in the same neighborhood. There is a certain field strength around the antenna, or electrical difference of potential per meter. If an antenna is erected in that field, current flows and the field strength drops a little. The antenna may be erected all the time, but the change takes place when the switch closing the antenna circuit is thrown. If the switch is closed all the time there is no change unless a tuned circuit is suddenly coupled to the antenna.

EXAMPLE OF VOLUME DROP

Suppose there are many antennas in the same neighborhood—on the same roof—and that all but one are receiving the same signal. Let a switch in that antenna be closed suddenly, or let the antenna be tuned to the same signal to which the other antennas are tuned. The signal strength in all the others will suddenly drop a little, perhaps quite a bit. Just how much it drops depends on how close the antennas are together and on how many there are.

The quality of inductance is another abstraction which can be illustrated with something with which everybody is familiar. Take any heavy body which can be held in the hand. Swing it back and forth. It will be easy to swing it slowly but quite difficult and strenuous to swing it rapidly. The rate of swinging is akin to the frequency of the current and the mass of the weight is akin to the inductance.

HOW can one tell an old radio set from a new set?—T.S.A. If the receiver is a commercial model, inspect the serial number, and inquire from the manufacturer or his distributor as to the year of that model. Inspect the receiver as to its outward condition and general appearance, as a shop-worn receiver of recent production may be considered "old." Test the receiver as to its ability to separate stations, as the newer receivers are more selective than those manufactured in previous years. The type of tubes used is another clue, because old sets did not include screen grid and 245 tubes, so if the receiver calls for these it is likely to be of recent manufacture.

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PLEASE let me know what books on radio a beginner should study. I do not want anything that is complex or that has any mathematics in it, as I want to get started on a simple course and branch into the more complicated phases later.—G.F. "Elements of Radio Communication," by Prof. John H. Morecroft, of Columbia University, is an admirable book for furnishing an elementary education on radio technique and processes. The importance of the vacuum tube requires that special attention be given to that subject, and "Radio Receiving Tubes," by Moyer & Wostrel, covers this subject in an excellent manner for novices. When you have digested these two important books, inquire of us for the next volumes to add to your radio library.

How to Construct Int

Each Circuit Is Individually Tuned

By Knollys

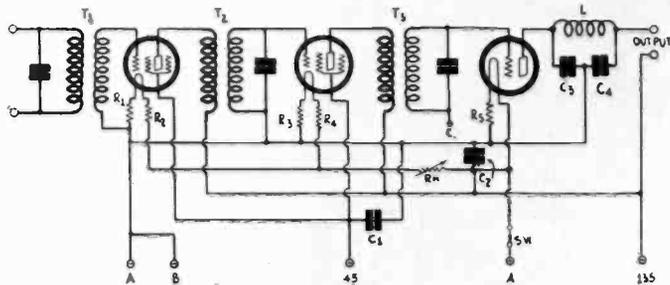


FIG. 23
A THREE-STAGE INTERMEDIATE FREQUENCY AMPLIFIER FOR DC SCREEN GRID TUBES, WITH SECONDARIES OF TWO TRANSFORMERS TUNED.

[Herewith is another installment of the work, "The Superheterodyne." The series was begun in the October 12th issue and continued October 19th, 26th and November 2d. Another article will appear next week.—Editor.]

A small rotatable coil can be used to good advantage as a vernier in the oscillation circuit even when only the higher oscillator setting is used. The inductances of the fixed and the rotatable coils and the coupling between them are adjusted so that the calibration scale attached to the small coil is spread out over the entire 180 degrees instead of being crowded within a small angle as in the case illustrated in Fig. 20.

Suppose the lower oscillator frequency limit is F_1 and the higher is F_2 . If the broadcast band is involved and the intermediate frequency is 200 kc., the higher and lower oscillator frequencies would be respectively, 750 and 1,700 kc. Let the minimum capacity in the oscillator circuit be C_0 and let the maximum be $C_0 + C$. Then if L_1 and L_2 are the two inductances needed at the two frequency limits, we obtain the following relationship among the factors involved:

$$L_2 = (F_1/F_2)^2 (1 + C/C_0) L_1$$

In this formula the frequency ratio is known, and for design purposes we may assign suitable values to the capacity ratio to get any desired ratio between the two inductances. If the rotatable coil is to act as a vernier the two inductances in the formula above should be very nearly equal. Indeed, they may be exactly equal at some frequency. The frequency ratio is 0.44, and we can assume that L_1/L_2 equals 1.25. Then what should the ratio C/C_0 be? Solving the formula we get 3.41 for the capacity ratio.

MAY CHOOSE AT WILL

We are at liberty to choose any suitable value of L_1 or of C . Since variable condensers are not as easy to make to specified values as inductances, we select a commercial value of variable condenser and determine the value of the inductance necessary. Let the condenser have a variable capacity range of 250 mmfd. We found that the capacity ratio should be 3.41. Therefore the zero capacity C_0 should be 73.5 mmfd. and the total capacity corresponding to the L_1 should be 323.5 mmfd. If we use this value together with 750 kc in the formula connecting frequency, capacity and inductance we find that L_1 should be 139 microhenries. Since we assumed an inductance ratio of 1.25, we find that L_2 should have a value of 111 microhenries.

Now if L is the sum of the inductances of the fixed and rotatable coils, and if M is the mutual inductance between them, then $L_1 = L + 2M$ and $L_2 = L - 2M$. Substituting the values of L_1 and L_2 just obtained and solving these two equations for M we find that

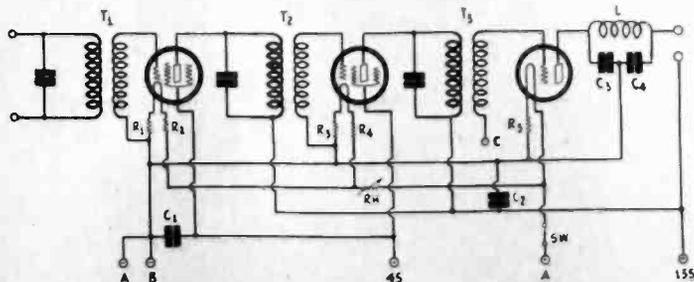


FIG. 24
AN AMPLIFIER LIKE THAT IN FIG. 23 EXCEPT THAT ALL THE PRIMARIES ARE TUNED.

the maximum mutual inductance between the two coils should be 7 microhenries. The small coil should be designed and mounted so that as it is turned through 180 degrees the mutual inductance varies from minus seven to plus seven.

CHANGING RATIOS

If it is desired to have a greater change in the mutual inductance as the small coil is turned, the ratio of L_1/L_2 should be made larger than 1.25. However, a similar change can be effected by selecting a different value for the capacity ratio C/C_0 , as can be seen from the formula given above. A study of the formula will show that if the capacity ratio is too large a higher inductance will be required at the higher frequency limit than at a lower frequency limit. It is for this reason that the zero setting capacity is made relatively large. It is desirable to have the larger inductance at the lower frequency limit. The formula shows that if this is to be satisfied the capacity ratio cannot exceed 4.14.

INTERMEDIATE FREQUENCY AMPLIFIERS

The sensitivity of the Superheterodyne largely depends on the intermediate frequency amplifier, for by far the greater amplification is obtained in this section of the receiver. The number of stages that should be used in this amplifier depends on the amplification that is required and the type of tubes used. When screen grid tubes are employed—and they seem to be best suited—it is doubtful that more than three stages can be utilized advantageously for broadcast reception, one of these being the detector.

Amplifiers may be constructed with either battery type or AC tubes according to the type of current that is available. There is little difference between the two, although the AC screen grid tubes now available give a slightly greater amplification than the battery type screen grid tubes.

Amplifiers with simple tuned circuits also may be constructed either with tuned primaries or with tuned secondaries. However, since a bypass condenser is needed in the plate circuit of the modulator tube it is preferable to tune the primary of the first intermediate frequency transformer whether or not this type of coupling is used in the succeeding stages.

In Figs. 23 to 26, inclusive, are shown four different intermediate frequency amplifiers, each of three stages or three tuned circuits. The first two are for DC tubes and the second two for AC tubes. In Figs. 23 and 25 the secondaries are tuned, with the exception of the first tuner in each instance. In Figs. 24 and 26 the primaries are tuned throughout.

VOLUME CONTROLS

In the two DC circuits the amplification is controlled by means of a rheostat R_h placed in the positive lead to the filaments of the two screen grid tubes, while in the two AC circuits the amplification is controlled by means of a voltage divider P_2 with which the voltage applied to the screen grids is varied. These two volume controls are about the best for the respective types of circuit, but additional controls may be needed in some instances. Complete volume control is necessary if any Superheterodyne is to be successful because of its enormous sensitivity. The signal level in every tube of the circuit must be kept below the overloading point regardless of the intensity of the signal at the antenna.

Each of these amplifiers is supposed to be operated with grid bias or power detection. In the battery-operated circuit a binding post has been provided for the bias on the last tube, and the bias to be applied at this post depends on the plate voltage and on the tube used. Usually the best voltage in any instance is found experimentally. The bias on the screen grid tubes is obtained automatically from the ballast resistors R_1 and R_3 , each of which is 10 ohms. The companion resistors R_2 and R_4 are also of the same value. For good volume control the rheostat R_h might have a resistance from 20 to 30 ohms.

BIAS FOR AC TUBES

The bias for the AC tubes is obtained from a drop in a potentiometer P_1 , which may have a value of about 2,000 ohms if the tube is a 227. The resistance R_1 might be variable so that the proper drop in P_1 can be found experimentally. The bias for the grids of the screen grid tubes is obtained from a portion of the drop in P_1 by returning the grids to the slider and the cathode to the junction of R_1 and P_1 .

Complete details of these amplifiers are not given here because in a later section complete Superheterodynes will be discussed in which the amplifiers shown in Figs. 24 and 26 will be incorporated. The values of the various elements are the same for either tuned primary or tuned secondary type amplifier.

Intermediate Amplifiers

Until Greatest Response Is Obtained

Satterwhite

Special attention is called to the radio frequency filter in the plate circuit of the detector in each of these amplifiers. The filter consists of one radio frequency choke L and two equal condensers C_3 and C_4 . The values of these elements depend on the intermediate frequency used and on the suppression permitted of the high audio frequencies. Values will be given when the complete circuits are shown.

The design of the intermediate frequency coils, of course, depends on whether the primary or the secondary is tuned. But screen grid tubes of the AC and battery-operated types are closely enough alike to permit the same design of coil for either. Naturally, the design depends on the intermediate frequency, since these transformers determine the frequency. It is not necessary, however, to design them exactly to any particular frequency. The essential thing is that they be tuned to exactly the same frequency, whatever it may be. For example, we may decide to select a frequency of 200 kc but if it so happens we use 190 or 210 kc. that is all right, provided that each tuned circuit is adjusted to the same frequency. The final adjustment should be made in the circuit after the amplifier has been otherwise completed. Adjusting the circuits to the same frequency in the laboratory against some standard and then putting them into the amplifier does not insure equality at all, because the distributed capacities will not be the same.

COIL CONSIDERATIONS

When a high intermediate frequency is selected it is possible to use small-sized solenoid transformers for the intermediate frequency. The size of the form and the number of turns in each winding depend on the tuning condenser selected. If this be of fairly large value the coil will be small and the effect of the distributed capacity will be small. Suppose we choose a .0005 mfd. fixed condenser, a standard value, and an intermediate frequency of 200 kc. The inductance required in this case is 1.266 millihenries.

A coil of this inductance can be made by winding 177 turns of No. 32 enameled wire on a 2-inch diameter and 112 turns to the inch. This winding will be 1.58 inches long.

This coil can be used for either the tuned primary or the tuned secondary type of transformer. The other winding, whether primary or secondary, can be wound with fine wire, say No. 36 enameled, on a form which fits snugly inside the tuned winding. If the untuned winding is the secondary, from 200 to 250 turns can be put on it, and these turns should be put on the inner form so that secondary winding is symmetrically placed with respect to the tuned winding. Since No. 36 enameled wire will wind 178 turns to the inch, the untuned winding will be from 1.12 to 1.4 inches long.

If the secondary is tuned, the construction can be the same but fewer primary turns should be used, say from 130 to 150. The higher number might be used for the battery-operated screen grid tube and the lower for the AC tube. Whatever number of turns is chosen it is important that all the coils be wound in the same way.

The condenser used for tuning one winding of the transformer should either be of the air or mica dielectric types. If fixed mica type condensers are used all should be as nearly equal as practicable. Ordinary commercial condensers of a certain rated value may vary from this value by as much as 15 per cent. above or below, but it is possible to get condensers which do not vary by more than 5 per cent.

It is not practical to select condensers of exactly the same value because it would be necessary to have a large number of them available from which to choose. The circuits can most easily be adjusted to the same frequency by using a midsize variable condenser across each fixed condenser. Such condensers can be obtained both in the air and the mica dielectric types.

ADJUSTMENT OF INTERMEDIATE FILTER

When adjusting the filter to resonance with the same intermediate frequency it is necessary to have a steady source of this frequency. The most convenient source is the heterodyne between a strong local carrier and the frequency generated in the oscillator. The local station is tuned in as usual. When the signal comes through the loudspeaker with greatest volume the value of the intermediate frequency is determined by the average of the natural frequencies of the filter coils. Then without making any readjustments of the setting of the local oscillator each of the intermediate filter condensers is adjusted until the volume in the loudspeaker is greatest. It may be necessary to remove a turn or two from one or more of the intermediate coils in order to effect accurate tuning. Removing turns in-

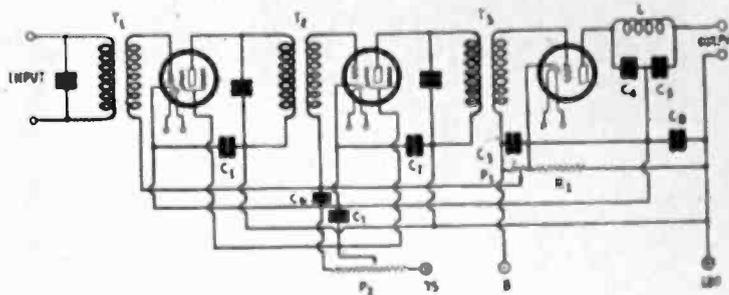


FIG. 25
AN AMPLIFIER LIKE THAT IN FIG. 23 BUT FOR AC SCREEN GRID TUBES.

creases the frequency and adding more capacity decreases the frequency.

It is also possible to rig up a special oscillator to supply the intermediate frequency, which can be done without a great deal of trouble. A suitable arrangement is shown in Fig. 27. The transformer T is similar in design to the intermediate frequency transformers in the filter. For oscillator a 201A tube is used and for output a 222 screen grid tube. This is used ahead of the amplifier to be adjusted, because it simulates the modulator which will be used in the Superheterodyne. The output terminals of this circuit is connected to the input terminals of the intermediate amplifier.

Since the intermediate frequency produced by this oscillator is unmodulated, no sound will be produced in the loudspeaker connected to the output of the receiver. Hence it is necessary to use a meter for determining resonance and as the detector is of the grid bias type it is only necessary to put a milliammeter in its plate circuit and adjust the intermediate coils and condensers until the deflection is greatest. The frequency of the oscillator is first set at the average of the natural frequencies of the intermediate tuners before any adjustments have been made. The average is found by turning the condensers in the oscillator until the deflection on the indicating meter is maximum. Then without changing the oscillator each intermediate filter circuit is adjusted for maximum deflection. When all have been adjusted the amplifier can be connected to the modulator in the receiver. A final adjustment of the tuned circuit next to the oscillator may be necessary before the indicating meter is removed and the audio frequency amplifier is substituted.

While a fixed grid leak of 0.5 megohm is shown in Fig. 27 just ahead of the screen grid tube, it may be better to use a potentiometer of this value, connecting the control grid to the slider, for if this is not done the oscillator may overload even the first tube. With the potentiometer, the input to the amplifier can be adjusted to suit the indicating meter. It is better to vary the output in this manner during the adjustments than to vary it by manipulating the volume control, for the volume control may change the distributed capacities.

OBTAINING AN IF STANDARD

If the intermediate frequency tuners are adjusted as has just been described, the value of the intermediate frequency is determined by chance. While this frequency is just as good for a Superheterodyne as one of any specified value, it may be desirable.

(Continued on next page)

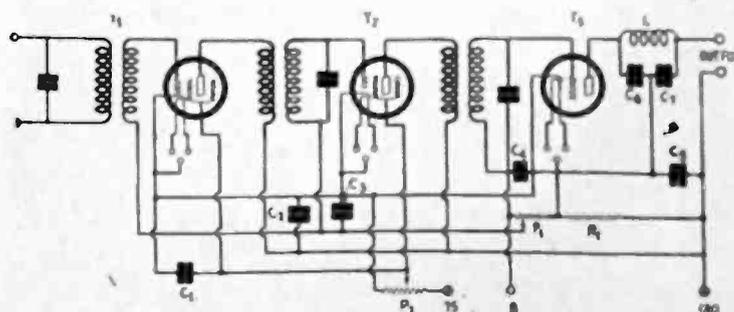


FIG. 26
AN AMPLIFIER LIKE THAT IN FIG. 24 BUT WIRED FOR AC SCREEN GRID TUBES.

Selectivity With Quality

Possibilities of Band Pass

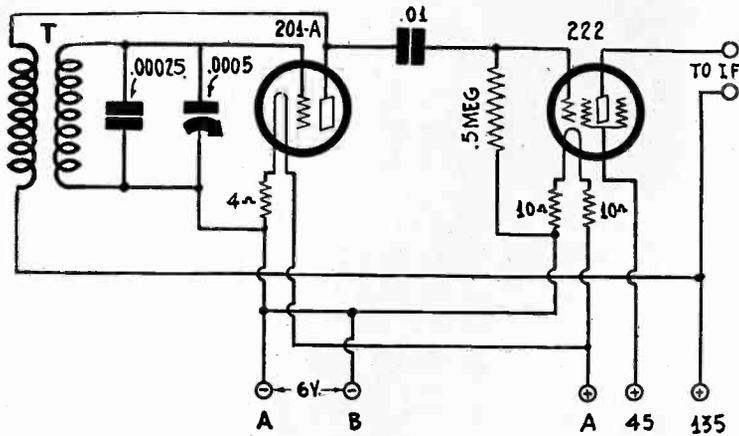


FIG. 27

AN OSCILLATOR CIRCUIT FOR GENERATING AN INTERMEDIATE FREQUENCY CURRENT FOR USE IN ADJUSTING THE TUNED CIRCUITS IN THE INTERMEDIATE FREQUENCY AMPLIFIER.

(Continued from the preceding page)

able to adjust the tuners to exactly a given value, say 200 kc. In order to do this it is necessary that the intermediate frequency oscillator be calibrated to the desired frequency before it is used. The simplest way to get it calibrated is to send it to an electrical standardizing laboratory after it has been constructed with the request that it be adjusted accurately to the frequency desired. This calibration can be obtained for a moderate fee.

But those who are skillful in handling vacuum tube circuits can get a close approximation to the desired frequency without taking the oscillator out of their own laboratory. Signals from a large number of broadcast stations are available to every one, and these signals are now held to definite frequencies with a high degree of accuracy.

The simplest way of using these is to tune in simultaneously two stations differing in frequency by the desired amount and then utilizing the beat between them. The next simplest is to tune in two stations which differ by half the desired frequency. For example, WEAJ is operating on 600 kc and WJZ on 760 kc. These differ by 100 kc. If an intermediate frequency of 100 kc is desired the beat between the carriers of these stations can be used directly. If an intermediate frequency of 200 kc is desired the second harmonic of the beat between the carriers of the same stations can be used. In every locality at least two stations can be tuned in which differ in frequency by an amount equal to the desired frequency or which differ by an amount which bears a simple relation to the desired frequency. There is a station for every multiple of 10 kc from 550 to 1,500 kc so that the beat between any two broadcast stations is a multiple of 10 kc, assuming that all stations are accurately on their assigned frequencies.

BEDLAM OF NOISE

When two broadcast stations are tuned in simultaneously for the purpose of getting the beat between them, the signals are first amplified suitably and then impressed on a modulator such as was shown in Fig. 7 or any other detector. The beat frequency and all its harmonics will appear in the plate circuit of

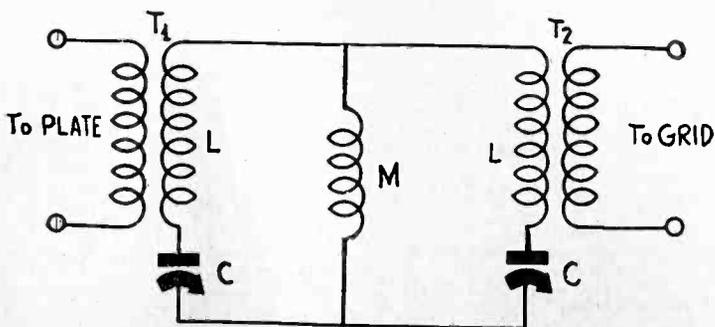


FIG. 28

A SIMPLE BAND PASS FILTER CONSISTING OF TWO SERIES TUNED CIRCUITS COUPLED WITH A SELF INDUCTANCE

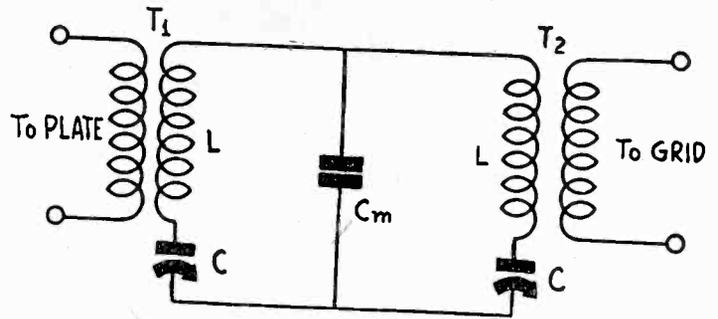


FIG. 29

A SIMPLE BAND PASS FILTER SIMILAR TO THAT IN FIG. 28 BUT USING A CONDENSER FOR COUPLING BETWEEN THE TUNED CIRCUITS.

the modulator tube and it is only necessary to connect an intermediate frequency amplifier to the modulator and then tune it to the desired harmonic. The noise that gets through will be composed of the signals of both stations and it will be bedlam. Tune for the greatest racket.

Many writers on the Superheterodyne have advocated the use of an intermediate frequency which is not an exact multiple of 10 kc, but rather one which is a multiple of 5 kc, on the ground that such a frequency would result in less squealing and less image interference. There is no justification for this. There will be squealing and interference aplenty regardless of the intermediate frequency, unless the interfering carrier is tuned out before it reaches the modulator, subject to the conditions which have been discussed already. If an intermediate frequency of 200 kc be selected nominally, any frequency between 210 and 190 kc will work just as well.

In view of this it is clear that the method of averaging, also discussed above, will yield a satisfactory intermediate frequency, and since this method of tuning the filter circuits is the simplest, it is recommended. We repeat this method. The transformers in the intermediate filter are constructed as nearly equal as practicable. Then condensers of equal value are connected across the windings to be tuned. The transformers should then be placed similarly in the amplifier with respect to tubes and shielding. When the receiver is complete any station is tuned in until the volume is greatest, using the radio frequency and oscillator controls. Then without changing the setting of the oscillator each of the intermediate frequency tuned circuits is adjusted with a trimmer until the response is the greatest.

A QUANDARY

As we found above, when the selectivity of the receiver is great enough to eliminate image interference as well as direct interference of carriers, it is so great that the upper side frequencies will be substantially reduced. The result will be excessive suppression of the higher audio frequencies. The output of the receiver will be predominantly bass, music will lack in brilliancy, voice will want in crispness, articulation will be poor, and, generally, the quality will be unsatisfactory.

If the selectivity in the radio frequency tuner is reduced much we encounter intolerable image interference. The only way, as we have found, of getting sufficient selectivity in this frequency level to eliminate image interference without cutting sidebands seriously is to use a high intermediate frequency. If the selectivity in the intermediate frequency level is reduced below a certain value, we meet direct interference between adjacent channels. And if we increase it so as to eliminate the interference, we cut the sidebands to the extent of making the quality of the output unsatisfactory.

There are two methods available by which necessary selectivity can be retained without ruining the quality. One is to employ a high selectivity and then build up the high audio frequency notes by an equalizer. The other is to employ band pass filters either in the radio frequency or the intermediate frequency tuners, or in both. Neither method is simple, nor entirely satisfactory.

A BAND PASS FILTER

A simple band pass filter is illustrated in Fig. 28. It consists of two transformers T1 and T2, which may be equal in design, two condensers C of equal value, and a small choke coil M. The secondary of the first transformer has the same inductance as the primary of the second. There are two equal tuned cir-

in a Superheterodyne

Filter and Compensator

cuits composed of the elements C and L. M constitutes a coupler between these circuits.

A filter of this kind has two resonance points, or maxima, the distance between which depends on the value of the coupling coil. One maximum is determined by the formula $w^2=1/LC$ and the other by $w^2=1/C(L+2M)$, in which w is 6.28 times the frequency of a peak, C is the capacity of either condenser, L the inductance of the coil in series with the condenser C, and M is the inductance of the coupling coil.

A similar filter circuit is shown in Fig. 29. This differs from that in Fig. 28 only in that the coupler between the two tuned circuits is a condenser C_m instead of a coil. The transmission characteristics of both filters is about the same. The points of maximum response for the circuit in Fig. 29 are given by $w^2=1/LC$ and $w^2=(1/C+2/C_m)/L$. The separation between the two points of maximum response therefore depends on the value of the coupling condenser.

Still another simple band pass filter is shown in Fig. 30. It consists simply of a radio frequency transformer in which both primary and secondary are tuned and in which the coupling between the two coils has a suitable value. The two tuned circuits, when not coupled to each other, are adjusted to resonate with the same frequency. When they are coupled the transmission characteristic contains two maxima the distance between which depends on the degree of coupling. Essentially the filters in Figs. 28 and 30 are the same with the exception that in one a self inductance is used for coupling and in the other a mutual inductance.

In any of these filters the distance between the maxima increases as the degree of coupling increases. When the coupling is close there are two definite points of maximum response; when it is very loose there is only one. There is one degree of coupling which separates these two conditions, and this is called the critical coupling. In a band pass filter the coupling should be greater than the critical, the amount depending on the desired separation between the two maxima.

SEPARATION OF MAXIMA

If it is desired to receive the higher audio frequencies up to 10,000 cycles without appreciable relative suppression, the band pass filter should be designed so that the two maxima fall 10,000 cycles above and below the carrier, and so that the transmission throughout this 20 kc band is approximately uniform. If, then, the carrier is 200 kc, the maxima should fall at 190 and 210 kc. If we put these two values into the formulas given in connection with Fig. 28 and divide one equation by the other, we find that M/L should equal $40/361$ in order that the peaks of the response be placed at the desired points.

We have already found that if the tuning condenser is .0005 mfd. and the intermediate frequency is 200 kc, the tuning inductance should be 1.266 millihenries. Therefore M should be 140 microhenries. There should be no mutual inductance between this coupling coil and either of the tuning inductances.

Now suppose it is desired to place the response peaks at 5,000 cycles above and below the carrier. We then have 205 and 195 kc to substitute in the two formulas for the peaks. Proceeding as before we obtain M/L equals .0526. If L equals 1.266 as before the value of the coupling coil should be 67 microhenries.

Let us see what the coupling condenser in Fig. 29 should be under the same conditions. We use the formulas given in connection with Fig. 29. These give the same ratio for C/C_m as the preceding formulas gave for M/L , namely $40/361$ for the 20 kc band and .0526 for the 10 kc band. Hence the values of the coupling condenser C_m should be .00551 and .00951 mfd., in the two cases, respectively. It will be noted that the narrower the band desired the larger the coupling condenser should be.

The circuit in Fig. 29 has the advantage over that in Fig. 28 that it is easier to eliminate stray coupling. But it is more difficult to adjust the value of the coupling condenser to the desired degree of coupling than to adjust the self inductance of the coupling coil to obtain the same coupling.

ADVANTAGE OF BAND PASS FILTER

In Fig. 31 are depicted the response characteristics of a simple tuner and of a band pass filter, the absolute value of the transmission having been adjusted to equality at the carrier frequency. The full line is that of a simple tuner and the dotted line that of a band pass filter having the maxima at 190 and 210 kc. It will be noticed that the solid line drops rapidly as the frequency varies in either direction from the point of resonance and that the side band suppression, therefore, is relatively large. The dotted line, on the other hand, is higher at 190 and 210 kc than at 200 kc.

An important feature of the dotted curve is that when it begins to drop it falls more rapidly than the full line. At about

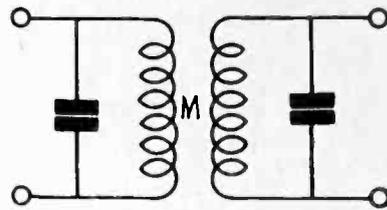


FIG. 30
A TRANSFORMER IN WHICH BOTH PRIMARY AND SECONDARY ARE TUNED IS A BAND PASS FILTER PROVIDED THE MUTUAL INDUCTANCE HAS A SUITABLE VALUE.

180 and 220 kc the curves cross, indicating that at these frequencies the suppression is the same for both types of filter. For higher and lower frequencies than these the suppression is greater for the band pass filter than for the simple tuner. Thus the effective selectivity of the band pass filter is much better and yet the side band suppression is much less, or it does not exist at all.

When the separation between the maxima in the band pass filter is 20 kc broadcast stations operating on frequencies differing from the desired frequency by 10 kc will interfere, for there is no suppression of them in the intermediate frequency filter and very little in the radio frequency tuner. Even stations the frequencies of which differ by 20 kc will interfere to some extent. To avoid this the maxima can be placed at 5,000 cycles above and below the carrier frequency. This may be done without cutting the higher side frequencies appreciably.

The band pass filter can be used with good advantage in the intermediate frequency level where the frequency is always the same. In the radio frequency level, however, it is not satisfactory due to the fact that the band width changes with frequency. It is about three times as wide at 1,500 kc as at 550 kc, for the same coupling between the elements of the filter. Moreover, it complicates the tuning, for there must be twice as many variable condensers as in a circuit employing simple tuners and the same number of stages. Every one of these condensers must tune its coil to the same frequency.

It is possible to combine the types of filter illustrated in Figs. 28 and 29 in the same intermediate amplifier, and it may be advantageous to use one of each. The response curve of either is not symmetrical about the carrier frequency to which the circuit is adjusted, due to the use of capacity in one and inductance in the other for coupling the two series tuned circuits. If one of each is used this lack of symmetry is practically eliminated.

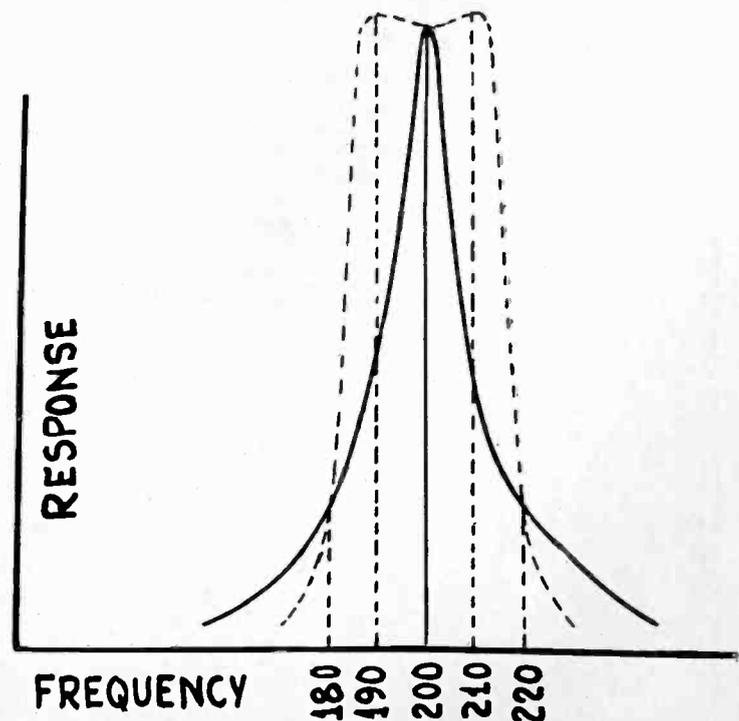


FIG. 31
CURVES SHOWING THE DIFFERENCES BETWEEN THE TRANSMISSION CHARACTERISTICS OF A SIMPLE TUNER AND A BAND PASS FILTER.

Too Much Bass in

Tuner, Audio Amplifier and Pa

By James

Contrib

WHAT is this thing in radio we call quality? What constitutes realism as the term is frequently used in talks about radio receivers? What is mellowness, crispness, roundness, fullness, sweetness, harshness, or boominess?

We have all heard the radio fan who waxes enthusiastic about the quality of his radio set every time he finds an ear whose owner cannot plug it up, who boasts that the quality of his receiver is absolutely perfect, yes, so like the original that every word the announcer utters can be understood. How would this "absolutely perfect" quality measure up against an impartial and inanimate standard of quality? Chances are that it would not rate highly. It is quite certain that it would not rate perfection, even as far as the standard could approach that condition.

A mother of a child learning to talk may understand every word the child utters even if the speech is still quite imperfect as judged by people not accustomed to the child's peculiarities of pronunciation.

UNDERSTANDING BY FAMILIARITY

The child's speech may be entirely unintelligible to all except the parents or to older sisters and brothers, and yet these may understand without any trouble. A man or a woman who has become accustomed to a certain radio receiver is nearly in the same position with respect to the set as the mother is to the child. Not quite the same, for the mother knows the child does not speak perfectly, yet she understands. The set owner does not know whether or not his set produces good or bad quality. He is satisfied with the quality because he has become accustomed to it. If he heard a receiver capable of as nearly perfect quality as at present possible, he would probably judge it imperfect and call it unsatisfactory.

WHAT IS REALISM?

Realism is simply that quality of a receiver which makes the reproduced sound appear identical with the original. It is difficult to tell by ear and memory when the reproduction closely resembles the original because the human ear is partial, erratic, and forgetful. An engineer, with suitable instruments at his disposal, can tell more definitely the degrees of faithfulness, and, of course, he can do that without hearing the reproduced sounds at all. Indeed, he can appraise the quality much better without hearing the sounds, for his ears are subject to the same deficiencies as those of anybody else. However, if he hears reproduced sounds frequently and knows by impartial tests that the quality is good, he soon learns to judge better than the best musician. He learns even more when he listens to sounds with known defects.

The term mellowness has been applied to that quality which indicates absence or weakness of the higher audio frequencies, moderate strength of the low notes, and even response in the middle. Judging by the term used to describe it, it is pleasing to most people.

Crispness has been applied to describe the quality which indicates especial strength of the higher audio frequencies, particularly in the region between 5,000 and 10,000 cycles per second. This quality is characterized by good articulation of speech, which means ease of understanding clearly all the words spoken and distinctness of all consonants uttered by a speaker. Many people don't like it because static and similar noises are brought out prominently. It is great, though, for listening to a prize fight, for all the incidental noises can be heard plainly, including what the announcer says. In a sense crispness is the opposite of mellowness.

WHAT COULD ROUNDNESS BE?

Sometimes the quality from a receiver is described as being round, full, and sweet. There is some doubt as to the exact meaning of these terms, but since they are always used to express praise, they must signify some pleasing quality, or they may mean simply that the praiser is chuck full of praise and that he lacks any more definite terms in which to describe it. Well rounded is the term that is most frequently used by this well satisfied person. Presumably the term indicates that the reproduction is balanced as to the reproduction of highs, middles and lows. Or it may be that the reproduced sound is characterized by what has been termed tone balance, that quality which results when the amplification is symmetrically distributed in the frequency scale about a frequency in the middle register. The amplification may be down both in the highs and the lows, but the effect is pleasing if it is down equally at both sides of the middle frequency.

By full is usually meant that the amplification is good on the bass notes. If the boom-boom of the bass drum or the bull fiddle come through well the reproduction is full, and this holds whether the prominence of the low notes is due to true amplification or to a

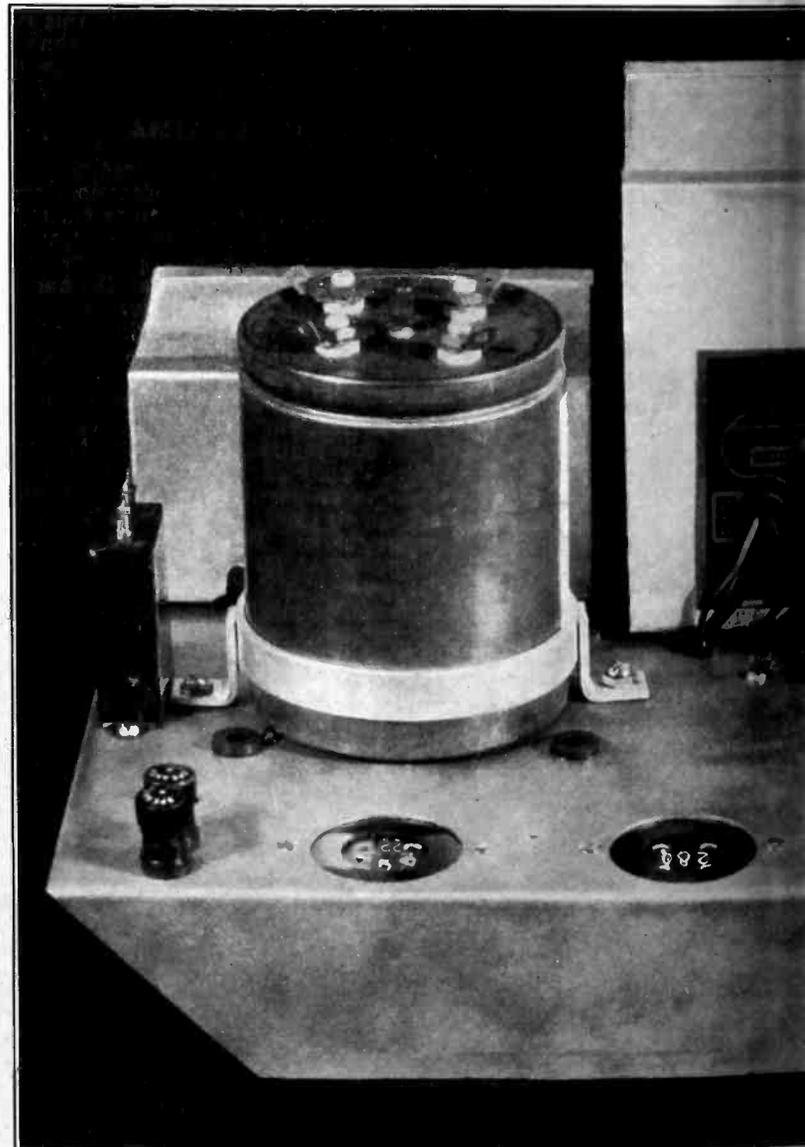
false resonance in the amplifier or in the speaker. By sweet reproduction is meant what have you. What could be sweeter than sweetness!

Harshness applied to a reproduced sound is a term that has a real significance. In nearly all cases it indicates that the amplifier is being overloaded either because the volume is too great or because the tubes, due to deterioration of improper voltages, are not capable of sustaining the signal. The quality might also arise because the B supply is not adequate, that it lacks in reserve to sustain the fortissimo passages. The term roughness is also used for the same kind of distortion, and it is also said that the sound is not clean cut. The ear is very sensitive to this form of distortion.

TOO MUCH BASS

There was a time when no radio receiver was capable of reproducing sounds below about 400 cycles per second. That was the period when radio reproduction was comparable with the reproduction from the old-time phonograph. Only high pitch sounds came through the little horn. The newness of radio was the only thing that saved the receiver from the junk pile. There was no entertainment value at all in the reproduction.

There were many reasons why the low notes did not get through. In the first place they were not broadcast, because the transmitting equipment in those days was almost as poor as the receivers. In the second place the audio transformers incorporated in the first audio amplifiers were in effect tuned circuits with a resonance peak



RELATIVELY EVEN AMPLIFICATION OF AUDIO FREQUENCIES IN THE BASS, MIDDLE OR TREBLE, IS AFFORDED BY THIS PUSHTON TUNER LAST WEEK'S IS

Modern Installation

Particularly Speakers are Responsible

E. Carroll

Editor

about 2,000 cycles, sometimes as low as 1,000 cycles per second. At the resonant frequency the amplification was enormous. Above and below this frequency there was not only no amplification but there was a loss. This characteristic was accentuated in the transformer having a high step-up ratio.

The third reason why the bass notes were absent was that the loudspeakers could not reproduce them even if they were impressed with considerable intensity on the speakers.

The publicity for bass note reproduction led to continuous improvement all along the line. Low notes were broadcast together with the middle and the high. Audio frequency transformers were designed which were effective down to as low as 30 cycles per second. At the same time the resonance peak in the middle register was reduced or pushed up to 5,000 cycles and higher. Loudspeakers were designed to reproduce almost anything that was impressed on them.

The public went low note mad. The criterion for good quality became the preponderance of bass in the loudspeaker. It did not matter whether anything else came through. And the result is that now there is too much bass and too little of everything else. Fans got what they wanted.

HOW BASS WAS OBTAINED

The bass was secured in many different ways. First, the sets were made so selective that everything but the sounds from the bull fiddle and the bass drum was tuned out by the process of sideband

cutting. Then condensers were put across the winding of coupling transformers and the loudspeaker with the result that every high note was carefully steered away from the loudspeaker. Good sized choke coils were also put in series with the line and this had the same effect. Some manufacturers have even went to the trouble of tuning the audio frequency amplifier at a frequency below 100 cycles, thus making sure that there would be plenty of bass whether there was anything else or not.

The same process went on in the design of speakers. They were made so that there would be either electrical or mechanical resonance at a low frequency. The reproducing unit was placed in compartments of a size which would accentuate low notes. This was either done intentionally or in ignorance, but boom-boom was the effect in either case. In order to make sure that there should be nothing left but bass, many manufacturers put high note suppression filters in the receivers or in the speakers. This was done primarily to reduce static and tube noises, but it had the effect of accentuating the bass and to render speech well nigh unintelligible.

NO PLEASURE ALL BASS

This preponderance of bass in modern radio sets would be all right if the reproduced music and speech were pleasurable, but they are not. It is nerve-racking, not only to those operating the receiver, but also to all others who are forced to listen. It is even more trying to other people because they are sure to get nothing but the umpah, umpah of the bass drum and the grunts of the low pitch saxophone, and they can't do anything about it.

That people are seriously annoyed by the continuous racket is evidenced by the fact that municipal health authorities have taken action to stop the noise. Health Commissioner Wynne of New York has appointed a committee of engineers and physicians, experts in speech, hearing, and neurology, to study the problem of noise in the city and to suggest remedies. There is no doubt that every apartment house dweller in the city will welcome the work of this committee and cooperate in every way, because the radio racket is their greatest annoyance and that is one phase of the noise problem which the committee will attack vigorously.

Does this mean that radio loudspeakers are to be banished if possible? Not at all. It simply means that an effort will be made to make people realize that the operation of a loudspeaker full blast all day and at all hours of the night is not consistent with public health, peace and happiness. There is no reason for shutting the speaker up entirely when it is only necessary to turn it down to a reasonable volume, a level which is entirely adequate for any home and yet low enough to confine the sound to the apartment where the speaker is located.

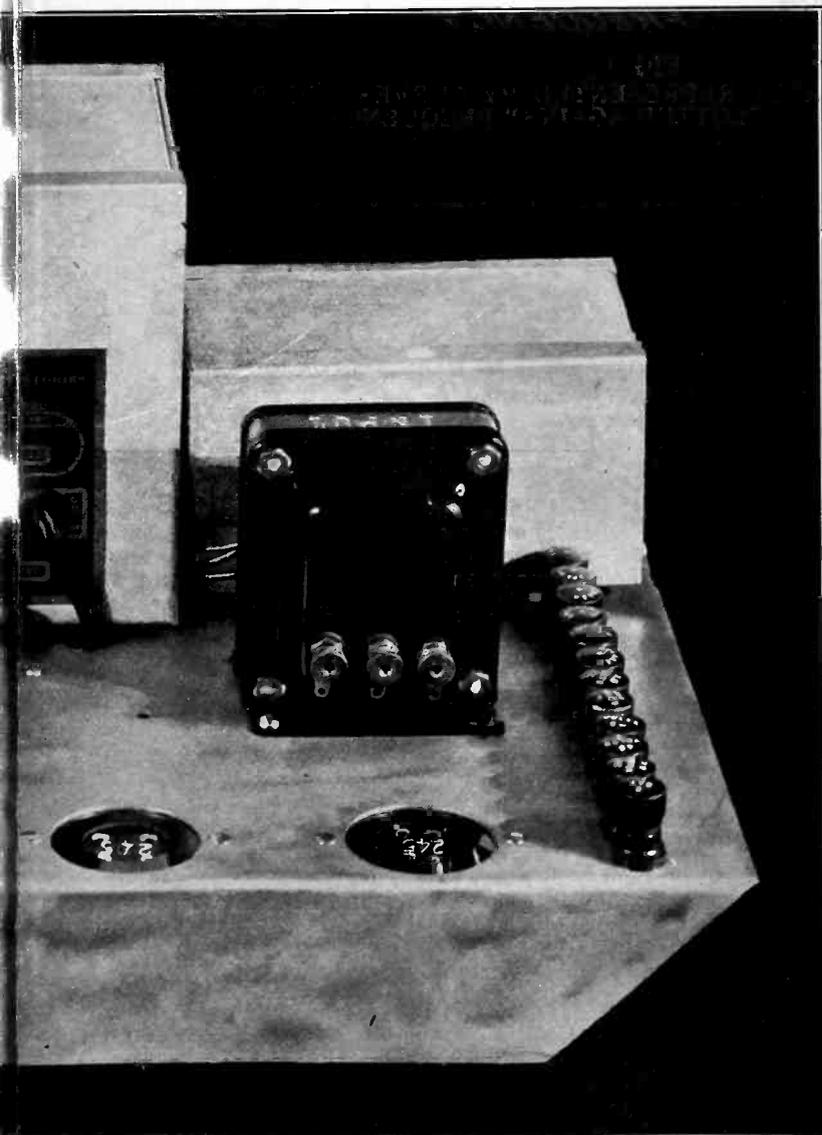
INCONSIDERATE HABITS

Much of the radio racket is due to nothing but bad and inconsiderate habit. One typical example may be mentioned. A powerful radio set, which is particularly strong on the bass notes, is located on the second floor of an apartment house. There are families above, below and on two sides. The set is operated directly from the house electric line, and hence needs no attention. Early in the morning it is turned on full blast and it is left on all day and all into the evening. The set is even permitted to play when nobody is in the apartment to listen to it. The woman of the house goes out every pleasant day to trade scandal with other women and give the children an airing. But she never turns the radio set off when she leaves, nor does she turn it down. The only saving grace about that case is that the set is turned off before eleven o'clock in the evening.

What does this typical bass reproducer do? It shakes the house just as if a bunch of flappers and shieks were dancing to the rhythm of the music. It is making nervous wrecks of the people living in neighboring apartments, and it is making the responsible family highly unpopular.

Of course, this family is not exempt from similar annoyances. There is a radio receiver in nearly every apartment, and one or more of them will annoy this family. The trouble, perhaps, is that no one realizes that his own set is loud enough to carry beyond the walls of his own apartment. It is only the other fellow whose set is too loud. Then, again, it must be granted that everyone has the best receiver on earth, and he is more than willing to give his neighbors a treat of real music.

Those who are in this frame of mind might do well to remember that the great Caruso was often cursed by his neighbors for disturbing their peace, and that quite recently a living Metropolitan diva was hailed to court by distracted neighbors for singing too vociferously at unseemly hours.



YES, AVOIDING OVER-ACCENTUATION IN ANY REGION, FULL POWER AMPLIFIER, AC OPERATED, DESCRIBED IN NOVEMBER 2D.

Selectivity Accurately Defined by Picture Only

HOW can the relative selectivity of receivers be expressed accurately in words? What is the usual method of showing comparisons?

There is no way of comparing accurately in words the difference in selectivity, as only very general terms are applicable, such as "poor selectivity," "good selectivity" and "high selectivity." These terms give no real clue to the situation. It is customary to show selectivity by plotting a curve of response against frequency. The cutoff at frequencies adjoining resonance will reveal the selectivity. The height of the curve will show the relative degree of amplification. Thus in Fig. 1 curve A represents the lowest order of selectivity, virtually none, while B is an improvement, as is C, and D represents a useful curve, that is, the selectivity is of the degree required for modern reception. E is the most selective curve, and at highest amplification, with a top that admits enough of a frequency band to preserve quality. If it is assumed that the width just under the hook at the top of curve is 10 kc the curve is then ideal, except for a minor absence of flatness at the top. The five curves may be taken as an indication of selectivity gained by cascaded tuned RF.

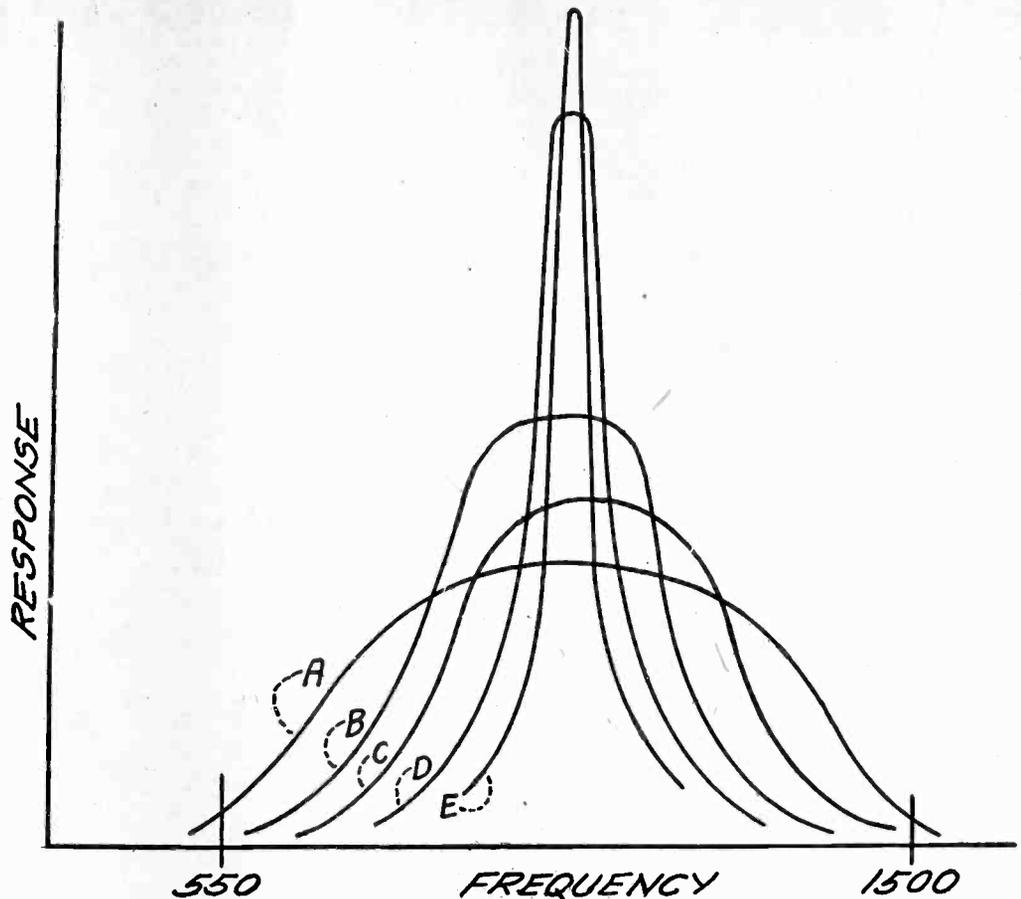


FIG. 1
SELECTIVITY IS USUALLY REPRESENTED BY CURVES, WHERE THE RESPONSE IS PLOTTED AGAINST FREQUENCY.

Right or Wrong?

(1)—A voltage drop in a resistor cannot be used as a negative bias and as a plate voltage at the same time.

(2)—A modulated wave is a wave the amplitude of which varies according to the amplitude of the wave with which it is modulated.

(3)—All the tuning condensers in a superheterodyne can be put on one control, including that of the oscillator, and still leave a choice between the higher and the lower oscillator settings for any given broadcast station.

(4)—The selectivity of any tuner depends primarily on the total effective series resistance in the tuned circuit.

(5)—Sideband cutting in a tuner is entirely independent of the selectivity of the tuning system.

(6)—It is the frequency ratio between the frequency to the carrier in conjunction with the selectivity which determines how much the side frequency is cut down.

(7)—Image interference in a superheterodyne can best be reduced by choosing an intermediate frequency of comparatively high value.

(8)—Radio waves and light waves cannot be of the same nature because light decreases in intensity directly as the square of the distance from the source, whereas radio waves decrease directly as the distance.

(9)—Sideband cutting is confined to the intermediate frequency filter.

(10)—Suppression of high audio frequency notes occur in the radio frequency tuner, in the intermediate frequency filter, and in the audio frequency amplifier which has too many and too large by-pass condensers.

(1)—Wrong. When heater type tubes are used it is possible to utilize the grid bias on the last tube for plate voltage or screen grid voltage on other tubes provided that the cathodes of these tubes are connected properly to the voltage divider.

(2)—Right. That is one way of looking at a modulated wave. The other way is to regard it as composed of three components, the carrier wave and the two side frequency waves. Each of the side frequencies must differ from the carrier frequency by an amount equal to the modulating frequency.

(3)—Right. This is made possible by introducing a variometer

coil in the oscillator circuit. Turning the coil in one direction brings in the higher frequency setting and turning it in the other brings in the lower setting.

(4)—Right. The selectivity is measured by the ratio of the reactance of the coil to the total resistance. The reactance remains substantially constant provided only a small frequency range is considered. The total resistance is made up of the effect of the resistance of the wire of the coil, the effect of eddy currents in other conductors in its vicinity, and by the effect of resistance, or rather conductances, connected across the coil and the tuning condenser.

(5)—Wrong. In the ordinary tuner sideband cutting is directly dependent on the selectivity. Selectivity cannot be had without sacrificing the side frequencies remote from the carrier.

(6)—Right. The absolute value of a side frequency means little in this respect. If the selectivity in the two cases is the same and if one carrier is 200 kc. and another 2,000 kc., the suppression of a 190 kc. frequency will be the same in the first case as that of a 1,900 kc. frequency in the second case.

(7)—Right. The higher the intermediate frequency the more is the interfering carrier suppressed by the radio frequency tuner.

(8)—Wrong. Light waves and radio waves are both electromagnetic waves and they obey the same laws under similar conditions. Due to the fact that they ordinarily differ so widely in frequency they appear to behave differently.

(9)—Wrong. Sideband cutting occurs wherever there is selectivity and it depends directly on the value of the selectivity.

(10)—Right. The high audio notes are suppressed in the radio and intermediate tuners because the corresponding side frequencies are cut down. They are suppressed in the audio amplifier because there are many effective by-pass condensers across the line. There are the plate to filament capacities, the grid to filament capacities, the distributed capacities in audio coupling units. There is also suppression due to series inductances such as radio frequency choke coils put in series with the line for the purpose of preventing radio frequency currents from being transmitted to the audio amplifier. Capacity in the leads to the loudspeaker also reduces the intensity of the high audio notes.

Pointers on the Diamond

Push-Pull Model, Battery and AC, Analyzed and Compared

[The Push-Pull Diamond of the Air has been designed for battery or AC operation. The battery model was discussed in the October 13th and 20th issues, with additional data on that model and some preliminary information on the AC model in the issue of October 26th. The same fundamental circuit is used in both, consisting of a screen grid RF amplifier, a detector, a first stage of resistance-coupled audio and a push-pull output. In the battery model the output may be 112A or 171A pairs in push-pull, but for the AC model two 245s are used. Picture diagrams of the wiring of both models are in preparation. The one for battery operation is scheduled to be published next week, issue of November 16th. Another instalment on the AC model will be published in that issue. —EDITOR.]

IN the assembly of the Push-Pull Diamond of the Air, either battery-operated or AC model, a cadmium-plated steel sub-panel is used, with sockets affixed and holes drilled to receive the parts, while the front panel matches this arrangement with proper holes.

It is agreed that screw heads do not enhance the appearance of the front panel, therefore a method was devised of hiding them from view. These screws affix the front panel to the subpanel. But it is necessary to take a few precautions to make the result successful.

First, the system used is to locate these screw holes at a point just under the knob. Therefore when the knob is attached in one instance to the volume control shaft and in the other instance to the tickler shaft, the screws already put in place and tightened with nuts are out of view. The knobs hide them.

GIVING ROOM TO THE VOLUME CONTROL

With the tickler shaft there is nothing in particular to consider, as there is no moving part within reach of the screw, but the volume control at the opposite side needs working room at the rear. This is provided by putting this screw in backward, and by using a flat head machine screw. Therefore the screw shank protrudes from the front of the panel, a nut is affixed to the screw, tightened down and the excess of the screw shank is cut off with snippers. Then the knob is put on, being pressed in deep enough to bite the shaft well, when the set-screw is turned, but not so deep that the rim of the knob touches the nut that has just been affixed.

This method will prove satisfactory and the desired end will be well achieved.

Another mechanical precaution is to insert the three circuit coil in the large hole drilled at the factory in the subpanel. This is almost inevitable, since the place to mount the coil is decided by the position of the hole in the factory-drilled front panel, yet it is well to be sure the three circuit coil fits nicely in place and that the terminal lugs on the coil do not come near to the subpanel. Since the subpanel is metal, naturally if the lugs touch it there will be a short circuit. This will be avoided if the lugs are bent inward, toward the center of the coil form, which may be done after the soldering of leads to these lugs has been completed, but should be done before the set is actually tested.

AC DIAMOND MORE SENSITIVE

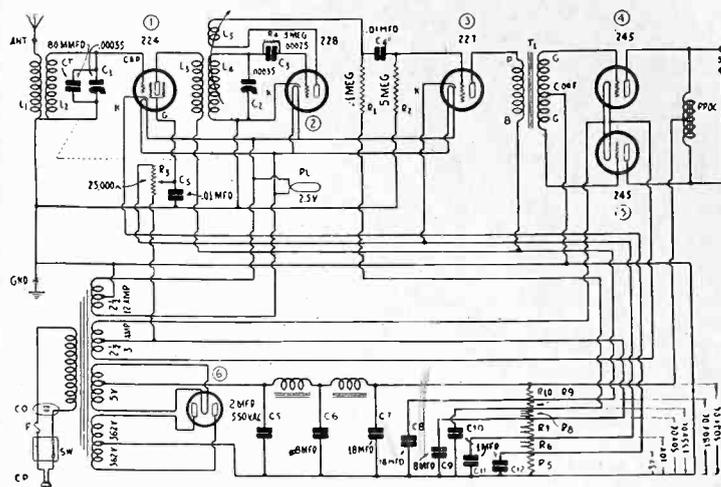
The AC model has an extra tube, the 280 rectified, and besides uses AC tubes, and the 245 output tubes in push-pull, but the radio frequency circuits in both models are as near the same as circumstances permit. They are almost identical. The performance differs however. The AC model is more sensitive, this being due in part to the higher plate and screen grid voltages, and in part to the higher amplification of the 224 AC grid tube as compared with the 222 battery-operated screen grid tube.

All the C minus points on the AC receiver are at ground potential, as the negative of the B supply, which is grounded, is always the grid return. This is true even for the detector, since the 227 or preferably 228 tube used here affords good detection by the leak and condenser method when the cathode and grid return are joined, that is, the cathode is grounded. This makes a zero bias, since there is zero potential difference between cathode and grid return.

BETTER QUALITY AND SELECTIVITY

Also it affords a little better quality than if the grid return of the detector were made to positive, since flow of grid current is kept very low by a zero grid return. With grid return is a few volts positive the flow of grid current becomes rather large, and often is large enough to reduce selectivity noticeably. However, both the battery-operated and AC models of the Push-Pull Diamond have sufficient selectivity.

Neither model will produce motorboating, and the AC model



THE TAPS OF THE VOLTAGE DIVIDER SHOULD BE USED AS SHOWN, AT FIRST, BUT ADJACENT TAPS MAY BE TRIED EXPERIMENTALLY, AS THEY SOMETIMES PRODUCE BETTER SENSITIVITY, DUE TO DIFFERENCES IN TUBES.

will work with hardly any hum, that is, even when no signal is being received the hum will be scarcely noticeable. When the program is coming in there will be no distinguishable hum. This condition is due largely to the excellent filtration, the double choke used in the B filter being of a total inductance of 80 henrys, and, by the way, the same type of unit is used for the push-pull output. The maximum current to be passed through this double choke should not exceed 125 milliamperes, but of course in the present circuit no such high current will flow in the B filter section, and certainly not in the push-pull plate circuits.

The total plate current at the output, adding the currents of the two tubes, should not exceed 65 milliamperes, and that is all that flows through each leg of the output choke, and the remaining receiver tubes will not draw more than 15 milliamperes, including the screen grid of the first tube, so a reading of 80 milliamperes or less should prevail.

HOW TO READ TOTAL CURRENT

This reading is taken by opening the B minus lead, as between C12 and the low end of the voltage divider and inserting the milliammeter with negative toward the rectifier and positive toward the unconnected end of the voltage divider.

You will find the voltage divider, which is a Multi-Tap, will operate without more than a trifle of heat, a comparison indeed with most voltage dividers, that get so hot that the enamel coating cracks off, exposes the wire to moisture, and eventually brings about rusting and severance of the wire itself. This breakdown in poorly designed voltage dividers is gradual, and begins to assert itself in the form of crackling sounds, but with the Multi-Tap all danger of suffering such nuisance is absolutely rendered impossible, as the resistance wire will carry 125 milliamperes without any trouble, and here we are using only about 80 milliamperes and not all of that through the entirety of the resistor winding.

OPTIONS ON TAP USE

Such a substantial voltage divider, not easy to manufacture, but well worth the trouble of its production, has fourteen taps, of which thirteen are useful. Only seven are used in this circuit, and the ones left blank are suggested in the diagram, but there is no reason at all why the used taps should not be different ones, as sometimes tubes will give better performance at a little higher or lower plate voltage.

A THOUGHT FOR THE WEEK

Rockets multiply. For instance: Recently the manager of an important broadcasting station discovered that a minor employee of the studio was charging admission—disguised as tips—to a small but troublesome group of persons who had been smuggled into the sacred precincts of the mike. Result: Another chap is looking for a job.

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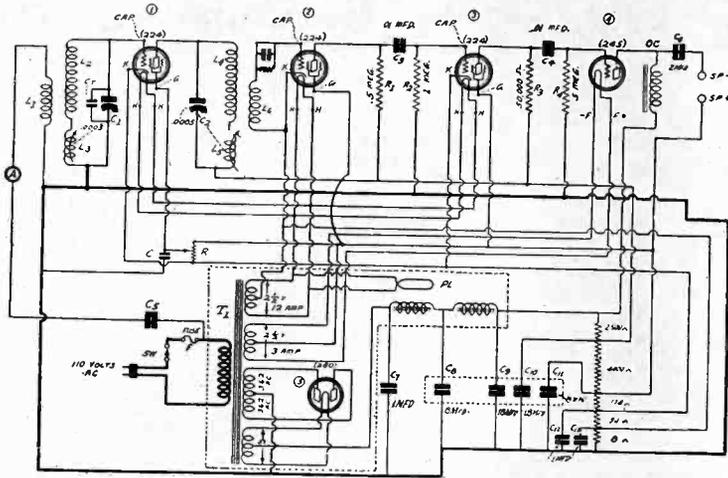


FIG. 804

A COMPLETE RECEIVER EMPLOYING SCREEN GRID TUBES AND RESISTANCE COUPLED AUDIO. ONE OF THE IMPORTANT FEATURES IS THE USE OF AN ELECTROLYTIC CONDENSER IN THE B SUPPLY UNIT.

COMPLETE RESISTANCE COUPLED RECEIVER

I WISH to experiment with resistance coupling and screen grid tubes, and I would appreciate your publishing a complete receiver of this type, preferably with AC tubes. If any trouble is likely to develop when using screen grid tubes in resistance coupling, please point them out.—J. O.

You will find such a circuit in Fig. 804. It employs a screen grid RF amplifier and a detector of the same type as well as an AF amplifier. The trouble which is most likely to occur is indifferent amplification due to improper voltages on the plates and the screens, and to some extent on the control grid. There will be no trouble if the plate voltage is high enough, but you should remember that in a screen grid tube the effective voltage on the plate counts and not the voltage applied to the binding post for the plate in question. If you think the effective voltage on the plate is too low, reduce the voltage on the screen on the tube, or you can both increase the applied plate voltage and decrease the screen grid voltage. Difficulties may also arise from regeneration in the amplifier. An electrolytic condenser of very large value is recommended across the voltage divider and another across the voltage taps leading to the plates of the screen grid tubes.

LARGE OR SMALL CONDENSER

I N MANY B supply units a large by-pass condenser is recommended next to the rectifier tube and in others a small one is recommended with a specific statement that the first condenser should not be large. Which is right and why?—A. G. W.

It is not necessary to use a condenser larger than 2 mfd. In many instances when a large condenser, such as a section of an electrolytic, a terrific hum results. When a large condenser is used it should be the last one in the filter.

LOUDSPEAKER BEDLAM

I LIVE in an apartment house in which there are loudspeakers all around me, all of which seem to be going full blast all the time. The noise is unbearable. Can you suggest any way of reducing the racket? Are there any laws that can be invoked against it?—M. M. C.

Thousands of other apartment house dwellers are suffering the same as you are and are looking for some relief. In some communities there are ordinances prohibiting the operation of loudspeakers that they will not annoy other people. In other places exceptionally bad cases are treated as a public nuisance. Possibly the best way is to get in touch with the neighbors in a friendly way and make them realize that their speakers are disturbing your peace and quiet. Perhaps they, too, are suffering from other speakers and are willing to cooperate. You know it is difficult for any one to tell just how far the sound from a given speaker will annoy people. In New York City the Health

Department has appointed a committee of experts on sound, hearing and neurology for the purpose of studying the effect of noise of all kinds on health and to suggest means for ameliorating the conditions. One method of reducing the noise will be to obtain the greatest possible publicity against it to make everybody realize the need of quiet. General realization on the part of the public will go a long way to stop all unnecessary noise. It is quite possible, also, that ordinances will be passed making it compulsory to tone down loudspeakers. One thing that causes more disturbance than anything else is the preponderance of low notes in many radio receivers. The lower notes can be heard plainly throughout an apartment building when other notes cannot be heard at all. Perhaps it will be necessary to put a limit to the reproduction of low notes if people cannot learn to use the receivers properly.

VOLTS PER METER

WHY IS a radio signal measured in volts per meter and what does this expression mean? Is it a fact that there exists a voltage difference between two points in space when a radio wave passes over the point? If so, is the voltage difference between two points in the same horizontal plane or between two points in a vertical plane?—H. A.

The intensity of a radio wave is measured in volts per meter, or millivolts per meter, because as the wave passes there exists a difference of potential between any two points. The distance between these points is measured in meters and the total potential difference in terms of a suitable sub-multiple of the volt. The difference of potential exists whether or not there is a conductor between the points; but if there is an antenna in the path of the wave an emf. equal to the potential difference between the ends is induced in the wire, and this emf. causes a current to flow. Usually the voltage difference exists between two points in a vertical plane and for that reason an antenna is erected vertically. It is the vertical portion of the antenna that counts. The horizontal portion simply adds to the capacity. There may also be a potential difference between two points in a horizontal plane, because the wave that leaves the antenna of the transmitting station vertically may tip forward as it progresses and ultimately there may be a considerable horizontal component. If the transmission takes place from a loop that is horizontal the major portion of the wave is horizontal as far as its effect on a vertical antenna is concerned. There are two parts to any wave, the electrical and the magnetic. When one is horizontal the other is vertical. A vertical antenna responds to the electric field when this is vertical. A loop antenna the plane of which is vertical responds to the magnetic field of the same wave.

HUM IN B SUPPLY

I HAVE just obtained a new power pack which is supposed to be all right, but so weak that even the signals from local stations cannot be heard distinctly in competition with it. What can be wrong?—T. J. O'B.

Many things could be wrong, but it may be that you have drawn a defective unit. Make sure of this point by comparing it with other B supply units of the same kind.

OPERATING LOW VOLTAGE MOTOR

I HAVE a powerful 6-volt DC motor which I wish to use on the 110-volt DC line. Can this be done efficiently either directly or by means of a charger and a storage battery? Which is the more efficient of the two methods?—J. B.

It cannot be done efficiently either way, if it can be done at all. It may be that the motor requires so much current that the present wiring will not carry it safely. If your wiring is heavy enough you are still confronted with the fact that about 95 per cent. of the power you take from the line will go toward heating up the line resistance that you must use to cut down the current. Of the two methods the direct connection is the more efficient. If you use a charger and a battery you must reckon with the 80 per cent. efficiency of the battery.

RESISTANCE COUPLING

I HAVE been told by radio engineers, and I have read statements to the same effect, that resistance coupling is capable of the most faithful reproduction and the best quality, but when I ask custom set builders their opinions of resistance coupling they always discourage its use. They seem to be unanimous that resistance coupling ought to be avoided at all

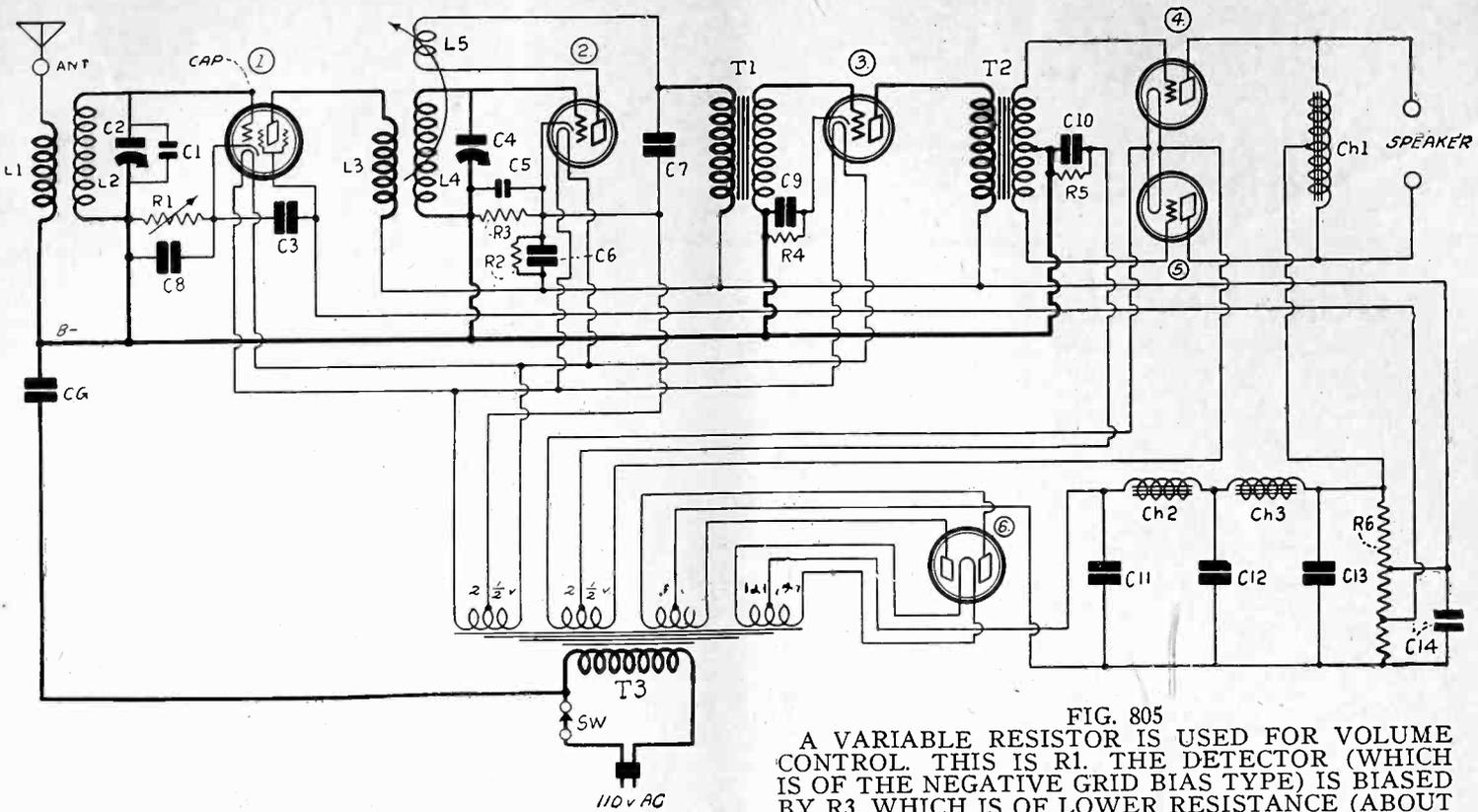


FIG. 805

A VARIABLE RESISTOR IS USED FOR VOLUME CONTROL. THIS IS R1. THE DETECTOR (WHICH IS OF THE NEGATIVE GRID BIAS TYPE) IS BIASED BY R3, WHICH IS OF LOWER RESISTANCE (ABOUT 1,800 OHMS) THAN OTHERWISE, DUE TO BLEEDER CURRENT FROM R2 (ABOUT 20,000 OHMS).

costs. I also note that manufacturers use transformer coupling, even those manufacturers whose engineers personally boost resistance coupling. Now what is your honest opinion?—D. McC.

There is no question at all that resistance coupling is capable of more faithful amplification than any other form of coupling, but there are many other factors which enter into the design of a receiver. In the first place, resistance coupling does not necessarily give better quality. In many instances it gives worse quality than first-class transformer coupling. Then it is subject to many difficulties from which transformer coupling is relatively free. Service men have had difficulty to solve these troubles and therefore they discourage the use of resistance coupling. This is one reason also why manufacturers use transformers, although they cost much more than resistance couplers. Many who understand the vagaries of resistance coupled amplifiers would not use anything else, yet they would not recommend their use to anybody who is not equally versed in the subject. Whenever the great laboratories must have distortionless amplification for any purpose they use resistance coupling. Whenever they can avoid using it they usually employ transformer coupling.

BIAS FOR VOLUME CONTROL

DOES varying the bias of an RF tube satisfactorily control volume? Should a bypass condenser be used across it? How may the resistance be made fundamentally lower without altering the bias? In the power tube stage where is C plus in an AC set.—D. W.

Variation of negative bias on the RF tube is satisfactory. See Fig. 805. R1 is the biasing resistor used for volume control. Its value depends on the amount of volume attenuation desired. A few thousand ohms usually will suffice. The resistor should be bypassed by .01 mfd. or higher (C8 in diagram). In the detector stage the biasing resistor R3 is fundamentally lower than otherwise, but at same bias, because extra current is passed through R3 due to connection of R5 to BX (about 135 volts) to furnish bleeder current. C plus in the power tube stage is the center-tap of the filament winding. C minus is ground. R5 is the biasing resistor for the push-pull circuit diagrammed.

WHY FOUR-TUBE SETS FOREVER

HOW IS it that you continue to publish four-tube sets when manufacturers put many more tubes in their sets? If more than four tubes were not necessary, surely the manufacturers would not design receivers with more. What's the answer?—W. D. W.

One reason is the same as the reason why there are more Fords than Lincolns. A four-tube set well designed will give just as good quality as a set with twice the number of tubes, and it will get all the local stations and many distant ones. Receivers using more tubes may be more sensitive so that more distant stations can be brought in or so that the local stations can be brought in with a small indoor antenna.

PUSH-PULL OR NOT

IS IT really worth while to use a push-pull amplifier or is push-pull only a fad? I can get enough volume to suit me with a single output tube, and it seems that I get as good

reproduction as could be expected. Just wherein is push-pull superior to single-sided amplification?—A. A. F.

Push-pull is not a fad. In the future it will undoubtedly be used more than it is now. Yes, a single tube gives plenty of volume, and, indeed, too much at times. The trouble is that it does not give as good quality on the same volume as does push-pull. It may well be that the quality from your single-sided amplifier seems as good as that from a push-pull. But have you heard two receivers of these types at the same time, or consecutively with only a moment between? The human ear has the habit of getting used to certain sounds and any different sound may seem strange and inferior.

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HOW HIGH GAIN AND SHARPNESS JOIN QUALITY

We know that with screen grid tubes amplification heretofore unknown can be obtained, and with remarkable sacrificing selectivity or destroying the radio frequency signal, a special tuning system must be used.

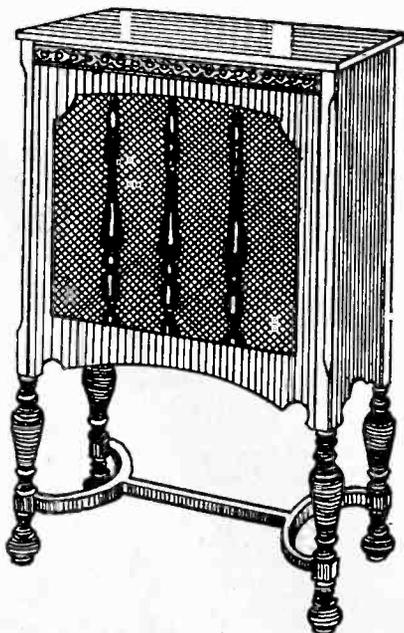
Let us see why. Suppose we use a radio frequency amplifier which permits the utilization of the maximum amplification of the screen grid tube. Then we are unable to tune in any distant station or local station operating on a frequency near to that of the same being tuned in, for it would be blanketed out. Then suppose we introduce selectivity. The side bands are then cut and the signal is destroyed.

With what is known as a band filter unit, all the amplification of the tube can be used and selectivity maintained. This unit precedes the first RF tube, pre-selecting the signal. This selected signal, which is an exact radio frequency signal reproduction of that transmitted, is then fed into the RF amplifier for strengthening. We thus have selectivity, with no side band cutting, and with maximum tube amplification.

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PUBLIC BEGINS LIKING REMOTE SET CONTROLS

Remote control of radio receivers is rapidly gaining in popularity. In every radio store in New York City there is at least one receiver prominently displayed which features remote control.

The object of remote control is to permit placing the receiver proper in a closet or other out-of-the-way place, leaving only a little control box at the operator's elbow. The control box is usually no larger than a small sized cigar box and contains a minimum of knobs and push buttons by means of which the receiver is controlled. A multiple-conductor cable leads from the control box to the receiver, and this cable can be concealed under the rugs or along the moulding. The control box permits the choice of any one of a certain number of specially selected stations. To get one of these it is only necessary to press the proper button on the control box.

There is now keen rivalry among manufacturers of receivers to work out the best system of remote control, for they believe that the next major development in radio will be along this line.

The remote controls usually work on a system of relays which operate when a button is pressed. One relay may close the line switch, starting the receiver, another may start a tiny motor which drives the tuning mechanism and still another may force the motor to stop at a specified point where the desired signal comes in.

Utah, Carter, Eby Merge; Frost President

In a statement of policy regarding the new trade parts organization built around the Utah Radio Products Company, Major Herbert H. Frost, president, announces that his group would not enter the radio receiver field.

The Utah Company recently acquired the H. H. Eby Company of Philadelphia and the Carter Radio Company of Chicago. Later Caswell-Runyon joined up.

Pilot Denied Permit On Aviation Channel

Washington. The application of the Pilot Electric Manufacturing Company of Brooklyn, New York, for an experimental license for a 250-watt transmitter to operate on the aviation channels, recently was denied by the Federal Radio Commission.

MARKET BREAK TAXES RADIO

The recent stock market break so taxed the facilities or radio transmitting stations sending special messages to brokers and stock owners aboard the ships, that the day and night operators were forced to operate on 12-hour shifts to put all the messages through.

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25 TO RECEIVE NEW WAVES BY DECEMBER 1ST

Washington.

The licenses of all stations throughout the country have been extended for ninety days from October 31st by the Federal Radio Commission, except the licenses of twenty-five stations, which were renewed for thirty days because the Commission will change the assignments of the stations.

The Commission has granted the application of the Southern Radio Corporation of New York City for a general experimental license to employ frequencies 23,060, 25,000, 27,500, and 30,000 kilocycles, with a power of 1,000 watts. The station is to be located at Linden, N. J.

A construction permit was also granted the Michigan College of Mining and Technology, at Houghton, Mich., to build a continuous-wave transmitter to operate on eight experimental frequencies to determine the best channel for radio communication with miners underground. The transmitter will use 250 watts.

The Ward-Leonard Co., Mount Vernon, N. Y., was granted a general experimental construction permit for a transmitter to operate on 1,694, 2,398, 2,256, and 4,795 kilocycles with a power of 250 watts.

The Atlantic Broadcasting Corporation received a renewal license for station W2XE to operate on 6,120 kc. and 5,000 watts at Cross Haddock Bay, N. Y., and also a construction permit for a transmitter of 20,000 watts to operate on 11,840 and 15,280 kc. at the same place. The 11,840 kc. frequency is to be shared with the Chicago Federation of Labor.

HQ-30 Proves Sensitive

The extreme sensitivity of the new Hammarlund HIQ receiver, the HIQ-30, which is the successor to the HIQ-29, was recently demonstrated to a group of prominent engineers at the laboratories of the Hammarlund Manufacturing Company in New York City. This receiver which has a sensitivity factor well under 1/2 microvolt per meter, brought in stations from Texas, Florida, Illinois and Pennsylvania during the afternoon when the locals were on, with full blast, and using a copper screen mounted on the rear of the receiver console as the antenna.

CORNELIA SKINNER HEARD AGAIN

Cornelia Otis Skinner, distinguished stage star and daughter of Otis Skinner, appeared for the third time on radio when she gave a varied program of dramatic sketches on the Eveready Hour over station WEAJ. She chose a wide range of dramatic effort, the feature number being "The Cold November Wind," an impressionistic word picture first written in French.

WFAA Has South's First Super Power

The new 50,000 watt transmitter of WFAA, which is located eighteen miles northwest of Dallas, Texas, is on the air. This transmitter, built at a cost of \$270,000, is the South's first high power broadcaster. The frequency of 800 kilocycles (374.8 meters) is used.

Teacher of Speaking Wins Diction Award

The first prize in the announcer's diction contest, recently held at the studios of the Columbia Broadcasting Company, 485 Madison Avenue, New York City, and sponsored by the Transitone Radio Corporation, was won by Joseph D. Meyer, instructor in public speaking at the College of the City of New York.

The second prize was awarded to Arnold Moss, of Brooklyn, New York, a former pupil of the winner of the first prize. The judges were David Ross and Bradford Browne, of the Columbia System, and Marley Sherris and Curt Peterson of the National Broadcasting Company.

Damrosch Begins 3-Year Music Treat

Broadcasting of the Fall music appreciation series directed by Walter Damrosch was recently started. The broadcasting, halted at the beginning of the Summer due to vacation time, is being done by the National Broadcasting Company over its coast-to-coast network.

The series is to be presented for three years, with Summer intermissions. The course consists of four series of concert lectures. Series A is for grades three and four; series B for grades five and six; series C for grades seven, eight and nine, and series D for high school, colleges and music schools.

WGY Using 200 Kw In Occasional Tests

The permit for as high as 200,000 watts for test purposes is being used by the General Electric Company experimental station, W2XAG, at Schenectady, New York. The permit states that the tests are to be held between midnight and morning subject to conditions which will present interference with regular broadcasting. The station operates on both broadcast (WGY) and short waves.

OPPOSE EXCESSIVE VOLUME

A campaign to stop the use of extreme volume on loudspeakers during the late hours of the night is being waged by the Bronx Home News, a borough newspaper in New York City. A plea to this end is made in every edition, and printed at the head of the radio program column.

CIRCUIT LURE STILL STRONG, SAYS CARTER

Contrary to the belief in some quarters, the radio parts business is not declining, tons of radio parts worth many millions of dollars being sold annually, according to A. J. Carter, of Chicago.

"Although not generally known, the manufacture and sale of radio parts is a mammoth industry in itself and growing larger," continues Mr. Carter.

"There are fewer manufacturers of parts, but their output is increasing and this great branch of the industry is in stronger and more responsible hands.

"There are still thousands of boys and young men, and a lot of gray haired men, too, who find radio a fascinating source of personal development and entertainment, and many do so with profit. In the latter category are thousands of custom set builders who assemble radio parts for neighbors, friends, or upon special order from the public, into receiving sets embodying the latest developments in the radio art.

"In addition to these large sources of business, the parts manufacturers sell vast quantities to factories engaged in the making of standard receiving sets."

By JOHN F. RIDER

"The Mathematics of Radio"

TABLE OF CONTENTS:

OHM'S LAW: IR drop, DC and AC circuits, peak and effective C voltages.

RESISTANCES: Basis for resistance variation, atomic structure, temperature coefficient, calculation of resistance variation, expression of amperes, volt and Ohm fractions, application of voltage drop, plate circuits, filament circuits, filament resistances, grid bias resistances. Parallel, series, wattage rating, maximum permissible current, low, distribution of current, calculation of resistance in parallel, in series, C bias resistances in filament circuits, in B eliminators.

DC FILAMENT CIRCUITS: Calculation of resistances.

AC FILAMENT CIRCUITS: Transformers, wattage rating, distribution of output voltages, voltage reducing resistances, line voltage reduction.

CAPACITIES: Calculation of capacity, dielectric constant, condensers in parallel, condensers in series, voltage of condensers in parallel, in series, utility of parallel condensers, series condensers.

VOLTAGE DIVIDER SYSTEMS FOR B ELIMINATORS: Calculation of voltage divider resistances, types of voltage dividers, selection of resistances, wattage rating of resistances.

INDUCTANCES: Air core and iron core, types of air core inductances, unit of inductance, calculation of inductance.

INDUCTANCE REQUIRED IN RADIO CIRCUITS: Relation of wavelength and product of inductance and capacity, short wave coils, coils for broadcast band, coupling and mutual inductance, calculation of mutual inductance and coupling.

REACTANCE AND IMPEDANCE: Capacity reactance, inductive reactance, impedance.

RESONANT CIRCUITS: Series resonance, parallel resonance, coupled circuits, bandpass filters for radio frequency circuits.

IRON CORE CHOKERS AND TRANSFORMERS: Design of chokes, core, airgap, inductance, reactance, impedance, transformers, half wave, full wave windings.

VACUUM TUBES: Two element filament type, electronic emission, limitations, classifications of filaments, structure, two element rectifying tubes, process of rectification, tungar bulb.

THREE ELEMENT TUBES: Structure of tube, detector, grid bias, grid leak and condenser, amplifiers, tube constants, voltage amplification, resistance coupling, reactance coupling, transformer coupling, variation of impedance of load with frequency, tuned plate circuit.

POWER AMPLIFICATION: Square law, effect of load, calculation of output power, undistorted output power, parallel tubes, push-pull systems, plate resistance.

GRAPHS AND RESPONSE CURVES: Types of paper, utility of curves, types of curves, significance of curves, voltage amplification, power amplification, power output, radio frequency amplification.

MULTIPLE STAGE AMPLIFIERS: Resistance coupling, design, calculation of values, effect of resistance, calculation of coupling capacity, effect of plate load, effect of input tube capacity, calculation, reactance coupling, tuned double impedance amplification, underlying principles, transformer coupling, turns ratio, voltage ratio, types of cores, plate current limitation, grid current limitation.

ALTERNATING CURRENT TUBES: Temperature variation hum, voltage variation hum, relation between grid and filament, filament circuit center tap, types of AC tubes.

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RADIO WORLD, 145 West 45th St., N. Y. City

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

Enclosed please find \$2.00 for which please send me at once one copy of "Mathematics of Radio."

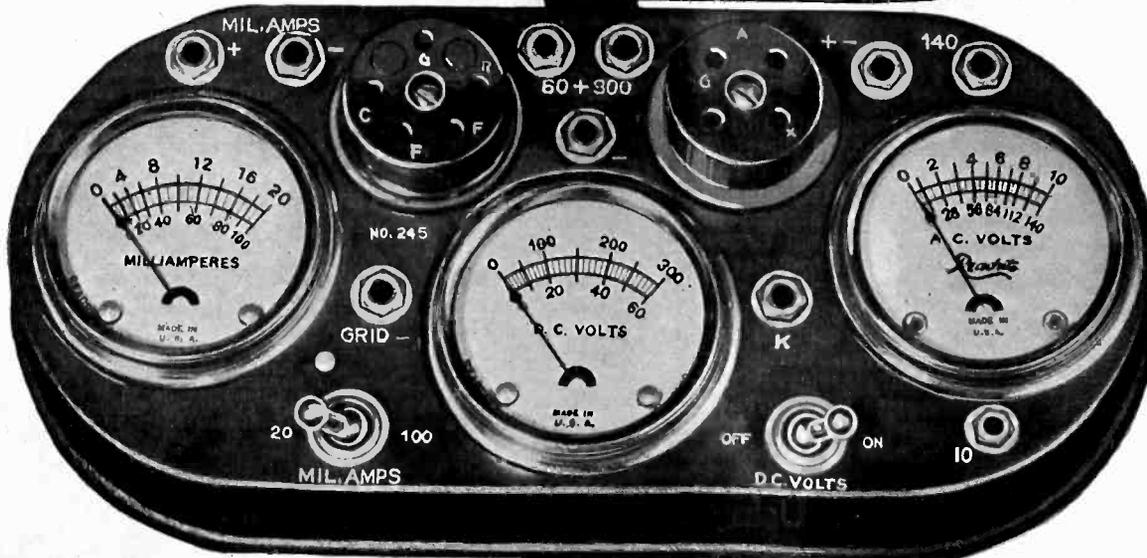
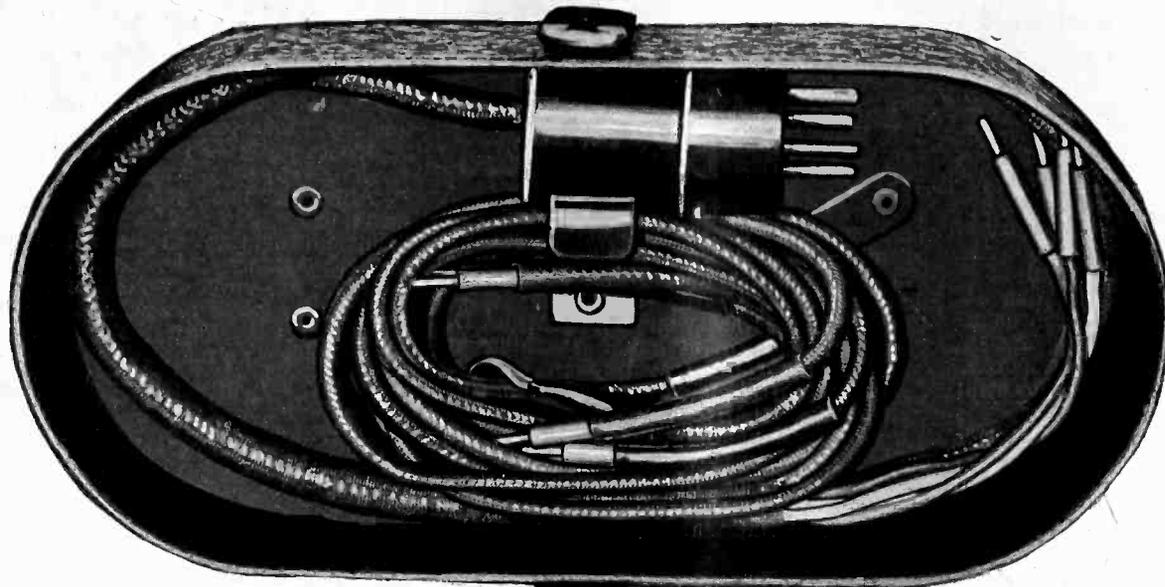
Name

Address

City State

New Jiffy Tester, J-245-x, Anal

Plate Voltmeter Range Enlarged to 600 volts, A



Note the fascinating appearance of the new J-245-X Jiffy Tester, with connector plugs and cable tucked beside the screen grid tube testing cable and the color-identified pair of test leads for using each of the three meters individually. As each meter is double range, you get six-meter service from this splendid outfit. This is the most popular type of Jiffy Tester and the most desirable in the low price range. It is entirely sufficient in accuracy.



Three meters built into a case, 3 1/4" high, 4" front to back, 8 1/2" long, with slip-on cover, both brown crackle-finished steel. Makes all tests of filament voltages, AC or DC, with AC voltage readings up to 140, plate voltages up to 300, plate current up to 100 ma. Tests 4-prong and 5-prong tubes, including screen grid tubes. Makes all tests to 600 volts DC, 560 volts AC, of all tubes, in conjunction with five accessories included at \$15.82.

The New J-245 Jiffy Tester, shown two-thirds scale.

What Test is Needed? J-245-x Makes It!

INSTRUCTIONS FOR J-245-X

A very complete three-meter tester. Polarity cords—red positive and black negative—with tips, are furnished for using meters individually. Also a special cord with clips is supplied for connecting to the control grid of screen grid tubes. No extra adapter is required for screen grid testing. A four-prong adapter is a part of the equipment, used with the five-prong plug on cable for connecting set socket with tester. These parts are held in the cover which makes a very compact and convenient outfit.

Service Procedure

Check line voltage by connecting red and black tipped cords at (+) (—) and 140. The other end of tipped cord insert in a divided plug which is screwed into outlet of line supply. If necessary adjust compensating device on set when set is not supplied with automatic voltage regulator. Start with the

first RF tube and test straight through to the power tubes. Leave all tubes in set except tube under test. Put plug into emptied set socket and tube into proper Jiffy Tester socket. Do not insert tester plug in rectifier socket which is fed by AC. See instructions for comparative testing of rectifier tubes. Place cable tips in tester jacks according to colors. Always do this before plugging into set socket.

Filament Volts

Place brown tip of cable in 10 jack and white tip of cable in (+) (—) jack. Read directly upper scale of AC Voltmeter, which will indicate equally accurately DC volts.

Grid Volts

By noting the plate and filament voltage for a corresponding plate current in milliamperes a grid bias voltage will be determined from the tube chart furnished with instruction sheet with all J-245-X.

To test grid volts at tester socket: Set DC volt switch OFF.

Place red tipped wire in 60 jack and touch to K jack.

Place black tipped wire in B— jack and touch to grid jack.

Reverse leads if DC voltmeter reads below zero.

Grid Condition

Push button to note grid condition indicating change in the plate current reading. The extent of plate current change estimates the tube's liveliness.

Plate Voltage

Connect all cable tips in their respective colored jacks, except YELLOW, which place in B— jack.

Have DC volt switch ON. Read 0-300 upper scale of DC Voltmeter.

Plate Current

With cable tips in their respective colored jacks set MIL-AMPS switch at 100. If milliammeter shows less than 20 set switch at 20. Read upper scale

on milliammeter with switch at 20 and lower scale with switch at 100. Use 100 for power tubes.

Cathode Volts

Set DC volt switch OFF. Place black tipped wire in B— jack and touch to 10 jack.

Place red tipped wire in 60 jack and touch to K jack.

Screen Grid Volts

(G post of socket)

Set DC volt switch OFF. Put yellow tipped cable wire in B— jack. Insert a tipped wire lead in 60 or 300 jack and touch to grid jack.

Control Grid Volts

(cap of tube)

Set DC volt switch OFF. Attach wire with clips to pig tail in receiving set and to top of tube in tester.

Place the red and black tipped wire leads in 60 and B— jacks. Touch B— wire to top of tube, and B+ or 60 wire to YELLOW jack.

When testing AC power supply circuits use the tipped cords and attach them to the tester jacks connected with the filament AC voltmeter. If higher voltages than 140 are to be measured the proper multiplier should be used. This is one of the five pieces of auxiliary equipment furnished with the outfit.

GENERAL

For individual and independent use of meters, remove tester plug from set socket, and remove from jacks all cable tips used for connecting set with tester.

To test 0-10 AC, DC volts plug one tipped cord into jack marked (+) (—) and other tipped cord in jack marked 10 v. Read directly on upper scale of voltmeter.

To test line voltage plug into jacks marked (+) (—) and 140 v. Read lower scale on voltmeter.

To test milliamperes plug black tipped cord in jack marked —MA, and red cord in jack marked +MA. Set MIL-AMPS switch to 20 or 100, according to measurement taken.

To measure the total plate current set MIL-AMPS switch to 100. Open the B—lead to set operated with batteries or eliminator and connect the end from set to jack marked +MIL-AMPS on tester. Connect the other lead from eliminator to jack on tester marked MIL-AMPS. If current is below 20 set switch to the lower reading.

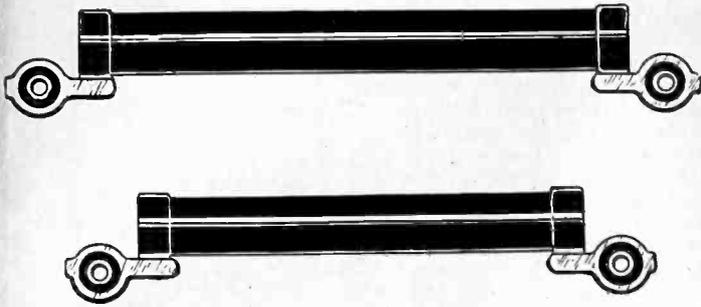
To make continuity or open circuit tests. With plug in receiver socket and tube in tester socket the deflection of the milliammeter shows circuit is continuous in the primary load. Testing transformers, chokes, etc., may be done by disconnecting them and connecting each winding between the plate voltage source and the B voltmeter. The voltmeter should show a lower reading if the circuit is continuous with the added resistance of a transformer, etc., between one of the connections to the voltmeter and the B voltage supply. Usually a 22 1/2 volt battery is used for this purpose.

To test for shorts in condensers, resistors, etc. With tube in tester connect condenser under test to jacks —MA and +MIL-AMPS. If milliammeter shows change in reading the part tested is shortened. Resistors, etc., may be tested by the same method as noted above for continuity tests, or by disconnecting tester plug from set socket and connecting part to be tested between an external source of current and individual meter.

Testing Rectifier Tubes

Usually this testing is done after all other tubes and circuits are checked. If the proper voltages are furnished to the plates at the different sockets then the rectifying tube would not require testing. The comparative method of testing is done by substituting a tube of known value for the one in the rectifier socket. Then, with the tester plugged into another of the set sockets, after removing the tube and placing in the tester, the readings of the instruments will show any difference in output of the two rectifier tubes as supplied to the tube in the tester. This test is most emphatic when made on the power tube or tubes.

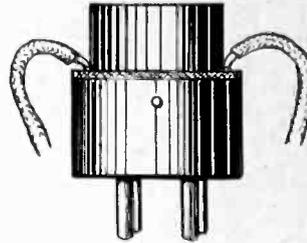
es All Tubes, Sets and Circuits Voltmeter Range Extended to 560 volts—Dandy Outfit!



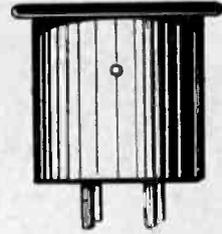
J-111 multiplier increases 140 volt AC range to 560 volts. Supplied with jack terminals (top illustration).
J-106 multiplier increases 300 volts maximum of plate voltmeter to 600 volts, with jack terminals.



J-19 changes UV socket of UV-199 tube receiver to take UX plug of Tester.



J-24 permits tests of Kellogg and old style Arcturus tubes as filament is on top.



J-20 changes UX socket of Tester to receive the odd base of the UV-199 tube.

List Price, \$26.10, Your Price \$15.82, Complete!

THE very exacting demands of service men, experimenters, teachers and students for an analyzer of sets, circuits and tubes, whereby great versatility is required with accuracy, are met by the brand-new Push-Switch Jiffy Tester, J-245-X. It is scarcely possible you will ever encounter a testing requirement that the new J-245-X will not fulfill.

The J-245 is housed in a steel carrying case, finished in crackle brown, and contains everything except the five accessories that give the new Jiffy Tester its high mark of utility and distinction.

The basic device is the J-245, consisting of three meters mounted on a panel, with sockets, jacks, and two switches, and including test leads and 5-prong plug with 4-prong adapter. The DC volts switch and cathode tester are new features of this.

There are five accessories, represented by the "X" in the catalogue number. These accessories greatly extend the range and usefulness of the basic device.

Therefore the new Jiffy Tester with ALL accessories (and you should have ALL of them) gives you close readings on low voltages and currents, yet reads all high values as well. Now you'll never be stumped.

J-245-X is especially designed to test up-to-date receivers, particularly those using screen grid tubes and 245 single or push-pull, testing out-of-date receivers just as well. It has an extensive usefulness and brilliant eye appeal. It tests sets with 201A, 200A, UX199, UV199, 120, 240, 171, 171A, 112, 112A, 245, 224, 222, 228, 280, 281, 227, 226, Kellogg tubes and old style Arcturus tubes. The two multipliers extend the ranges of two meters.

Into the case of the basic J-245 are built the following meters: one reading 0-20 ma. and 0-100 ma. for plate current, change-over switch included; one reading 0-60, 0-300 volts DC for plate voltages and DC house line voltages; and one reading 0-10, 0-140 volts AC and DC (though the meter is marked AC), thus 0-140 may be used for DC line voltage.

The two plated switches and nine tip jacks are on the panel. The jacks are marked to receive the five-tipped leads which emerge from the plugged cable connector. These leads are colored red, blue, brown, white and yellow, and so are little rings around the tip jacks that the leads connect to. All nine jacks are marked besides.

One switch is for change-over on the milliammeter, and the other is for the grid return to note a tube's "liveliness." How this is noted is explained in the instruction sheet.

Two sockets are on the panel, one 5-prong, the other 4-prong, for holding the UX and UY tubes, including screen grid tubes, both AC and battery types. To enable full test of screen grid tubes, including AC 224 and DC 222, a screen grid cable is supplied with the basic J-245.

The compact J-245-X (meaning including accessories), therefore, tests all plate voltages up to 600 volts, including B eliminators, all filament voltages, DC or AC, up to 10 volts; all plate current up to 100 ma. Besides, it provides close readings for plate current of 20 ma. or less and for B voltages of 60 volts or less, and AC voltage readings up to 560, including AC line voltage. Besides, it reads screen grid voltage and control grid bias voltage.

The base that contains the meters has four feet on it, is only 1 1/4" high, and snugly receives the cover. Inside the cover is a spring clip to hold the plugged cable, with a 4-prong adapter, as well as the red and black separate test leads for use of each meter independently, and the screen grid cable. You have three separate double-range meters independently accessible, in other words, six meter service, besides the plug-in feature for joint use of all meters in testing receivers, tubes, continuity, shorts, opens, etc. Used as a unit, the J-245 gives simultaneous readings on all meters. Use of individual meters gives one, two or three readings at a time.

This outfit has a genuine leather handle on the top for carrying, and a braided strap for keeping the cover from coming off accidentally. It is the very thing that the service man, experimenter, student and teacher have been looking for.

Order Cat. J-245-X and you will be surely overjoyed at the possession of such a handy, dandy, reliable and rugged Jiffy Tester, the neatest one you ever saw, and one that abundantly answers the purposes of service work. A tube data sheet tells how to determine if tubes are O. K.

IF YOU are a service man you are lost without meters. You may carry individual meters around with you and still remain perplexed, for lack of any means of obtaining access to the voltages or currents you desire to test. Therefore, an analyzer like the J-245-X is just the thing, and it is much more neatly made than you could possibly make a tester yourself,

since, besides the engineering talent required to design such a device, thousands and thousands of dollars must be invested in dies. You reap the benefit of expert engineering, quantity production and careful instruction as to use when you buy a J-245-X. It is unqualifiedly recommended as superior to any tester that is anywhere near so low in price. You could pay twice as much and get half as much value!

Order a J-245-X today. It is sold on a 5-day money-back guaranty, which nobody else offers. Try it out for five days after receipt. If not fully satisfied for any reason, or for no reason at all, send it back with a letter asking for refund of the money you paid. The refund will be made promptly. There are no strings to this guaranty!

Remit \$15.82 with order and we pay the cartage to any place in the world. We positively guarantee speedy service as well.

BESIDES fetching appearance, sturdiness, compactness and low cost, the J-245-X affords versatility by rendering individual access to each meter.

Use the red and black test leads for this purpose. Suppose you want to know the total plate current drain of all tubes of a receiver. Use the milliammeter at its "0-100" setting, connect the test leads to "milliamps +," and the other ends of the leads in the negative B line.

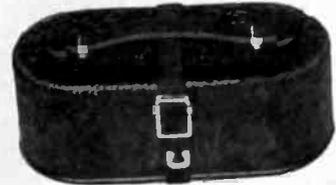
This accessibility of each meter—six meter service, remember—heightens the value of the J-245-X more than 100 per cent, and is a new feature.

You are all set to go when you possess the J-245-X. You will not even experience limitations when desiring to test the B voltages on 210 and 250 tubes or desire to test UV 199 or Kellogg tubes which have filament emerging from a cap at top.

The plate voltage on a 210 is usually 350 volts while that on a 250 is usually 450 volts, and the B voltmeter, by use of multiplier, reads up to 600 volts.

Also, you may desire to test high AC voltages. In some places the line voltage is 220 volts AC. You may want to measure power transformer high voltage secondaries. The use of the other multiplier (for the 140 volt AC meter) permits readings to 560 volts, so center-tapped secondaries up to 1,120 volts may be measured. Multiply the reading on half the secondary by two.

Extension of the serviceability of the Jiffy Tester to a final form of remarkable completeness, enabling as many tests as analyzers make that cost more than \$100, is an important achievement. Push-switch service is one feature. Extension of meter ranges is another, as the accessories permit voltages as high as 560 AC and 600 DC to be measured directly, and 1,120 volts AC indirectly. The J-245-X (consisting of the new J-245 and five accessories) is packed in a strong carton and safe delivery is guaranteed. You run no risk whatever. Our 5-day money-back guaranty is absolute.



How the J-245 looks when the cover is slipped on and the strap is tightened. The handle is genuine leather

PLEASE USE THIS COUPON!

Guaranty Radio Goods Co., 143 W. 45th St., New York City, just East of Broadway.

Enclosed please find \$15.82 M. O. for which please send at once, at your check

expense, the J-245-X, as advertised, with the five accessories, instruction sheet, carrying case.

Please send C. O. D. I will pay \$15.82, plus cartage.

Name.....

Address.....

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

**5-DAY MONEY-BACK ABSOLUTE GUARANTY!
SHIPMENT 24 HOURS AFTER RECEIPT OF ORDER!**

New High Mu AC Tube

228 Provides Higher Amplification and is an Excellent Power Detector



228 AC High Mu Tube, with an amplification factor of 45 is an exclusive contribution to tube science by Kelly laboratories.

WHEN signals are weak in an up-to-date AC receiver using 227 tube as detector or audio amplifier, replace the 227 with the new 228 high mu AC tube and be amazed at the difference in volume.

The up-to-date receivers have high impedance primary in the first audio transformer, or have a resistor in the plate circuit, so the high mu tube is a boon indeed.

As a detector the 228 can be used with leak and condenser, with grid returned to cathode, or as a negative bias (power) detector. See table, lower left corner.

Since the 228 has the same base, same prongs and same heater voltage as the 227, it can be used for replacement and improvement, and without requiring any wiring changes or any other changes. Simply insert the 228 in the socket from which the 227 is removed.

228
\$2.50

CHARACTERISTICS OF THE 228

Heater voltage 2.5 volts AC.
Heater current 1.75 amperes.
Amplification factor 45.
Mutual conductance 1,000.
Plate voltage 180 volts.

Grid bias, detector -6 volts.
Grid bias, amplifier -2.5 volts.
Load resistance, 0.1 to 0.5 meg.
Internal plate resistance 45,000 ohms.

The plate current under normal operation is less than one milliampere. Hence the 228 tube imposes minimum load on the B supply.

The 228 is not suitable as a radio frequency amplifier.

224 at \$3.00—245 at \$2.25—227 at \$1.50—226 at 95c

The screen grid tubes have proved not only their capability but their dependability, and in AC circuits the 224 AC screen grid tube is popularly used as amplifier and detector, with the 245 as output, singly or in push-pull. Safe and satisfactory, Kelly 224 tubes are made with the same expertness and precision that characterizes the entire line of Kelly tubes. Our products are used by laboratories, technicians, experimenters and general consumers because of proven merit.

The Kelly 224 screen grid tube is not only excellent as a radio frequency amplifier but as a detector, especially applicable as a space charge detector.

A suitable high impedance load should always be in the plate circuit of any screen grid tube. For RF a large untuned primary, or a tuned primary, for detection and AF a resistor of 50,000 ohms or higher, usually considerably higher, or a high impedance inductance. You will find Kelly 224 fully meets your most exacting requirements.

The 224 and 227 are 5-prong (UY) tubes, the 245 and 226 4-prong (UX) tubes.

Battery Type Screen Grid 222 at \$3.50

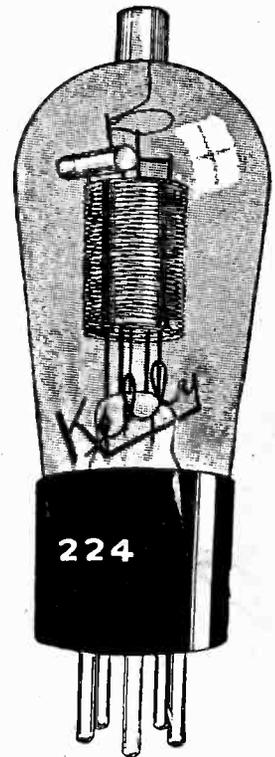
The battery operation the 222 screen grid tube is an important contribution, because enabling such high amplification that battery circuits are put on a par with AC circuits in performance. The 222 is the most popular battery-operated tube for up-to-date circuits and the Kelly model is made to produce clear reception and have exceptionally long life.

5-Day Money Back Guarantee!

You run no risk whatever when you purchase Kelly tubes. Not only are they expertly made but they are sold on a 5-day money-back guarantee. This exclusive form of protection enables you to be the ultimate judge in your own laboratory or your own home, with no appeal from your decision on our part. If you are not delighted with the performance of Kelly tubes, we are not even satisfied,

and will promptly refund your money on the foregoing 5-day basis.

If at any time after the five days expire, after receipt of tubes by you, there should develop any adverse condition for which you deem the tube at fault, you may communicate directly with us, and we will give the matter prompt attention. Our aim is to render a real service and through such efforts have we built up our volume of business.



Kelly Tube Company, 143 West 45th St., N. Y. City

Enclosed please find \$..... for which ship at once tubes marked below:

- | | |
|--|--|
| <input type="checkbox"/> 228 AC high mu. @.....\$2.50 | <input type="checkbox"/> 222 battery screen grid.....\$3.50 |
| <input type="checkbox"/> 224 AC screen grid @.....\$3.00 | <input type="checkbox"/> 240 battery high mu.....\$1.25 |
| <input type="checkbox"/> 245 AC power tube @.....\$2.25 | <input type="checkbox"/> 112A battery power tube.....\$0.95 |
| <input type="checkbox"/> 226 AC amplifier @.....\$0.95 | <input type="checkbox"/> 171A battery power tube.....\$0.85 |
| <input type="checkbox"/> 227 AC det.-amp. @.....\$1.50 | <input type="checkbox"/> 201A battery tube.....\$0.65 |
| <input type="checkbox"/> 171A AC power tube @.....\$0.95 | <input type="checkbox"/> UX199 battery tube.....\$1.25 |
| <input type="checkbox"/> 210 AC power tube @.....\$4.50 | <input type="checkbox"/> Matched pair of 245s for push-pull (for both).....\$4.50 |
| <input type="checkbox"/> 250 AC power tube @.....\$6.00 | <input type="checkbox"/> Matched pair 171As for AC Push-Pull (for both).....\$1.90 |
| <input type="checkbox"/> 280 AC rectifier @.....\$1.75 | |
| <input type="checkbox"/> 281 AC rectifier @.....\$3.50 | |

ALL PRICES QUOTED ARE SELLING PRICES AND ARE NET

Name

Address

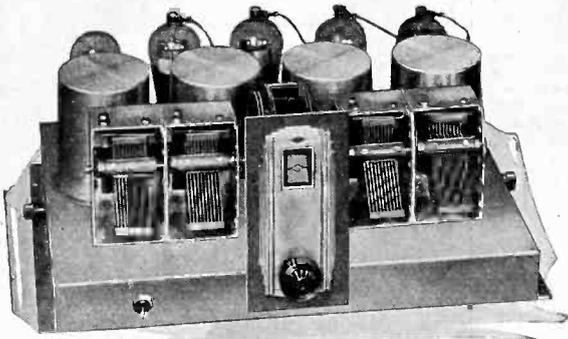
City State.....

Put cross here if C.O.D. shipment is desired.

Types of Tubes and Their Voltages

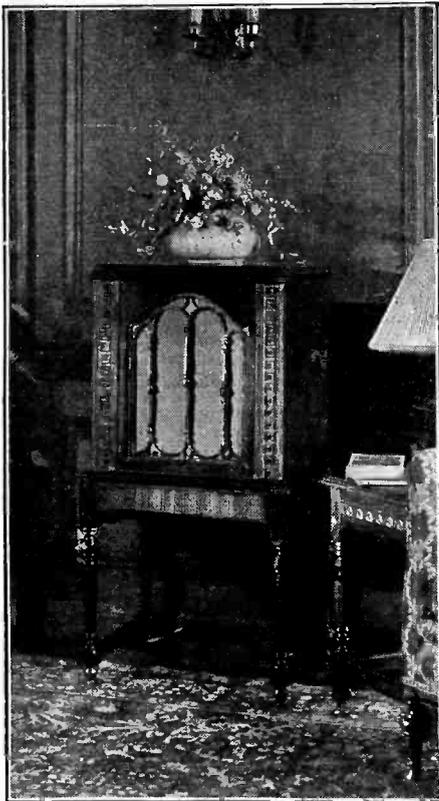
Tube	Fil. Volt	Amplifier		Detector		Remarks
		Plate Volts	Neg. Bias	Plate Volts	Neg. Bias	
228	2.5 AC	180	2.5	180	6	Heater type, 5 prongs.
224	2.5 AC	180	1.5	180	6	Heater type; 50 volts, 75
245	2.5 AC	250	50.0	—	—	—
226	1.5 AC	135	9.0	—	—	—
227	2.5 AC	180	9.5	180	16-25	Heater type
171A	5A Cor DC	180	40.5	—	—	—
210	7.5 AC	350	27.0	—	—	—
250	7.5 AC	450	84.0	—	—	—
280	5.0 AC	350AC	—	—	—	Full-wave rectifier
281	7.5 AC	700AC	—	—	—	Half-wave rectifier
222	3.3 DC	135	1.5	135-180	4-7	50 volt, 45
240	5.0 DC	135-180	3-4.5	135	1.5-3	—
112A	5.0 DC	135	9.0	135	Leak-cond.	—
UX199	3.3 DC	90	4.0	90	Leak-cond.	—

NATIONAL SCREEN GRID TUNER



The most sensitive tuned radio frequency tuner so far developed, the MB-29 is long on distant reception, and penetrates seemingly unsurmountable barriers to reception. On the MB-29 the stations come in no matter where you are. The MB-29, designed by James Millen and Prof. Glen H. Browning, is the choice of the most discriminating. It is designed only for AC operation, uses four stages of screen grid RF and a power detector (227). Use 135 to 180 volts on the detector. Testimonials from radio's hardest-boiled experts prove this is the circuit of circuits. Buy the parts and find fullest radio delight. You will be sure nobody else has a tuner as good as yours, unless he too has an MB-29. Complete component parts for National Screen Grid Tuner MB-29, mounted on frosted aluminum chassis, including rainbow modernistic drum dial HC. Order catalog No. MB-29-K, list price, less tubes, \$69.50. Your price **\$40.00**

PEERLESS Super Dynamic Console Speaker

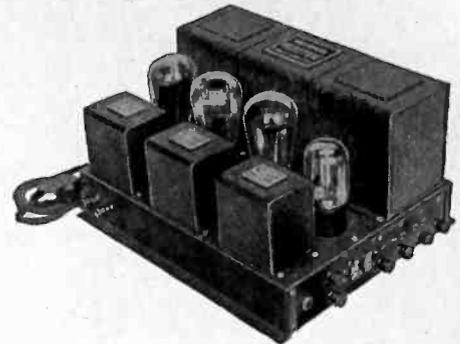


Peerless Super Dynamic 12" AC-operated speaker, built into a Sonora console, with 2,000 mfd. filter condenser to kill hum; equipped with special rectifier and switch. Speaker by United Rep. Corp. List, \$155.00. Your price **\$37.50**

The famous Peerless AC dynamic speaker, with Kuprox rectifier and 2,000 mfd. hum-killing condenser built-in, all housed in this 40" high Sonora cabinet of fascinating ply-walnut. The cabinet is all one piece-carved legs, marqueterie panel and grille pillars. Sliding back is made of caned steel, acoustically open to present boominess. This imposing floor model speaker, exactly as illustrated, in original factory packing case, shipping weight 100 lbs. Never in your life did you hear of such an amazing bargain-highest class, perfect, guaranteed merchandise at more than 75% off list price! Look at that beautiful console cabinet, its graceful legs, with archer's bow tiepiece; its rosetted side panels at front, its shapely grille pillars, all in two-tone effect, with high-polish surface of ply-walnut. The speaker sets against a golden grille, with ample baffle board concealed. Order catalog PSHB @ \$37.50. The console, which has removable back, is 40" high, 19" wide, 16" front to back. Speaker only, with 2,000 mfd. and Kuprox rectifier, all built up at factory. Order Cat. SO @ \$23.50. Cabinet only, Order Cat. CO @ \$15.00.

MB-29

Push-Pull Amplifier



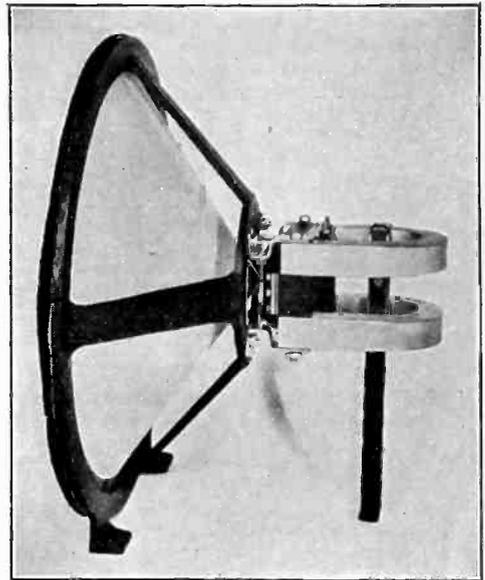
The National Velvetone Push-Pull Power Amplifier (shown at right) consists of an AC-operated filament-plate supply, with two stage transformer audio amplifier and output transformer built in. Made only for 110-V., 50-60 cycles. Sold only in completely wired form, licensed under RCA patents.

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! **\$55.00**

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

Farrand Inductor

Absolutely unexcelled tone quality, with amazing sensitivity, is assured when you use Farrand Inductor Speaker and a fine audio amplifier. The chassis is sold completely erected with unit and supporting brace mounted. The unit, cone spider, and ring are sturdily put together. Use a baffle board or box of your own choice. A new principle is involved in the Inductor Chassis. The armature moves up and down, in a wide gap, instead of from side to side in a tiny gap. Hence the armature does not strike the pole pieces.



The chassis is offered at professional discounts, the prices quoted being net. The outside diameters of the two different sized models are 9" and 12" respectively. The speaker should be selected, no matter what size, that matches the impedance of the output tube or tubes. See list below. The larger size gives better low-note response. For single 112, 112A or 210 output tube, 9" diameter, order Cat. N9R @ \$11.95.

For 171, 171A, 245 or 250 single output, or ANY push-pull output where you have an output transformer or midtapped impedance, order Cat. N9G @ \$11.95.

Same as above, only 12" outside diameter, order N12R for single 112, 112A, or 210 tube, @ \$12.95. For single 171, 171A, 245, 250, or for ANY push-pull, order Cat. N12G for 12" size, @ \$12.95.

Farrand Inductor Speaker (12" size illustrated). List price, \$22.50. Your price \$12.95. Consult information at left as to suitable type speaker for your output tube. The 12" is preferable if you have room.

Short Wave Circuit



National Thrill Box, 4-tube short wave circuit, 15 to 535 meters, battery-operation of filaments; B supply, either batteries or eliminator.

Get a real kick out of listening to foreign stations on a real short-wave circuit, the National Thrill Box. Uses one 222 screen grid RF amplifier, one 200A detector, one 240 first audio and one 171A or 112A output. Single control. Buy the parts and build the circuit in two hours. Data sheet shows dial settings where foreign stations come in. Cat. SW4EF, all parts, including decorative brown steel cabinet, all six plug-in coils, list price \$51.90 (less tubes). Your price \$31.00.

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| Cat. PSHB @ \$37.50 net | Cat. PPPA @ \$55 net |
| Cat. SO @ \$23.50 net | Cat. SW4EF @ \$31 net |
| Cat. CO @ \$15 net | Cat. N9G @ \$12.95 net |
| Cat. N9R @ \$11.95 net | Cat. N12G @ \$12.95 net |

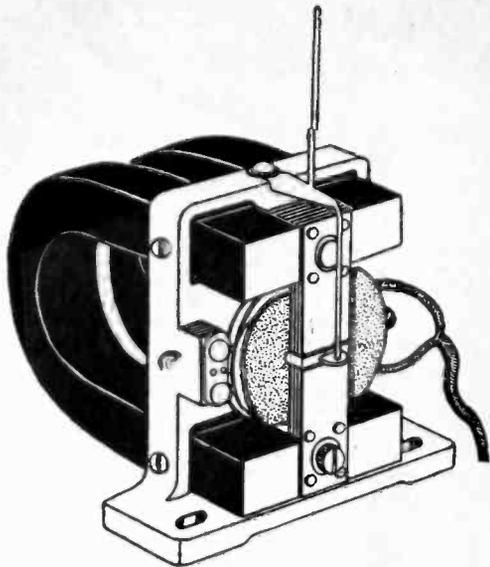
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New Junior Model
POLO UNIT \$4

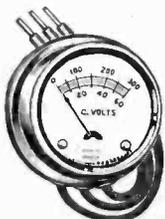


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DC VOLTMETER

With three 28" tipped leads built in



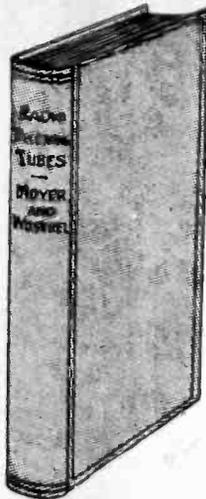
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A portable type, high resistance meter, 2 1/2" outside diameter, for close reading of direct current voltages up to 60 volts, and for reading DC voltages up to 300 volts. Three vari-colored 28" insulated leads, with jack tips, are built in. Black is 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.

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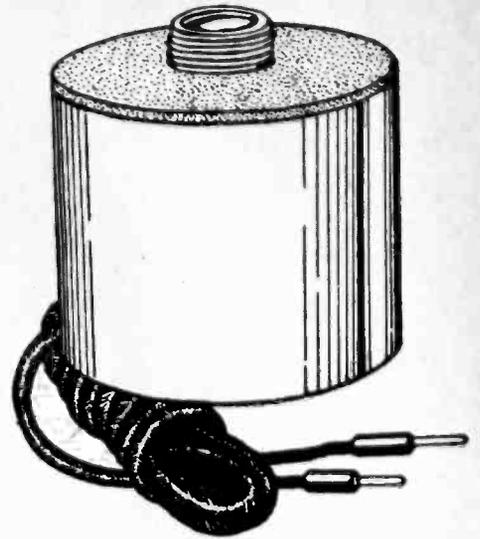
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This unit is pre-eminent for horn-type speakers, such as the exponential horns or other long travel horns. The faintest word from a "whispering tenor" or the tumultuous shout of the crowd or highest crescendo of the band is brought out clearly, distinctly. Stands up to 450 volts without filtering. Works right out of your set's power tube, requiring no extra voltage source. Standard size nozzle and cap are die-cast aluminum, one piece, with milled platinum-like finish. The casing is full nickel, of highest possible polish. Works great from AC set, battery set or any other set, push-pull or otherwise.

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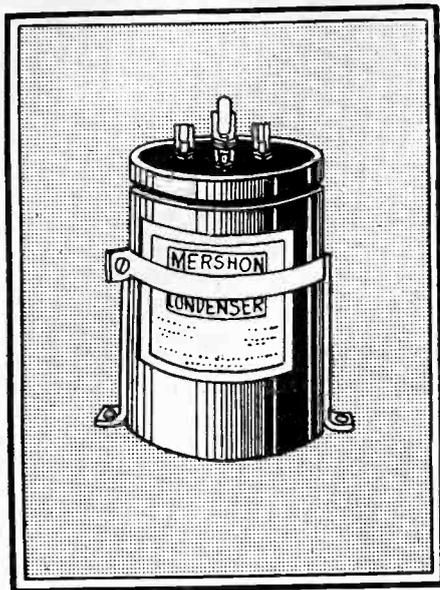
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Mershon electrolytic condensers are instantly self-heating. They will break down only under an applied voltage in excess of 415 volts D.C. (commercial rating; 400 volts D.C.) but even if they do break down because overvoltage, no damage to them will result, unless the amount of leakage current and consequent heating of the electrodes and solution cause the solution to boil. Voltages as high as 1,000 volts will cause no particular harm to the condenser unless the current is high enough to cause heating, or the high voltage is applied constantly over a long period.

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How to connect: The copper case (the cathode) always is connected to negative. The lugs at top (anodes) are connected to positive. Where there are two different capacities the SMALLER capacity is closer to the copper case.

Mershons of equal capacity may be connected in series for doubling the voltage rating, or in parallel (any combination) to increase the capacity to the sum of the individual capacities, the rating remaining the same, 400 volts.

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[Note: Add 20c to above prices if bracket is desired. No brackets sold separately.]

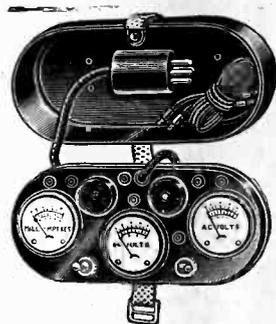
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[ESTABLISHED 1904]

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- CD—12 ft. AC cable, male plug..... .70
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- Knob for tickler..... .18
- Screen grid clip..... .06
- All parts\$51.77
- Kelly tubes, one 224, one 228, one 227, one 280, two 245\$13.25

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Name

Address

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

Component Parts for 245 Push-Pull Power Amplifier

(as described and specified by Herman Bernard)
Check off which parts you desire. All parts sold separately

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- C2—One .01 mfd. mica fixed condenser..... .35
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- C1, C2—Two .00035 mfd. ext. shafts @ 98c 1.96
- C3, C5—Two .01 mfd. mica condensers... .70
- R—One 6.5 ohm filament resistor..... .25
- R1, Sw—One 75 ohm switched rheostat.. .80
- R2, C4—2 meg. Lynch leak, grid clip condenser51
- R3—One .25 meg.30
- R4—One 5.0 meg.30
- R5—One 1.3 ohm filament resistor..... .20
- Ant., Gnd., Sp. (+) Sp. (—)—Four posts @ .1040
- One drilled front panel 7x18" 1.85
- One socketed, self-bracketing metal subpanel, all holes drilled..... 3.50
- One National new modernistic drum dial with color wheel, pilot bracket, 6v. lamp, hardware, knob 3.13
- Two matched knobs for rheo. and tickler @ .1836
- Five vari-colored cable leads @ .07..... .35
- Flexible link and insulated shaft..... .55
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- All parts\$43.57
- One 280, one 227, two 245 Kelly tubes..... 7.75
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[Note: For 40 cycles 110v. order Polo P40 FPS at \$10; for 25 cycles 110v. order Polo P25 FPS at \$11.]

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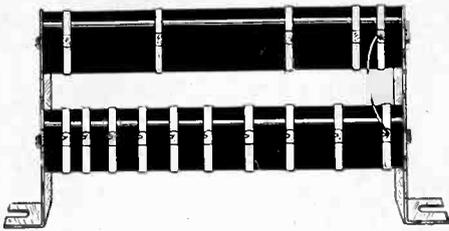
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There long has been a need for obtaining any necessary intermediate voltage, including all biasing voltages, from a Multi-Tap Voltage Divider, but each lug has to be put on individually by hand, and soldered, so that manufacturing difficulties have left the market barren of such a device until now.

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The expertness of design and construction will be appreciated by those whose knowledge teaches them to appreciate parts finely made.

When the Multi-Tap Voltage Divider is placed across the filtered output of a B supply which serves a receiver, the voltages are in proportion to the current flowing through the various resistances. If a B supply feeds a receiver with two-stage audio amplifier, the last stage a single-sided 245, then the voltages would be 250 maximum for the power tube, 180, 135, 75, 50, 40, 35, 30, 25, 16, 10, 6, 3, 1, and 0.5. By suitable connection of grid returns the lower voltages may be used for negative bias or even for positive voltage on the plates. Even 0.5 volt is provided for negative bias of a space charge detector (224 tube) in resistance-coupled audio.

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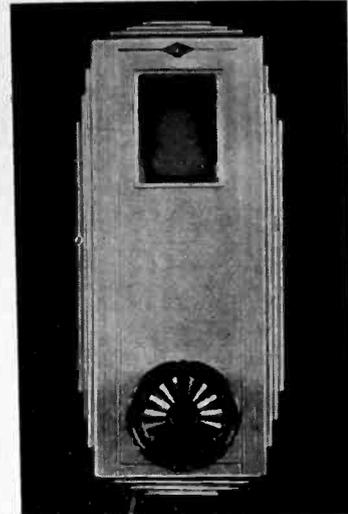
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Polo 245 Power Supply

Scientifically Engineered, It Insures Superb Performance

THE Polo 245 Power Supply consists of a filament transformer, a high-voltage (plate) winding and two separate chokes, all built in a single cadmium-plated steel casing, for powering 224, 227, 228 and 245 tubes. The output may be a single 245 or two 245s in push-pull, because the chokes are large enough and strong enough to handle 100 milliamperes, while the power tube filament winding will easily take care of the two 245s. The entire supply is exceedingly compact and will fit in a cabinet that has the usual 7" high front panel. The high-voltage winding is of sufficiently high AC voltage to produce full 300 volts when the maximum direct current through any part of a voltage-dividing resistor is 80 ma. Of the 300 volts 250 are applied to the output tube's plate and 50 to its grid for negative bias.

All windings except the primary (110 volts, 50 to 60 cycles) are center-tapped, including the 5-volt winding for the 280 rectifier tube. The impedance bridge method is used for establishing the electrical center. Taking the positive rectifier voltage from the center of the 5-volt winding, instead of from either side of the filament, is a small extra advantage, but shows an extra stroke of careful workmanship to insure superb performance.

Another interesting point is that the high-current winding for all the 2.5-volt AC tubes to be used in a receiver or amplifier is rated at 12 amperes. This means that six heater tube tubes may be worked well within the limits of the winding (total of 10.5 amperes used), while seven tubes may be used with the permissible excess of only .25 ampere over the rating (total 12.25 amperes). Of course the two or three other tubes (280, 245) are additionally supplied, from their individual windings. Hence a total of ten tubes may be worked (including 245 push-pull and 280 rectifier).

This is no mere estimate, but a scientific fact. The wire used on this 12-ampere winding is the equivalent of No. 9. Please read our chief engineer's report herewith.

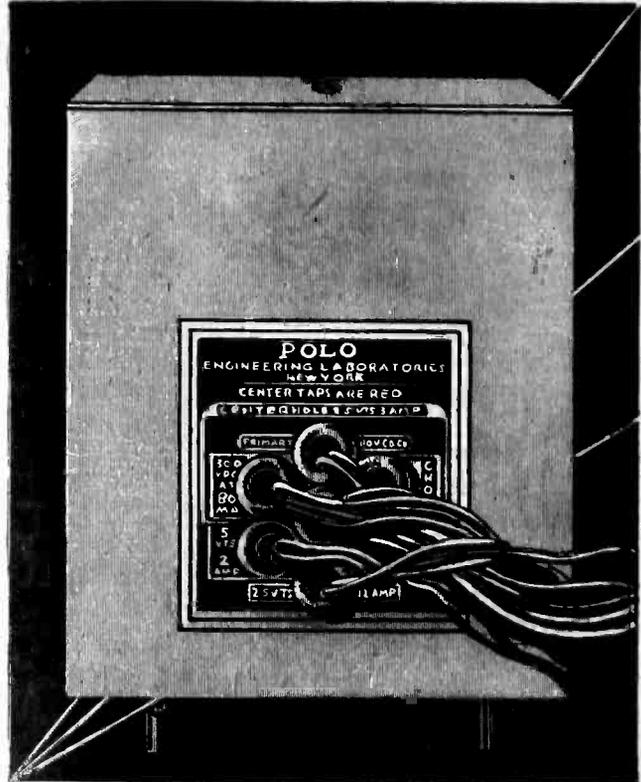
The two chokes are 50 henries each, and each choke is on a separate core.

The 245 Power Supply weighs 16 pounds. The shipping weight is 17 pounds.

For 40-cycle current, 110 volts, a special supply 2" higher, is made. Cat. P245, S40 (Code Cyclone). Price \$13.50.

The 245 Power Supply, with chokes, is made also for 25 cycles, 110 volts. Only this particular combination is made for 25 cycles, although the filament-plate supply (less chokes) and the filament supply (less chokes and high-voltage winding) are made for 40 cycles.

For 25 cycles order Cat. No. P245 S 25 4 5/8" wide x 5 1/8" front to back x 9 1/8" high. Shipping weight 25 lbs. (Code Cypress) at.....\$14.50



Polo 245 Power Supply, including two chokes built in, size 4 5/8" wide x 5 1/8" front to back, 6 1/8" high. Cat. No. P245 PS 110 volts, 50-60 cycles (code Cyclops).....\$10.00
Cat. No. P245, S40, for 40 cycles, 110 volts; size 4 5/8" wide x 5 1/8" front to back, by 8 1/8" high (code Cyclone).....\$13.50

Chief Engineer's Report on Polo 245 Power Supply

By Walter J. McCord, Chief Engineer

Every precaution has been taken to produce a 245 power supply of superb performance, and in proof thereof I take pleasure in submitting for close study by engineering minds the specifications followed, with advice to novices.

- (1)—Overall dimensions of the casing, 4 5/8" wide x 5 1/8" front to back x 6 1/8" high.
- (2)—Filament and plate secondary windings as follows: 724 volts at 100 mills, center tapped at 362; 5 volts at 2 amperes, center tapped; 2.5 volts at 3 amperes, center tapped; 2.5 volts at 12 amperes, center tapped.
- (3)—Two 50-henry chokes, DC resistance of each, 420 ohms.
- (4)—Primary draw with all secondaries worked at maximum, 88 watts.
- (5)—One transformer core with 1" x 1 1/4" cross-section; window opening 2 1/8" x 3/4". Two choke cores with 3/8" x 1 1/4" cross-section; window

- opening 1/2" x 1 1/4"; .014" air gap. The laminations are stamped from high-grade Silicon sheet steel having 1.92 watts loss per pound. The joints in the transformer are all overlapping, holding the magnetic leakage to a minimum.
- (6)—Size of wire and resistance of each winding as follows: Primary—No. 24 wire, DC resistance, 5.2 ohms. Plate Sec.—No. 30 wire, DC resistance, 104.5 ohms. 5 v.—No. 18 wire, DC resistance, .102 ohms. 2 1/2 v., 3 a.—No. 18 wire, DC resistance, .051 ohm. 2 1/2 v., 12 a.—.059 x .180 rectangular wire (equals approximately No. 9 wire), DC resistance, .008 ohm.
- (7)—Total weight of block 16 lbs.

- (8)—Casing is made of sheet steel and is cadmium plated. Four 3/8" mounting screws are placed in the bottom, permitting the block to be mounted on its base in a very small space, as no space is required for mounting flanges.
- (9)—Care should be taken in connecting the leads so that none of the secondaries is shorted. A shorted secondary, either a direct short or through a defective condenser, soon will burn out a transformer. Care should be taken also in connecting the primary to the proper current. The primary should be connected to 110 v. 50-60 cycles AC, never to 220 volts, neither should it be operated on a line voltage of 130 or over.

FILAMENT-PLATE SUPPLY

The Polo 245 Power Supply, less the two built-in chokes, is available to those desiring to utilize chokes they now have, and who do not find the compactness afforded by the consolidated unit absolutely necessary.

The Filament-Plate Supply has the same voltages on the secondaries, at the same ratings, as does the unit that includes the chokes.

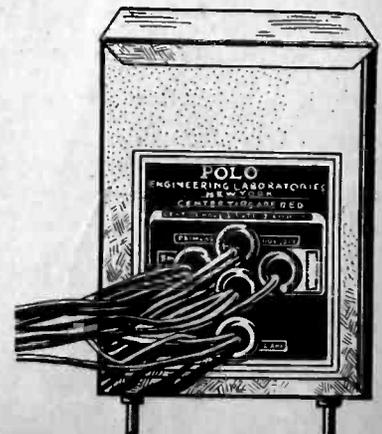
Polo Filament-Plate Supply, consisting of five windings; primary 110 v., 50-60 cycles. Cat. No. PFPS (code Cymbal), \$7.50.

Same as above, except for 40 cycles 110 v. AC and a little greater height. Cat. P40 FPS (code Cylinder), \$10.00.

FILAMENT SUPPLY

A filament transformer only, in a smaller container than any of the others, but with the same voltage and current ratings, provides 2.5 v. at 3 amperes, 2.5 v. at 12 amperes, 5 v. at 2 amperes.

The Polo Filament Transformer, consisting of four windings as described; primary, 110 v. 50-60 cycles. Cat. No. PFT (code Cyclist) \$4.25. Same as above, except for 40 cycle, 110 v. AC, Cat. P40 FT (code Cyanide), \$6.25.



Polo 245 Filament Plate Supply (less chokes) is 4 1/2" wide, 5" high, 4" front to back. Weight 9 lbs.

NO C. O. D. ORDERS.

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P245 S40 (code Cyclone).....	13.50
P245 S25 (code Cypress).....	14.50
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