July 27th, 1929 15 Cents

RADIO WORLD

REG. U.S. PAT. OFF.

The First and Only National Radio Weekly

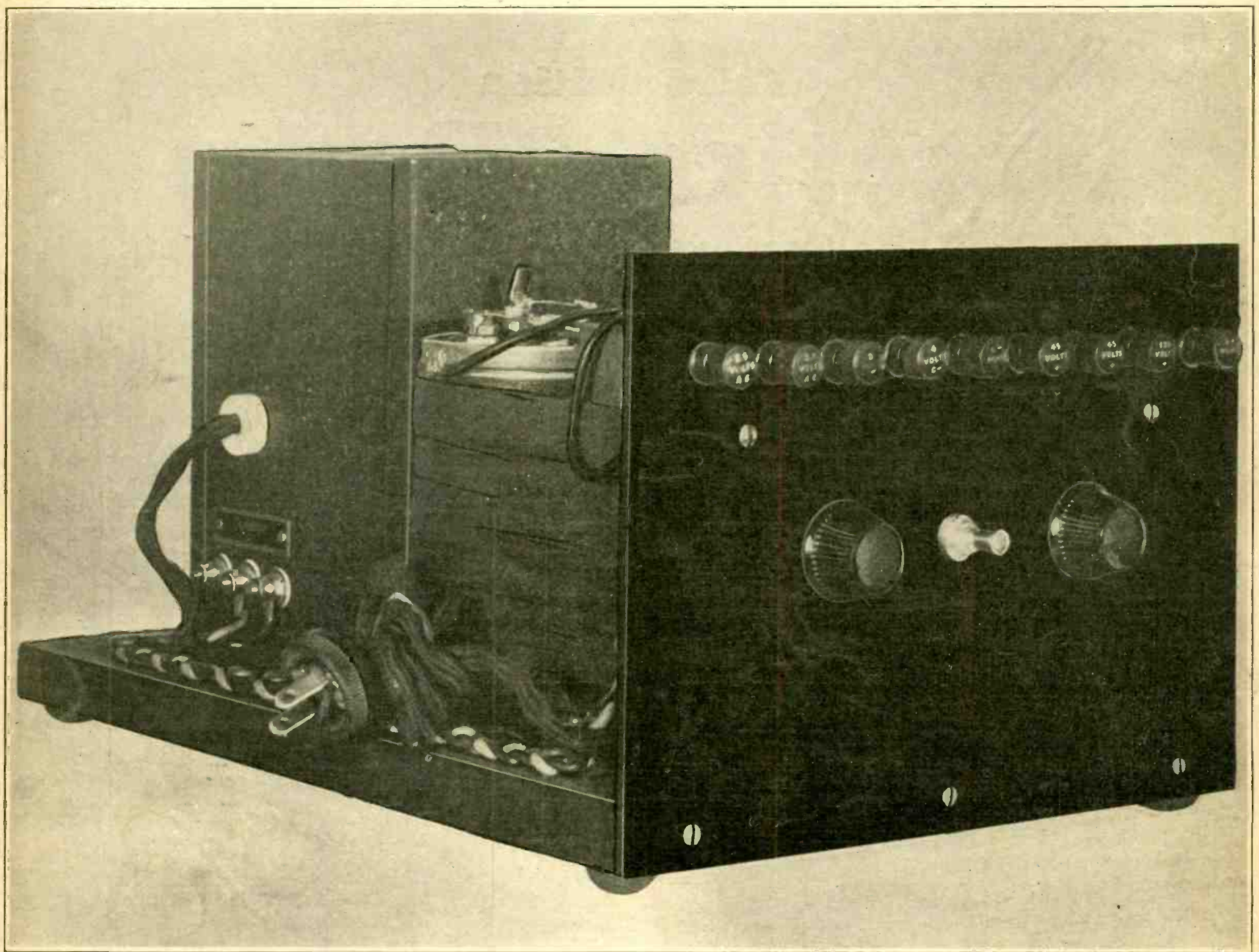
383rd Consecutive Issue—EIGHTH YEAR

WHY NOT USE THE SCREEN GRID TUBE AT FULL GAIN?

6-TUBE S-T CIRCUIT WITH 245 PP OUTPUT

Astounding Complexity of Plate Current

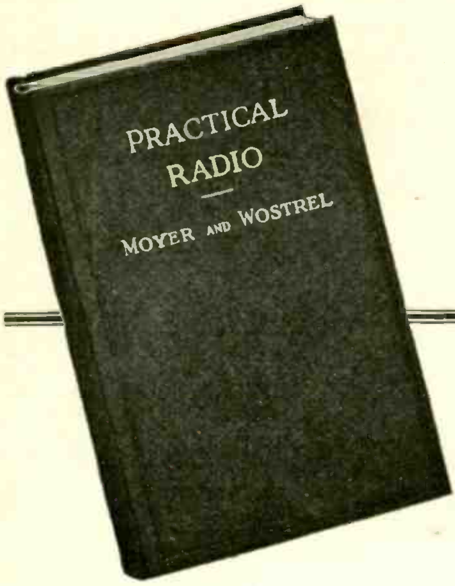
B COMPACT FOR 245 PUSH-PULL



Plate, Grid and Filament Voltages for a push-pull audio output, using 245s, and B and C voltages for the rest of the receiver are provided by this compact. See Page 3

Oscillation In Audio Amplifying Circuits	Forum for Readers to Air Their Views	Tone As the Asset Most Precious in a Set	New Morecroft Book for Novices

Radio World, published by Hennessy Radio Publications Corp.; R. B. Hennessy, Pres.; Herman Bernard, Sec'y; all 145 W. 45 St., N. Y. C.



A real radio reference book for the "listener-in"—

This book tells you:—

- —what radio is;
- —how a radio set works;
- —how to select, operate and care for radio receiving sets;
- —how to construct your own receiving set;
- —how to test your set;
- —how to select a loud speaker;
- —how to select, test and use vacuum tubes properly;
- —how to locate common troubles;
- —how to remedy them.

Third Edition

Practical Radio

Including the Testing of Radio Receiving Sets

By JAMES A. MOYER
Director of University Extension, Massachusetts Dept. of Education

and JOHN F. WOSTREL
Instructor in Radio Division of University Extension, Massachusetts Department of Education

378 *pages*, 5½ x 8, 223 *illustrations*

THE book presents the fundamental principles of radio so simply and clearly that any person of average training will be able to read, understand and apply them. Both the inexperienced amateur and the technically trained specialist will find the book valuable. In Chapter XI there are accurate working drawings as actually used in radio shops together with complete lists of materials required for constructing eight typical receiving sets.

The radio trouble chart shows at a glance the probable cause of most common troubles.

Special attention is given in this revision to loud speakers, battery eliminators, chargers and vacuum tubes.

CHAPTER HEADINGS

Price:—$2.50, postpaid

A companion volume

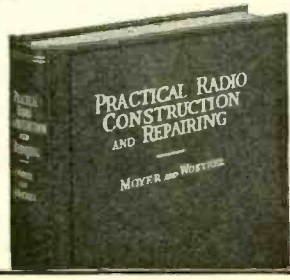
A book for the amateur constructor who makes his own set and is desirous of making it in approved professional style; for the man who has bought a commercially made broadcast receiver and wants to know how it works and how to make repairs when unsatisfactory conditions appear; for the radio dealer and his assistants who are called upon to test, "shoot trouble" and repair radio receivers.

Moyer and Wostrel's

Practical Radio Construction and Repairing

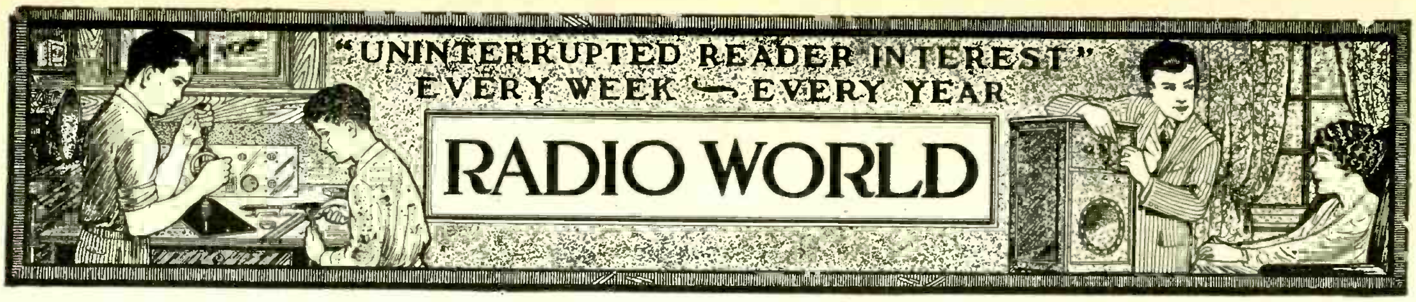
319 *pages*, 5½ x 8, $2.00

The book tells you how to build modern radio sets; how to adjust and repair the set you have, and how to test and repair commercial broadcast receivers.



RADIO WORLD

145 West 45th Street New York City
[Just East of Broadway]



Vol. XV, No. 19. Whole No. 383
July 27th, 1929
15c per Copy, $6.00 per Year
[Entered as second-class matter, March, 1922, at the Post Office at New York, N. Y., under Act of March, 1879.]

Technical Accuracy Second to None
Latest Circuits and News

EIGHTH YEAR

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

A PUSH-PULL "B"

Compact Works 245s and Feeds Other Tubes

By Harvey Sampson

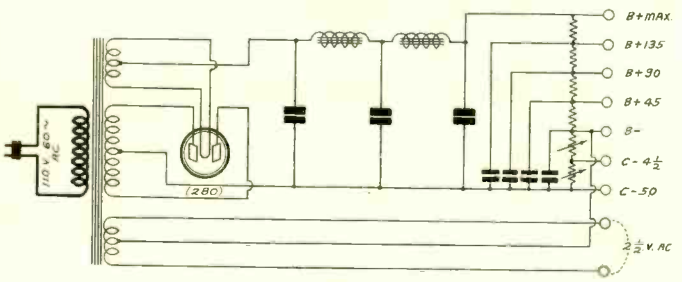


FIG. 1
SCHEMATIC DIAGRAM OF THE B SUPPLY DEPICTED ON THE FRONT COVER AND IN FIGS. 3 AND 4.

A SENSITIVE receiver that incorpates a couple of 245 power tubes in push-pull requires a plate supply device that can deliver a current up to about 90 milliamperes and maintain a voltage at this current about 300 volts. Previously this has called for two -81 type rectifiers because the -80 tube was not rated at such high voltage. Now the specification of the -80 tube have been changed a little so that now the maximum voltage is 400 volts and the maximum current is 110 milliamperes. Thus a single -80 type rectifier can be used for the service outlined above.

Such heavy service demands a power compact which is capable of carrying the current and to maintain the voltage. A suitable compact especially designed for this service can be obtained. It includes a power transformer with two filament windings, one for the rectifier tube and one for the 245 power tubes, one high voltage, center-tapped winding, and two filter chokes.

But it is not enough to have a suitable tube for rectification and a sufficient power pact. High current drain puts a heavy requirement on the filtering condensers, for the higher the current the less effective is a condenser of given capacity.

Electrolytic Condensers Used

A good way of insuring against hum in a heavy-duty power supply is to use electrolytic condensers, which can be obtained in large capacities and which are formed to withstand voltages up to 400 volts. The power supply unit shown in the picture herewith shows two such condensers. Each one of these condensers has capacity sections of 8, 8, 18, 18 mfd. The higher capacities are nearer the copper edge. In addition to the two electrolytic condensers there are two sections of paper dielectric condensers, each comprising three 1 mfd. units.

In connecting these condensers one of the 8 mfd. sections should be connected across the line next to the rectifier tube. An 18 mfd. section should be connected across the line at the junction of the two choke coils. The rest might well be connected across the line at the output side of the filter. The smaller condensers are distributed among the taps on the voltage divider.

One reason for connecting one of the smaller sections next to the rectifier tube is to prevent excessive current in the tube during the charging periods, and the reason for connecting such an enormous capacity, 78 mfd., across the output of the filter is to prevent feedback in the amplifier due to a high impedance of the power supply unit. This large capacity practically insures against motorboating when the B supply is used with resistance coupled amplifiers and other circuits capable of high gain at low frequencies.

Grid Bias Provided

Grid bias for the power tubes and the other tubes in the receiver is provided by drops in resistance section on the voltage divider. The so-called B minus on the voltage divider is placed 50 volts up from the negative terminal of the B supply. Thus if the grid return of the power tubes is made to the negative side and the midpoint on the filament transformers for the power tubes to the 50-volt point, the bias on the power tubes will be 50 volts.

A minus, or the cathodes, or the mid-points of the filament transformers for the other tubes in the receiver also are connected to the 50-volt point and the various grid returns are made to suitable points below it, that is, toward the negative terminal of the B supply.

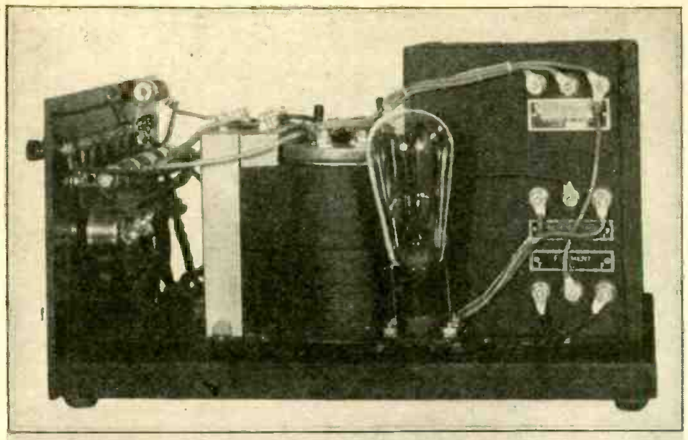
For determining the resistance between the 50-volt point and the negative terminal the entire current drawn by the device should be used, for all the current flows through this section. This includes the bleeder current and the currents taken by all the tubes. For example, if the total current is 90 milliamperes, the resistance should be 50/.09, or 555 ohms. The taps for the bias on the other tubes is placed on this resistor, with the grid bias measured from the 50-volt point downward. For a screen grid tube requiring a bias of 1.5 volts the tap should be placed at 16.65 ohms below the 50-volt tap, provided the receiver is such that it requires any bias not supplied by the drops in the filament ballasts. These examples are only illustrative.

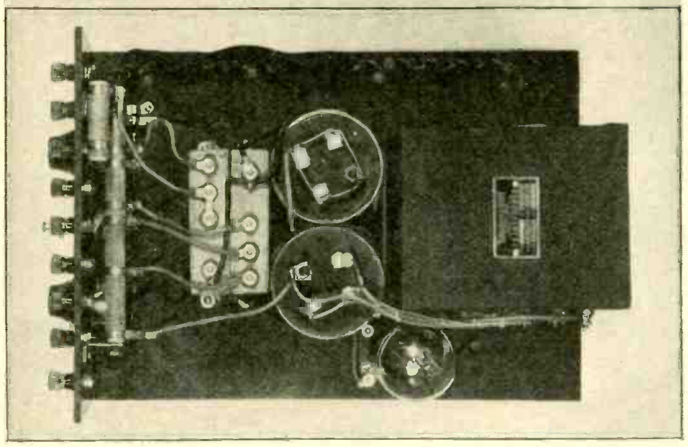
The plate voltage divider above the so-called B minus point should be adjusted to give the voltage required by the various tubes in the circuit other than the power tubes. Suppose that voltages of 45, 90 and 135 are required. To a first approximation it may be assumed that the bleeder current alone flows through all of resistors above the 50-volt point. If this current is 15 milliamperes, there should be 3,000 ohms between any two voltage taps differing by 45 volts. The resistor placed between the 135-volt tap and the positive side of the line will take more current than 15 milliamperes, because the tubes calling for 135 volts on the plates take considerable current. If the highest voltage is 300 volts during normal

(*Continued on next page*)

LIST OF PARTS

One Thordarson R-245 power compact.
Two Mershon Electrolytic condensers each 8,8,18,18 capacity and high voltage test.
Two Acme 1,1,1 condenser units.
One X type socket (four prong).
One 280 type rectifier tube.
Two Clarostats connected in series (part of grid bias resistor).
One Electrad wire-wound resistor, with adjustable taps.
Nine binding posts.
One baseboard 9¼x13 inches.
One panel 11x7 inches.





FIGS. 2 AND 3
TWO VIEWS OF THE B SUPPLY WHICH HAS BEEN ESPECIALLY DESIGNED FOR USE WITH 245 POWER TUBES IN PUSH-PULL.

operation, the drop in the resistor will be 165 volts. Then if the current is 30 milliamperes, the resistance should be 5,500 ohms.

Adjusting Resistors

As fixed commercial resistors which will any particular case cannot be obtained, it is recommended that the voltage divider be made of a number of resistors having sliding contacts which can be moved about as required by the voltage and current distribution desired. Such resistors are available and one type is illustrated in the photograph. The metal bands around these resistors can be clamped at any desired points. The adjustment should be made with the aid of a high resistance voltmeter.

Use 4 Mfd. Here

The paper dielectric condensers should be connected across the voltage divider resistor sections from the 50-volt tap. That is, the common terminal of a condenser is connected to the 50-volt tap, rather than to the negative side of the B supply, and the other condenser terminals are connected to the various voltage taps. There should be on condenser of large capacity across the entire grid bias resistor section. It should be of 4 mfd. capacity or more.

This extra condenser is not shown in the picture, one of the small paper dielectric sections being used. There is a way of getting a larger capacity across the grid bias section without adding another. Note that the electrolytic condensers are connected to the negative side. One of the 8 mfd. sections could then be connected across the grid bias resistance by simply moving one lead. No section of the electrolytic condensers can be used across the plate voltage taps because the polarity would not be right.

Quick Conversion Table, Frequency to Wavelength

kc.	m.	kc.	m.	kc.	m.	kc.	m.
1500	199.9	1260	238.0	1020	293.9	780	384.4
1490	201.2	1250	239.9	1010	296.9	770	389.4
1480	202.6	1240	241.8	1000	299.8	760	394.5
1470	204.0	1230	243.8	990	302.8	750	399.8
1460	205.4	1220	245.8	980	305.9	740	405.2
1450	206.8	1210	247.8	970	309.1	730	413
1440	208.2	1200	249.9	960	312.3	720	416.4
1430	209.7	1190	252.0	950	315.6	710	422.3
1420	211.1	1180	254.1	940	319.0	700	428.3
1410	212.6	1170	256.3	930	322.4	690	434.5
1400	314.2	1160	258.5	920	325.9	680	440.9
1390	215.7	1150	260.7	910	329.5	670	447.5
1380	217.3	1140	263.0	900	331.1	660	454.3
1370	218.8	1130	265.3	890	336.9	650	461.3
1360	220.4	1120	267.7	880	340.7	640	468.5
1350	221.1	1110	270.1	870	344.6	630	475.9
1340	223.7	1100	272.6	860	348.6	620	483.6
1330	225.4	1090	257.1	850	352.7	610	491.5
1320	227.1	1080	277.6	840	356.9	600	499.7
1310	228.3	1070	280.2	830	361.2	590	508.2
1300	230.6	1060	282.8	820	365.6	580	516.9
1290	232.4	1050	285.5	810	370.2	570	526
1280	234.2	1040	288.3	800	374.8	560	535.4
1270	236.1	1030	291.2	790	379.5	550	545.1

Right or Wrong?

(Answers on page 6)

(1)—The current-carrying capacity of a resistor depends on the voltage difference between its terminals.

(2)—The wattage dissipation of a resistor is independent of the position and the surroundings of the resistor.

(3)—If the wire is of uniform cross-section, the voltage drop in the resistor is also uniform, that is, in every section of equal length the voltage drop is the same.

(4)—Two resistors of equal value and rated at the same wattage work at the same temperature regardless of the purpose for which they are used.

(5)—If the total resistance, or the resistance per volt, of a voltmeter is known, the value of an external resistance can be measured with the single voltmeter and a battery of known voltage, provided that the battery resistance is negligible.

(6)—The condenser in a B supply subjected to the greatest stresses is the one next to the rectifier tube.

(7)—The frequency limits of hearing for normal ears depends on the intensity of the sound.

(8)—The most frequent cause of audio transformer breakdown is excessive current through the primary.

(9)—The most frequent cause of condenser breakdown is deterioration of the dielectric due to heat generated by high AC.

(10)—A battery-operated receiver is more selective than an AC-operated set.

In the three-electrode tube it is allowable to increase almost indefinitely the load resistance in the plate circuit, and the higher it is the higher the amplification. Change of plate or grid voltage is not necessary. In the screen grid tube this is not true.

For given plate and screen voltages there is a load resistance value which cannot be exceeded without either decreasing the screen voltage or increasing the plate voltage.

Pointed Queries

AT present I am using a rotatable coil in the antenna circuit as the volume control. But the control is critical. Also, the detuning effect is considerable. The set starts to squeal when the antenna coil approaches zero coupling. Even so, by retuning I can get about the same volume at slight coupling as I got at full coupling. Is there a remedy?—R. E.

The antenna coil has too many turns of wire. The volume control will be effective and the detuning consequence will be slight, if you reduce the number of turns to one, two, three or four. The number of turns will depend largely on the strength of your antenna pickup. Try four turns, then reduce if necessary. To obviate squealing when low coupling is used, wind a single extra turn of wire around the antenna winding. Short circuit this single turn. The tendency to squeal at loose coupling of the antenna winding is due to reduced effective resistance, because less of the antenna resistance is reflected in the secondary.

* * *

I BOUGHT a set from a fellow who lives in the city. It worked fine in his house. It is an AC set. When I brought it to my home, in the country, while it worked, there was no comparison in the performance. Volume was low. I don't know what to do. I brought the set back to the seller's home and again it worked great. At my home once more I tried it. Again it worked poorly.—T. W.

The AC voltages in the country districts are often lower than the rated 110 volts. In fact, even in less densely parts of the city the same effect prevails sometimes. Measure the filament voltages in your home as compared to those obtained from the same receiver in the seller's home and you will confirm this estimation, if it is true. If the receiver has a voltage-reducing device, intended to safeguard the tubes from too high voltage where line fluctuations exist, or where the line voltage is steadily high, remove this device. Increase the number of turns on the primaries of the radio frequency transformers by one-quarter.

TONE THAT THRILLS

Any One Can Build Audio Amplifier Superb

By Herbert E. Hayden

ALMOST everything tonal in a radio receiver depends on the choice of the audio amplifier, because it is responsible for pure quality and largely responsible for volume.

The radio side of the receiver may be anything you care to make it, with excellent sensitivity and good selectivity from a most modest arrangement, such as one stage of tuned radio frequency amplification and a detector tube, to many stages of TRF and a grid bias detector.

It is a safe rule to use grid bias detection where the radio amplification is high, and even in instances where it is only moderate, providing the type of detector tube and plate load connected thereto are properly chosen.

Choice of a Speaker

There is so much extraordinary enjoyment to be derived from first-class audio frequency amplification, such an almost exclusive advantage, that the best possible choice should be made. This does not restrict any one to any particular type of coupling. Any one who has read even a little about coupling devices for the audio channel must know that all the coveted advantages have been claimed for every conceivable type of coupling. But one fact remains: transformer, impedance, double impedance, tuned impedance, resistance, impedance-resistance and resistance-impedance, all can provide excellent results, if proper values are chosen, together with suitable tubes rated voltaged.

An adjunct to the choice of the audio channel, because of the effect on tone values, is the selection of the loudspeaker. Just now the dynamic is most popular. The inductor type, which is mainly magnetic, although it is called dynamic, is coming into favor, and is well entitled to popularity.

The dynamic speakers and chasses are numerous, and many manufacturers make them. The inductor type is made by few manufacturers.

Regular magnetic types of units and speakers are numerous. Horns are available with long tone travel chambers. All of these, if good ones, will produce fine results.

However, some of the dynamics in particular are filtered to overcome shortcomings, such as over-accentuation of certain audio frequency regions, others have an artificial bass predominance, while the curse of most of them is that they are housed in resonant chambers, such as console compartments, and are boomy beyond endurance.

However, your ear will give you an adequate report on these circumstances, or, if you purchase a speaker or unit without hearing it, a bona-fide money-back guarantee will give you the same test as if you heard the device before purchasing. In fact, there's nothing like trying it out in your own home, on your own receiver.

Avoid the Deterrents

Two deterrents to excellent tone quality are poor transformers and inadequate bypassing in AC circuits. No good transformer is purchaseable at a cheap price. A list price of $9 to $15 for a high-grade transformer is to be expected. Those who have trade contacts usually can obtain a discount, and if they are entitled to one they have had enough experience to verify the fact that cheap transformers never produce the fine tone of the excellent one.

Resistance coupling lends itself very nicely to experimentation with the screen grid tube, type 224 or 222. Two audio stages are enough. With tubes of lower amplification constant it was usual to employ three stages of resistance coupling, but it is now possible to get as much gain, even more, out of two stages, when the screen grid tube is used, as with three stages, using general purpose tubes or even 240 high mu tubes in the detector and first audio sockets.

When the audio channel is properly chosen and constructed, with suitable bypass condensers from the positive B voltages to ground, and across audio biasing resistors, particularly the last stage, which should be at least 4 mfd., and a proper speaker is chosen, you will get a real thrill.

Question of AC Hum

While factory-made receivers are improving, it is not unusual for the hum problem in an AC set to be "solved" by the use of poor audio transformers or a purposely-inserted filter so that frequencies below 150 cycles are cut off. Thus the 60-cycle hum and the second harmonic of that frequency, or 120 cycles, which contributes most of the hum, are not heard, but neither are the valuable notes in the region below 150 cycles, notes on which you depend for realism and character in music. In speech this cutoff matters little, but in music it is disastrous.

On the subject of hum in AC receivers, it should be acknowledged that some hum has to be endured. When the low-note response is stifled the hum is less, but who wants such a discriminating audio amplifier? Certainly not the person with a discriminating ear! When the music is playing it is always loud enough to make the hum lose its comparative existence, and even when speech is heard, there is no hum with it. During those few moments of otherwise silence there will be a little hum, but what of it? Would we sacrifice the very advantage of faithful reproduction that we cherish so much, just to get rid of a little hum that really can't be assayed as annoying?

What Can Filter Do?

Filtration should be adequate,but it scarcely can be relied upon to eliminate all hum. The parts are not being made with which to do this, and if they were made, nobody would want to pay the price. For instance, a $10 choke coil, to-day's list price, if made to the exacting specifications of total hum elimination (if that were possible), with suitably large filter condensers to be used with it, would list at, say, $25 for the choke and as much for the condenser block. People who know their radio have registered the choice of enduring a little hum during moments of non-listening in, rather than pay a 100 per cent. premium to omit all the hum, granting total elimination is possible, which is not so certain.

In battery sets there is no hum problem, unless a B eliminator is used, but even then hum is in the distant background, if noticeable at all, because the plate current drain is likely to be small, and the magnitude of the hum is proportional approximately to the square of the amount of current drawn from the B supply. Thus if a supply is intended for a modest drain, say, 35 ma for a set with filaments battery-operated, no larger bleeder current should be endured in that supply, or any other cause of large current drain. If a B supply is rated at 35 ma at 180 volts, for instance, assuming the maximum voltage will be used on the power tube, don't draw more than 40 ma.

Much Distortion Still Obtains

While radio has progressed mightily, and improvements in tone, simplicity of operation and sensitivity have been many, it is still a fact that much that is heard in homes to-day on the radio is as far from tone quality as one would dare to wander. A radio channel can be relied on to enable good tone, since the purity depends on what happens after the detector. Therefore any who possess receivers now, with which they are dissatisfied for tonal reasons alone, need only replace the present audio channel with a fine, modern one. If poor transformers are used now, they may be removed, high-grade ones supplanting them, and tubes chosen accordingly. This does not necessarily mean that other tubes are required than the ones that have been in use.

There will be just as much volume, maybe more, after the change has been made, and yet the improved tone quality will be marked. Those who listen to the receiver, the householders no less than the visitors, will comment on the great improvement.

Much for Little

Where it is a case of building a new receiver for yourself, you will almost always get fine tone quality, because the circuits offered to home-constructors of radio receivers are designed with special care in respect to the audio channel. It is recognized that unless there is a supreme tonal advantage in building your own audio amplifier, then there is no object in building it. On the radio side the home constructor is offered circuits that with fewer tubes outperform many factory-made receivers using many tubes, or if the experimenter is asked to build a circuit that has a "large" radio frequency amplifier, then he will pull in stations from all over the country, and put nearly all other types of receivers to shame on DX.

THE INCONCEIVA OF PLATE

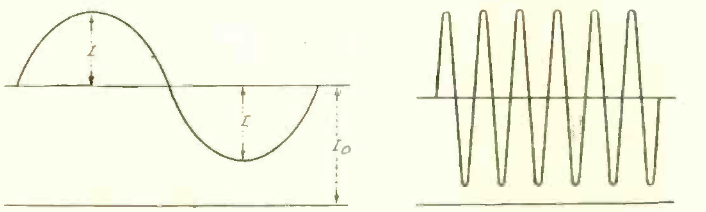


FIG. 1
AT LEFT IS SHOWN A SINGLE WAVE OF A CURRENT OF AMPLITUDE I AM IMPRESSED ON A STEADY CURRENT Io. THIS MAY REPRESENT A PURE AUDIO TONE. AT LEFT ARE SIX COMPLETE WAVES ALSO IMPRESSED ON A STEADY CURRENT. THIS REPRESENTS A RADIO FREQUENCY CURRENT.

Waves and Harmonics

By Roger

WHAT is the nature of the plate current in a detector tube when a modulated signal voltage is being impressed on the grid? It is inconceivably complex. In order to form an idea of what is occurring in the plate circuit it is necessary to simplify the problem. For example, instead of assuming that the radio frequency wave is modulated by all audio frequencies it is assumed that it is modulated by a single audio frequency. Even with this simplification the plate current is complex.

In Fig. 1 the right-hand curve represents six complete cycles of a radio frequency current or voltage. The curve at the left in the same figure represents a single wave of a current of lower frequency. I is the amplitude of this wave. A radio frequency wave modulated with a single audio frequency may be represented by a curve like that at the right in which the amplitude varies according to the wave at the left.

When the modulated voltage wave is impressed on the grid of the detector tube there results a plate current which is a greatly distorted copy of the original wave. If there were no distortion there would be no detection.

The very complex current wave in the plate of the detector can be broken up into components having different frequencies. There will be a steady current which can be measured with a direct current milliammeter. This is represented by Io in Fig. 1. The audio and radio frequency currents can be regarded as ripples on top of this steady current.

An audio current of the frequency of modulation will appear as one of the ripples. This is the only component which is desired in the output. But there will also be a second harmonic ripple on the top of the steady current, and mixed in with the frequency of modulation. Besides this harmonic there will be higher harmonics of all conceivable frequencies. But the intensities of these higher harmonics decrease so rapidly that only the first few are of appreciable magnitude.

The carrier frequency and all its harmonics also appear in the plate current as ripples in the direct current. Only the first few radio frequency harmonics are of sufficient magnitude to need consideration. There are certain conditions where the higher RF harmonics may be detected. For example, if they are produced in the RF amplifiers ahead of the detector and if the detector circuit oscillates, harmonics generated by the oscillator may produce audible beats with the harmonics of the signal generated by the RF amplifiers.

What becomes of the various components of the plate current in a typical detector, such as that in Fig. 2, for example? The direct current component flows from the battery at B plus up through the primary L4 of the transformer, through the tickler L3 to the plate, and thence to the negative of the B battery. The audio frequency components follow the same route as the direct current. However, all the higher harmonics of the modulation frequency do not flow this way, because some of them are so high as to be properly considered radio frequencies. This is true for even the lowest audio frequencies.

The radio frequency components of the plate current flow through condenser C rather than through the primary and the battery. It might be said that they start at A minus, flow through the condenser C, through the tickler and thence through the tube to A minus.

Separation Not Complete

The separation of the high and the low frequencies in the condenser and the primary is not complete, except that no direct current can flow through the condenser. If the modulation frequency is 10,000 cycles possibly 90 per cent. of the signal current will flow through the transformer and 10 per cent. through the condenser. If the modulation frequency is 100 cycles very nearly 100 per cent. of the current flows through the transformer and only a trace of it through the condenser.

While most of the carrier frequency flows through the condenser, a small part flows through the transformer. But at ordinary radio frequencies the part that flows through the transformer is very small.

The primary of the transformer has a certain distributed capacity. Through this much of the radio frequency current may flow. But this capacity is very nearly in parallel with C. It differs only in that the current that flows through the distributed capacity must flow through the B battery while the current through C goes directly to the negative of the

Right or Wrong?

(Questions on page 4)

(1)—Wrong. The current-carrying capacity of a wire has nothing to do with the voltage across it but depends on the resistivity of the wire on the wire surface exposed to air, and on the ventilation around the wire. But the voltage determines the current that will flow through a given resistor.

(2)—Wrong. The position of the resistor determines the ease with which heat can escape. The more easily the heat can escape the greater is the wattage dissipation, because the wattage is proportional to the heat radiated or conveyed away per second.

(3)—Right. This is correct provided that the wire is not only of uniform cross-section but also of uniform resistivity, that is of equal resistance per unit volume.

(4)—Wrong. If that were true a 40-watt lamp would give no more light than a 40-watt resistor in a B supply unit, or else the resistor would shine as brightly as the lamp.

(5)—Right. Let R be the total resistance of the meter and Re the external resistance, the Re = R (E/V — 1), where E is the potential of the battery and V is the voltage reading on the meter when the voltage of the battery is measured through the external resistor.

(6)—Wrong. More frequently it is the final condenser which breaks down, although the rectified voltage during the operation is higher on the first. The final condenser is often subjected to enormous voltage surges from the amplifier which cause breakdown.

(7)—Right. If the intensity is low enough, or high enough, the upper and lower limits of hearing merge.

(8)—Wrong. The most frequent cause of breakdown is voltage surges in the amplifier caused by stopping and starting plate currents.

(9)—Wrong. High voltage across the terminals is the cause. It is true, though, that heating lowers the strength of the insulation.

(10)—Wrong. There is no difference between the two types of receiver in this respect. The selectivity is obtaind from tuning coils and condensers. The same can be used in AC circuits as in battery-operated sets.

BLE COMPLEXITY

CURRENT

n a Detector Analyzed

Braintree

filament. A high impedance in the battery would force the current through C.

All the current that flows through the primary of the transformer affects the magnetization of the core of that transformer. This is true of the steady current as well as of the alternating components. The steady current produces a saturation effect, which lowers the impedance of the transformer primary, provided this current is considerable. This change in the magnetization produces no voltage in the secondary of the transformer except when the current is started and stopped.

The alternating components produce an alternating change in the magnetization of the core, and thus produce corresponding voltage changes in the secondary.

How Tickler Works

The direct and audio-frequency components of the plate current produce no effect when they flow through the tickler coil L3. The RF components, however, induce voltages in the secondary L2. These voltages are those of the signal carrier and its harmonics. All are modulated with the original signal.

The tuned circuit L2C2 responds only to the frequency to which it is adjusted. No matter what the frequency of resonance, the tickler will carry currents of this frequency, together with all its harmonics, provided that a signal current of this frequency is flowing in L1. Thus L2 is exposed to two coils in which the same signal current flows and it may pick up voltages from both. If the current flowing in L3 induces voltages in L2 in the same direction as L1 induces voltages therein, oscillation may build up. That is, there will be regeneration. And if the voltages induced by L1 and L3 in L2 are opposed, degeneration occurs. It is conceivable that the two voltages induced could be equal and opposite in phase. When they are, there would be no signal voltage induced in L2. This, however, cannot occur in a single tube because the voltage induced by L3 is proportional to that induced by L1.

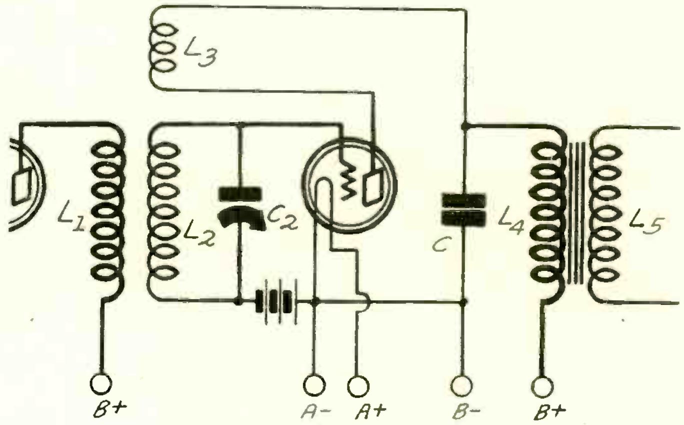


FIG. 2
A TYPICAL REGENERATIVE DETECTOR CIRCUIT.

Due to the fact that the tuned circuit L2C2 responds to only one frequency and not to any of the harmonics of that frequency, it does not matter whether there are harmonic frequencies in the currents in L1 and L3. The signal voltage impressed on the grid of the detector will be a pure radio frequency voltage, except as it is modulated. The tuner suppresses the higher modulation frequencies, whether they come from L1 or L3. So that if the regeneration is very great the voltage impressed on the grid at these frequencies tends to become unmodulated. This effect does not obtain at very low frequencies to an appreciable degree for ordinary tuned circuits. This is the side band cutting effect which occurs in all sharply tuned circuits.

New Morecroft Book for Novices

Elements of Radio Communication, by John H. Morecroft, published by John Wiley & Sons, Inc., New York. ($3.00).

As the title of this new book by Professor Morecroft indicates, it is an elementary discussion of radio communication. It explains all the fundamental concepts of the science of radio and shows their application to the art. No mathematics higher than simple algebra is used anywhere in the book, and no more of this than is necessary to explain quantitative problems. From this viewpoint the book will commend itself to thousands who prefer to get their information by reading English rather than mathematical symbolism.

While much of the subject matter is the same as that contained in the author's "Principles of Radio Communication," there is a great deal of new matter which has been added to the subject since the larger book was published.

The author's treatment of modulation is decidedly novel and instructive. The explanation of side frequencies and side bands is done so that no one reading the section can fail to get very clear ideas of these concepts. All will be convinced side frequencies are really present in a modulated wave and that they are not merely mathematical conveniences. For example, it shows what the effect of a modulated wave has on a wavemeter when readings are taken at many different settings near the setting of the resonance point for the carrier. Three peaks are shown, a high one in the middle and two lower ones at the sides of the high. Similar curves are shown for a case in which the carrier is modulated with more than one frequency.

The side bands are illustrated in the same manner, assuming that the carrier is modulated equally at all frequencies up to 5,000 cycles. This method of representing the composition of a modulated signal such as that from a broadcasting station leads to a very simple manner of illustrating side band cutting. A typical resonance curve is simply superposed on the curve that would be obtained on the wave meter were the signal modulated equally throughout the band up to 5,000 cycles. The explanation is novel, correct in its representation, and shows more clearly than any other method just what occurs.

The first chapter deals with simple laws of electric circuits, which include general electric topics not especially confined to radio but needed for the proper understanding of radio circuits. The second chapter deals with laws especially applicable to radio circuits such as tuning, reactance, and resistance. The next chapter discusses waves and radiation and related topics. The vacuum tube receives consideration in the fourth chapter.

As most of the students of radio are interested in broadcasting, most of the treatment is directed to this field. The last chapter deals with all kinds of receiving sets, from the simple crystal circuit to the most modern AC operated receiver. Balanced circuits, push-pull amplifiers, different loudspeakers, selectivity and fidelity, filters and neutralization are dealt with. Numerous curves are included in the book to illustrate principles and the performance of tubes and circuits.

This is a particularly instructive chapter.

In discussing resistance-coupled amplifiers the author makes the statement that they require a plate voltage twice as high as that required by a choke coil coupled amplifier because of the high voltage drop in the resistance. This statement is erroneous because for equal impedance and equal signal amplitude the voltage drop in the coupling device is the same whether the device is a pure resistance or an inductance. It is not at all necessary to raise the plate battery voltage in a resistance-coupled amplifier but it may be necessary in an impedance-coupled circuit because of the slightly higher amplification.

—*J. E. A.*

SG AND 245 P IN 6-TUBE

Enormous Gain is Esta

By James

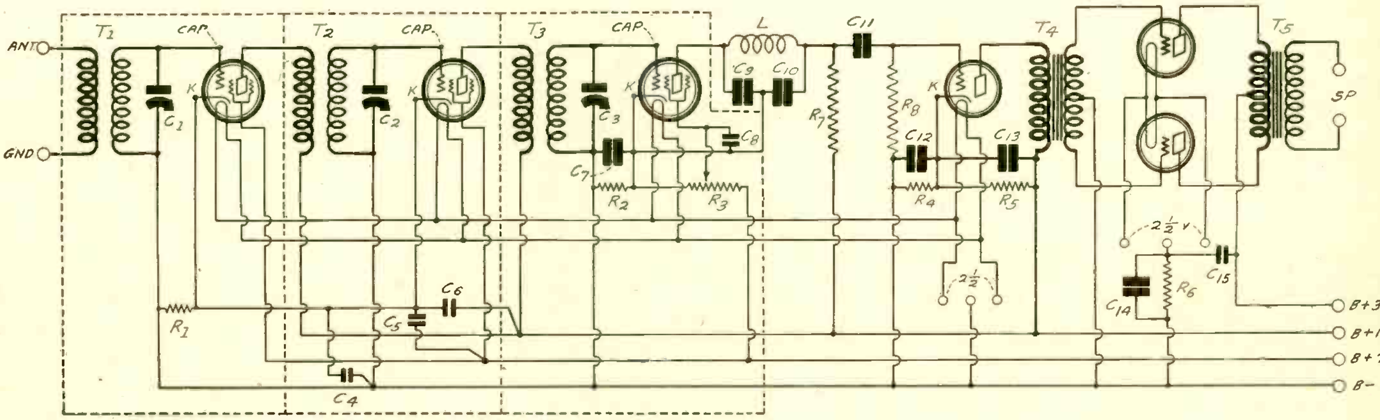
Contributing

FOR amplification and detection the screen grid tube is unexcelled, and for that reason the tube is used in increasing numbers for both functions. If best performance, however, is to be assured it is necessary to design the circuit carefully so as to take advantage of the properties of the tube.

As to radio frequency amplification there is no difficulty, because the tube was designed for that purpose, and the proper adjustments have been well worked out. It is only necessary to insure that the filament plate, screen and control grid voltage have the correct values, and that the tube be given a reasonably high load.

The control grid bias for either type of screen grid tube, that is, AC or battery, is 1.5 volts. It is true that a somewhat higher gain can be obtained when the bias is zero, but when it is, the plate current is excessive and the selectivity of the circuit is not so good. A higher bias than 1.5 volts may be used, but there is no particular gain.

The screen grid voltage for the 224 AC tube is normally 75 volts. This assumes that the grid bias is 1.5 volts and that the



load impedance on the tube does not exceed 100,000 ohms. If the load impedance is higher than this value, it is necessary to reduce the screen voltage, or to increase the plate voltage over the normal 180 volts. If the load on the tube is a parallel tuned circuit, or the primary of a radio frequency transformer coupled closely to a tuned secondary, the load impedance is not likely to be as great as 100,000 ohms, and therefore under these conditions of operation it seems that the normal values of 1.5 volts for the control grid, 75 volts for the screen and 180 volts for the plate are advisable.

No Load on Screens

An important consideration is that there should be no impedance in the screen circuit. If there is, the characteristics of the tube change and the tube loses some of its screen grid properties. If it is necessary to put a resistance in the screen circuit, that resistance should be by-passed with a condenser of low reactance at the lowest frequency at which the tube is to function. It is often desirable to put a resistance in the screen circuit for controlling the amplification.

The receiver depicted in Fig. 1 incorporates two AC screen grid tubes as radio frequency amplifiers. It also uses the same type of tube for detection. The loads on the two RF amplifiers are radio frequency transformers T2 and T2, the primaries of which are coupled closely to the secondaries. The tuning is done in the secondaries with the condensers C2 and C3. Since these two tuned circuits are similar in every respect, it is possible to put C2 and C3 on the same shaft, or otherwise to gang them up. The input transformer T1 is like the others, but since the primary is connected to the antenna, it is advisable to put C1 on a separate control.

The grid bias for the two RF amplifiers is obtained from the drop in resistance R1. The plate and screen currents of both the first tubes flow through this resistance, and since the total current is about 10 milliamperes, the value of the resistance should be 150 ohms to cause a drop of 1.5 volts. While the plate or the screen currents vary as the signal voltage varies, the sum of the plate and screen currents remains practically constant, for the variation in the plate and screen currents are nearly reciprocal. Hence there will be almost no signal voltage fluctuation in R1. Nevertheless, it is desirable to by-pass the resistance R1 with a large condenser C4, which should be not

LIST OF PARTS

C1—One .0005 mfd. condenser.
C2, C3—Two .0005 mfd. condensers on common control.
C4, C5, C6—Three .25 mfd. condensers, 400 volt test.
C7, C8—Two 1 mfd. by pass condensers, low voltage test.
C9, C10—Two .00025 mfd. condensers.
C11—One .01 mfd. stopping condenser, mica dielectric.
C12, C13—Two 2 mfd. by pass condensers, 400 volt test.
C14—One 4 mfd. by pass condenser, low voltage test.
C15—One 2 mfd. by pass condenser, 600 volt test.
T1—One RF tuning coil, Guaranty Radio Goods Co. RF5.
T2, T3—Two interstage tuning coils, Guaranty Radio Goods Co. TP5.
T4—One Ferranti push-pull input transformer.
T5—One Ferranti push-pull output transformer.
L—One RF choke coil, from 5 to 85 millihenry.
R1—One 150 ohm resistor, or one 0-5,000 ohm variable resistor.
R2, R4—Two 1,000 ohm resistors.
R3—One 25,000 ohm voltage divided (potenitometer).
R5—One 25,000 ohm fixed resistor.
R6—One 800 ohm fixed resistor, 5 watt capacity.
R7—One 100,000 ohm metalized resistors with mount.
R8—One 2 megohm metalized resistor with mount.
Four Y type sockets (five-prong).
Two X type sockets (four-prong).
Three 224 type tubes.
One 227 type tube.
Two 245 type tubes.
Eight binding posts.
One B supply capable of supplying about 90 milliamperes.
Three aluminum shields.
Two dials.

USH-PULL TUBES CIRCUIT

blished by Expert Design

H. Carroll

Editor

less than .02 mfd. Note the connection of this condenser to the junction of the two grid return leads.

Low Screen Impedance Assured

Low impedance in the screen grid circuits is assured by the use of C5, which is connected between the junction of the two screen return leads and the cathode. This condenser also should be no smaller than .02 mfd. The same applies to C6, which is connected between the junction of the two plate return leads and the cathode.

The screen grid detector requires special treatment if it is to function most efficiently. The grid bias is very critical and it depends on the voltage in the plate circuit, the screen voltage and the resistance in the plate circuit. If the load impedance at audio frequencies is a pure resistance not higher than 100,000 ohms, the applied plate voltage is 180 volts, and the screen grid voltage 75 volts, the needed bias is approximately 3 volts. But it is not enough to know merely the approximate bias.

The bias is obtained from a resistance R2 placed between the cathode and the grid return. Since the plate current normally is very small in the detector, a very high value resistance would be needed if that alone were used to establish the drop. Hence the current is augmented by connecting a resistance R3 from a suitable point on the plate voltage supply and the cathode. In Fig. 1 R3 is connected to the 75-volt tap on the B supply. The question now is what the values of R2 and R3 should be to establish 3 volts across R2 when the plate and screen currents plus the current through R3. We may choose the value of R3 arbitrarily and then proportion R2 as required. Under the conditions it is reasonable to assume that the sum of the plate and the screen grid currents is .2 milliampere. Suppose we make R3 25,000 ohms. It is connected between 75 less 3 volts. That is, the voltage drop in R3 is 72 volts. Hence a current of 2.88 milliamperes will flow through it. This plus the .2 ma current through the tube will flow through R2. Or the total current in R2 is 3.08 milliamperes. The drop in R2 should be 3 volts. Hence the resistance should be very nearly 1,000 ohms.

Finding the Operating Point

It is probable that the exact conditions assumed will not obtain. Likewise it is probable that a slightly different grid bias will give better detecting efficiency. It is not practical to vary the values of resistances, for the exact values required may not be obtainable. A very simple method of adjusting the circuit is to vary the screen grid voltage. As this voltage is increased the bias required is increased and conversely, as the screen grid voltage is decreased the required grid bias is decreased. Therefore if R3 be made a voltage divider, and if the screen grid return to be connected to the slider any screen grid voltage from 72 to zero may be applied. Within this wide range the grid bias obtained from the drop in R2 is sure to be the best for maximum detecting efficiency.

Not only does the voltage divider R3 furnish a method for finding the optimum combination of grid bias and screen grid voltage for best detection, but it also furnishes a splendid volume control. Within the range furnished by the voltage divider the detecting efficiency varies from maximum to zero. Thus the voltage divider furnishes a very good volume control as far as the audio frequency level is concerned, but it does not furnish a control of the input of the detector. If a control is needed ahead of the detector a very good one may be obtained by making R1 variable. If this has a maximum value of 5,000 ohms the bias on the two RF tubes can be made so high that the amplification is practically cut down to zero. But if such a variable resistor is used, it should have a minimum resistance at least as low as 150 ohms.

By-passing is even more necessary in the detector circuit than in the radio frequency amplifiers. And since audio frequencies as well as radio frequencies are involved, the condensers should be large. C7 and C8 should not be smaller than 1 mfd. each. The filter condensers 69 and C10 are across the audio frequency line and therefore they should be no larger than necessary. The capacity of each of these should not exceed .00025 mfd. Note that all the by-pass condensers associated with the detector return to the cathode.

Series Choke Coil

The choke coil L in the plate circuit is inserted to prevent the RF components from reaching the audio amplifier. C10 is connected on the right of this coil to help functioning. C9 serves both to prevent signal currents from entering the amplifier and to establish a low impedance to the RF currents. In some instances L is omitted, and when it is C9 and C10 should be a single .0005 mfd. condenser. The inductance of L need not exceed 5 millihenries, but an ordinary 85 millihenry choke can be used. It should not be any higher.

If the resistance R7 be 100,000 ohms, the condition that the load on the detector tube should not be greater than this value will be satisfied. The actual load will be less than this amount because C11 and R8 are in shunt with R7. If C11 be made .01 mfd. and R8, 2 megohms, the load impedance at all audio frequencies will be about 5 per cent. less than 100,000 ohms.

The combination of .01 mfd. for the stopping condenser and 2 megohms for the leak is satisfactory from the point of view of frequency distortion, because the time constant is .02 second, a value that gives good low note reproduction. The condenser should be of the mica dielectric type. Any other type will leak too much. All the leakage should be done by the resistor.

Now if the amplifier were to be resistance coupled throughout the tube following the detector could well be a screen grid tube also. But in this instance the final stage is push-pull. That requires a transformer T4 between the first audio and the output stages. This in turn imposes the requirement that the fourth tube be one of relatively low internal resistance. The only tube suitable is the 227 heater type.

How Bias is Obtained

The bias on the first audio tube is obtained in the same manner as that on the detector, namely, by the use of a grid bias resistor R4 and a support resistor R5. It may not be absolutely necessary to use R5 in this instance for there is considerable current flowing in the tube. However, the operation of the tube is improved if the current through R4 is not entirely that from the plate current alone. The total voltage available for this tube is 180 volts. Of this 12 will be allotted to the bias and the remaining 168 volts for the plate. The plate current under these conditions will be approximately 5.5 milliamperes.

Suppose that R5 is 25,000 ohms. What must R4 be? Since the voltage across R5 is 168 volts, the current through it will be 6.72 milliamperes. Then the total current through R4 will be 12.22 milliamperes. The value of R4 must then be nearly 1,000 ohms.

Two condensers, C12 and C13, are connected across the two resistors R4 and R5, respectively. Each of these condensers should not be smaller than 2 mfd.

The two tubes in the output stage are 245s. A push-pull input transformer T4 is required between the 227 and the power stage and push-pull output transformer T5 between the power stage and the speaker, unless the power transformer is built into the speaker.

The plate voltage required by the two 245s is 250 volts and the grid bias 50 volts, or the total voltage required is 300 volts.

The bias is obtained by means of a resistor R6 connected in the common lead to the mid tap of the filament transformer. The plate current in each of the tubes is 32 milliamperes, so that the total current through R6 is 64 milliamperes. Since the drop in R6 is to be 50 volts, its resistance should be 781 ohms. As the bias on the tube may be somewhat higher than the rated value, an 800 ohm resistor could well be used. The resistor is shunted with a 4 mfd. condenser C14.

OSCILLATION IN A

Motorboating and Other

By J. E. Anderson a

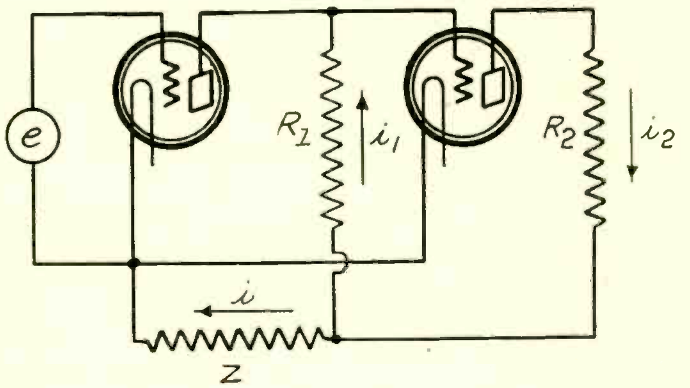


FIG. 50
A TWO-TUBE RESISTANCE COUPLED AMPLIFIER SHOWING THE DIRECTIONS OF THE PLATE CURRENTS AND THE NET CURRENT IN THE COMMON IMPEDANCE. THE CIRCUIT IS STABLE.

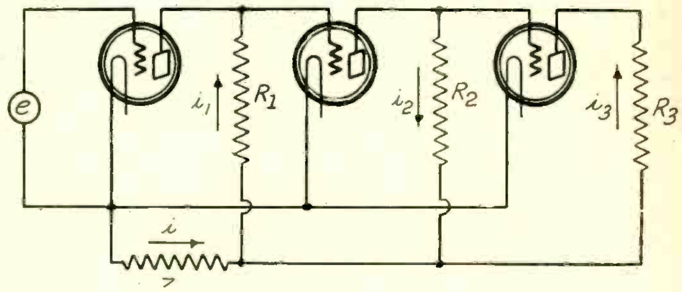


FIG. 51
A THREE-TUBE RESISTANCE COUPLED AMPLIFIER SHOWING THE DIRECTIONS OF THE PLATE CURRENTS AND THE NET CURRENT IN THE COMMON IMPEDANCE. THE CIRCUIT IS OSCILLATORY BUT MAY BE STABLE AT VERY HIGH FREQUENCIES WHEN THE LOAD IS INDUCTIVE

[*The subject of audio-frequency oscillation is discussed herewith as part of the series of articles by J. E. Anderson and Herman Bernard on "Power Amplifiers." This series was begun in the June 1st issue. Herewith is published the ninth consecutive weekly instalment, constituting a valuable discussion of the effects of common impedance. Methods of suppressing audio oscillation will be published next week, issue of August 3d.—Editor.*]

Oscillation in Audio Amplifiers—Its Cause

Just as there may be oscillation in a radio-frequency amplifier because of feedback from one stage to a preceding, so may there be oscillation in audio-frequency amplifiers because of feedback. Indeed, this oscillation is the principal reason why amplifiers fail to give satisfactory service, and there is scarcely any amplifier which is not subject to the trouble.

When this oscillation is at a low frequency, is is popularly called "motorboating" because of its resemblance to the put-put sound emitted by a motorboat engine. The oscillation is not limited to a low range of frequencies but may occur at any frequency from an extremely slow swinging of the signal similar to fading to a very high super-audible frequency. The intensity of the oscillation may be anything, from a very feeble ripple in the steady plate current to complete paralysis of the amplifier.

The frequency and intensity of the oscillation depend on the amplification of the circuit and on the nature of the circuit and its power to supply. In some instances the oscillatory condition is so feeble that the amplifier seems to be stable, but the condition manifests itself as a blasting on certain notes. Usually there is only one frequency at which this blasting occurs, and that is the frequency at which the circuit would oscillate if the feedback were a little greater.

Many explanations for this oscillatory condition have been made, some of which are wholly untenable. One of these is that the oscillation is due to blocking of the grids of the amplifier. The assumption is that when the signal amplitude is so large as to force the grid of one of the tubes positive, this grid accumulates a negative charge, which gradually becomes so large as to reduce the plate current in the tube to zero, and hence render the amplifier inoperative. This explanation is self-contradictory, yet it is the one most frequently given.

To account for the recurrent nature of the phenomenon, the assumption is made that the grid unblocks, thus giving it a chance to repeat the accumulation of the negative charge.

If blocking of the grid were the cause of the phenomenon, the wave form of the oscillation would be very irregular, but an oscillograph shows that it is very nearly of a sinusoidal form, or as near that as the shape of the grid voltage, plate current characteristic and the intensity of the oscillation permit.

A more reasonable explanation of the phenomenon is to assume that it is a regular oscillation due to feedback, and that it differs in no way from the oscillation in a circuit especially designed to oscillate.

The medium by which energy is fed back from one stage to earlier stages is the impedance which is common to the plate circuits of the amplifier, and sometimes to the impedance which is common to the grid circuits, or to a combination of these two common impedances. By common impedance we shall mean the impedance common to the plate circuits, and when we have occasion to speak of the common impedance in the grid circuits we shall modify the expression accordingly.

Now the common impedance is the impedance of the plate voltage supply device which serves two or more tubes, together with any impedance which may be in series with this impedance in such a manner that it is included in two or more plate circuits.

We shall attempt to explain the phenomenon of oscillation in several typical amplifiers on the assumption that the common impedance is the cause. We shall find that the feedback does not always lead to oscillation or blasting, but that it often causes increased stability and a reduction in the amplification.

Those who are interested in the mathematical treatment of this subject will find a more complete explanation in an article by one of the present authors in "Proceedings" of the Institute of Radio Engineers, March, 1927* The present explanation will be mostly qualitative.

Let us first consider the simple resistance-coupled circuit in Fig. 50, a circuit stripped of all components not necessary to the explanation. R1 is the load resistance of the first tube and R2 that of the second tube. Z is the common impedance, which may be the resistance of the B battery or the impedance of the B supply device. The currents $i1$, $i2$ and i are the AC components of the currents in the three impedances, and e is the signal voltage impressed on the grid of the first tube.

The signal voltage impressed on the second tube is the voltage drop in R1 and Z, that is $(R1i1+Zi)$. This voltage is multiplied by the amplification constant u2 of the second tube and at the same time it is reversed in direction, since any tube reverses the voltage impressed on its grid. Hence the voltage in the plate circuit of the second tube is $u2\ (R1i1+Zi)$. This gives rise to current $i2$. It is clear that currents $i1$ and $i2$ flow in opposite directions through Z, so that the direction of i which is the difference between $i1$ and $i2$, is determined by the larger of the two plate currents. Since the second tube is an amplifier, $i2$ is usually larger than $i1$, and therefore i flows in the some direction as $i2$, or in a direction opposite to that of $i1$. Hence the input voltage $(R1i1+Zi)$ to the second tube is decreased by the feedback through Z, for Zi is inherently negative. Therefore, in this circuit, the larger Z is, the less the amplification in the circuit. It follows that this two-tube amplifier is stable. It would neither blast nor oscillate.

It may happen that R2 will contain reactance as well as resistance, as it will if it is the impedance of a loudspeaker. If R2 con-

(*The author was J. E. Anderson.—Editor.)

UDIO AMPLIFIERS

Regenerative Consequences

nd Herman Bernard

tains inductance, $i2$ will be retarded by an amount depending on the inductance and the frequency. But the retardation cannot exceed 90 degrees. The effect of this retardation is to reduce the stability, but the reduction cannot be so great as to make the circuit oscillatory, for this would require that the retardation exceed 90 degrees. It may also happen, for certain frequencies, that the reactance of R2 is condensive. If it is, $i2$ will be advanced, but the advance cannot exceed 90 degrees. Hence when the load on the circuit contains condensive reactance the stability is reduced by an amount depending on the frequency and the capacity involved. But the reduction cannot be so great as to make the circuit oscillatory as long as the advancement of $i2$ does not exceed 90 degrees.

We conclude that this two-tube circuit is stable for all frequencies but that if the load contains reactance, the degree of stability will vary with the frequency. The stability is greater the greater the common impedance Z. Indeed, if Z is very large, the stability may be so great that there will be no amplification at all.

If the two tubes in Fig. 50 are of the 240 high mu type, and if load resistances R1 and R2 are 100,000 ohms, the amplification is 459 times when the common impedance is zero. When Z is a pure resistance of 1,000 ohms, the amplification is 431. When Z is a pure resistance of 10,000 ohms, the amplification is 289.

Now let us turn to Fig. 51 to investigate a resistance-coupled circuit having three plate circuits on the common impedance. It will be seen that the first and the third plate currents flow through Z in the same direction while the second flows through Z in the opposite. The sum of the first and third currents is much larger than the second so that the direction of i, the algebraic sum of the three currents, is in the direction of $i1$ and $i3$. The second current tends to decrease the amplification, just as it did in the circuit in Fig. 50, but the third current tends to increase it. The fact that i flows in the direction of $i3$ shows that the tendency to increase the amplification is greater than the tendency to decrease it.

The conclusion is that this circuit is unstable, and the instability is greater the larger Z. Whether or not the circuit will oscillate or merely blast at certain frequencies depends on the total amplification in the circuit and on the value of Z. If high mu tubes are used with customary coupling resistors, it is almost certain that the circuit will oscillate violently at some frequency if the plate supply is either an old B battery or any B supply unit. This circuit is the most unstable of all circuits ordinarily used.

The condition for oscillation in this circuit is that the expression $z1z2z3+Z\,[z1z2(u3+1)+z2z3+(z3-u3R2)\ \ (R1+u2r1+r1)]$ be zero, where $z=r+R$, and r is the internal resistance of a tube, R the load resistance and u the amplification factor of a tube. The subscripts indicate to which tube these quantities belong.

The negative term in the brackets is often larger than the sum of all the positive terms, and when this occurs, this expression is zero for a real value of Z. Hence the circuit will oscillate provided that Z is large enough.

If all the impedances involved are pure resistances the frequency of oscillation would be zero; that is, the currents in the various tubes would either become very great or else zero. The circuit would become unbalanced and inoperative. For example, the unbalance might take such direction that the voltage on the grid of the last tube is so much negative as to make the plate current in the last tube zero. This might also occur if there are reactances in the last plate load and in the common impedance. Perhaps it is this unbalance which has given rise to the blocking theory.

It is interesting to discover the value of the common impedance which will make the above expression zero for a typical circuit. Let us suppose the following conditions: R1 and R2, 100,000 ohms; r1 and r2, 40,000 ohms; $u2$, 30; r3, 10,000 ohms; R3 20,000 ohms; and $u3$, 8.5. Substituting these values in the expression for the condition for oscillation gives 647 ohms for Z. A higher resistance than this is often met in old B batteries, and nearly all B supply units have a resistance higher than this value.

Now suppose that the simple three-tube circuit in Fig. 51 contains an inductive reactance in series with R3. This reactance, for example, might be that of a loudspeaker. With this reactance in the load circuit how is the condition for oscillation affected? The same expression as that given for pure resistances holds provided that z3 be made to include the reactance. This impedance is now a complex quantity.

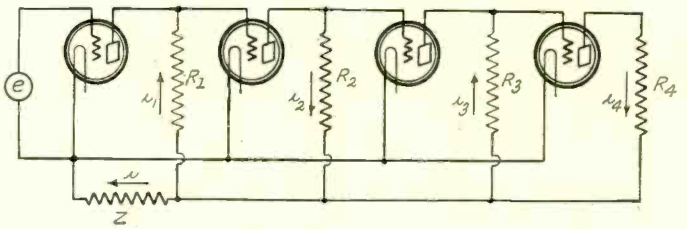


FIG. 52
A FOUR-TUBE RESISTANCE COUPLED AMPLIFIER SHOWING THE DIRECTIONS OF THE PLATE CURRENTS AND THE CURRENT THROUGH THE COMMON IMPEDANCE. THE CIRCUIT IS STABLE BUT MAY BE UNSTABLE AT HIGH FREQUENCIES IF THE LOAD IS INDUCTIVE

Suppose the speaker has an inductance of one henry and an effective resistance of 5,000 ohms. Let the other quantities be the same as in the preceding example. What should the value of Z be to make the circuit oscillate at 10 cycles per second, a typical motorboating frequency?

Substitution in the formula and solving for Z gives $316+j1.322$ for the complex value of the common impedance. This means the resistance should be 316 ohms and the inductance 211 millihenries. At some other frequency the common impedance required to produce oscillation might consist of a resistance in series with a capacity. The impedance of an ordinary B supply device, looking into its output terminals, may be of either style, depending on the frequency. Since the common impedance may be of either type, and since its value is often much greater than that required, one may expect oscillation in a circuit like that shown in Fig. 51 when it is served either with an old B battery or any B supply device.

The circuit shown in Fig. 51 is not unstable for all frequencies when the output impedance contains inductance. If there is an inductance in series with R3 the current $i3$ will be retarded relatively to $i2$ by an angle depending on the frequency. There will be one frequency at which the retardation is such that the component of $i3$ in phase with $i1$ and in opposite phase with $i2$ is just equal to the difference between $i1$ and $i2$. When that occurs, there is no effective regeneration and the circuit behaves as if Z were not present.

For higher frequencies the component of the third current opposed to the second current is so small that the second current determines the current through Z. Then degeneration or reverse feedback occurs, and the circuit is stable.

The circuit in Fig. 51, then, is oscillatory at low frequencies and stable at high frequencies, provided the load on the third tube is inductive.

It is possible from the expression for the condition of oscillation to determine the frequency at which the circuit just becomes stable. The expression is set equal to zero and solved for Z. Then the real part of Z is set equal to zero. This gives an equation for the frequency sought. If the values for the impedances previously used be substituted in the formula the frequency turns output to be 15,450 cycles per second. Thus the circuit is unstable throughout the audio range.

This computation assumes no distributed capacity in the speaker winding. Since capacity is present in all instances, it is probable that there will be no high frequency at which the circuit changes to stability.

By instability is not meant that the circuit will oscillate at any frequency, but that the amplification will be higher than it would be if Z were not present. If the circuit oscillates at all it will most probably be at a low frequency.

Let us now investigate a resistance-coupled circuit having four tubes on the common impedance. Such a circuit in simplified form is shown in Fig. 52. The designations of the various impedances and currents have the same meaning as in the three-tube circuit in Fig. 51, $i4$ and R4 having been added to account for the last tube.

WHY NOT USE F

Bernard Tuners
Circuit Provide

By Herma
Managi

[Last week, issue of July 20th, first details were published about the Bernard tuner, a new coil that extends the frequency range and which is a self-stabilizer at radio frequencies. The theory of the coil together with constructional details for the benefit of those desiring to experiment with this type of tuner, was given. It was explained then that the experimental data were not exactly like the commercial coil that will be made to the inventor's specifications. This week the construction of the commercial coil is discussed and a compact four-tube receiver design, using these new inductances, is subjected to technical analysis. Constructional details regarding this circuit will be published late in August or early in September, and other circuits, embodying the new tuning system, will follow. Read RADIO WORLD *each week for exclusive news of this valuable and fascinating system.—Editor.]*

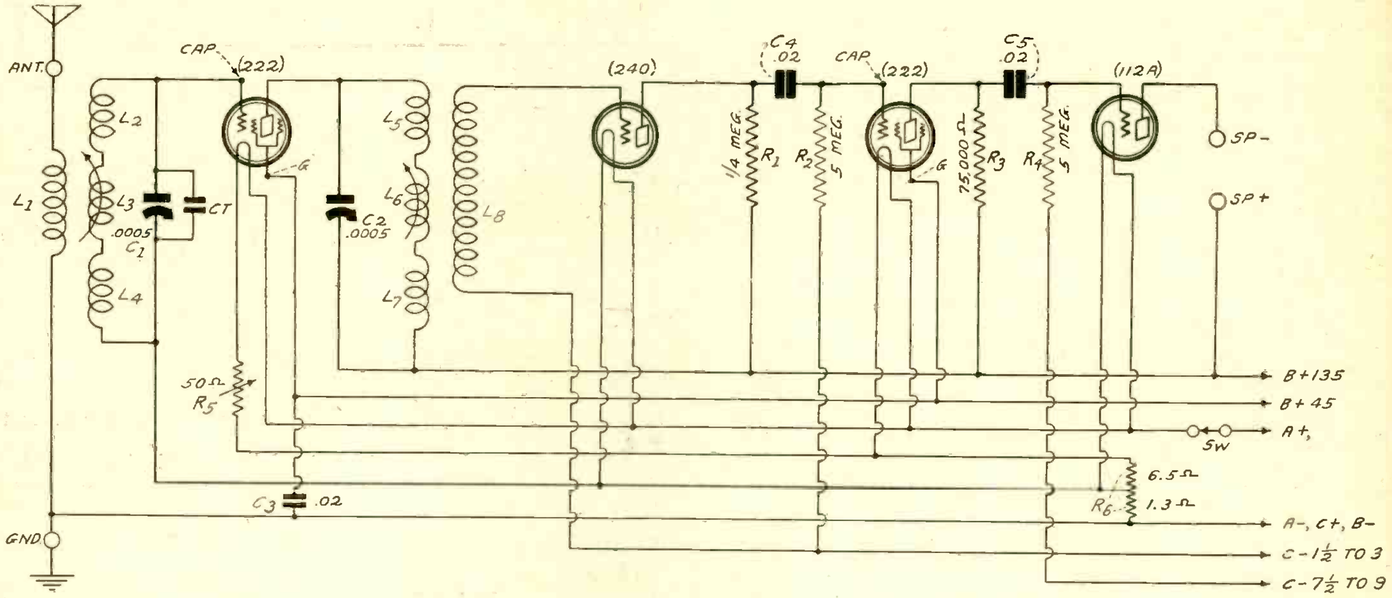


FIG. 1

"THERE NEVER WAS A RADIO-AUDIO CIRCUIT OF BETTER TONE QUALITY," SAYS THE AUTHOR, DISCUSSING THIS ASTONISHINGLY SIMPLE RECEIVER THAT AFFORDS GOOD SELECTIVITY AND HIGH SENSITIVITY. THE TECHNICAL GROUNDWORK IS DESCRIBED IN THE ACCOMPANYING TEXT. THE CIRCUIT WILL BE KNOWN AS THE H B COMPACT.

IT is incredible to some the great results obtainable from a four-tube circuit. Surely if the screen grid tube is capable of the high order of performance claimed for it, then it must be possible to incorporate in a four-tube design the proper constants for obtaining a good order of selectivity and excellent sensitivity, using only one screen grid as the complete radio frequency amplifier, and perhaps another such tube as audio amplifier. The reason is that the tube has a theoretical amplification constant of around 300, or more than thirty times as great as that of the 201A and equivalent tubes. If anywhere near so much gain is possible, then why not use it?

The design of a four-tube receiver, using a screen grid radio amplifier, high mu power detector, a first stage of screen grid audio amplification and a 112A output tube, is shown in Fig. 1. The tuning coils are the ones I invented, whereby a moving coil in series with a fixed inductance, is connected to the shaft of the tuning condenser, so that turning the condenser turns the moving coil equally, thereby adding the variometer tuning effect to the condenser tuning effect, increasing the frequency range and stabilizing the circuit due to the bucking effect of the moving coil at the higher frequencies. The design of the intended commercial coil that serves this purpose is shown in Fig. 2.

The moving coil may be sandwiched between the two other windings, from an electrical viewpoint, or may be at the low potential end (grid return or plate return in Fig. 1). This will depend on how the moving coil's terminals are brought out, and this detail is now in its final stages of settlement, prior to production of the coil, which will begin about the middle of next month.

The present discussion of the coil and the four-tube battery model circuit is prompted by the advisability of giving readers of RADIO WORLD preliminary and exclusive information on the subject, and to permit them to conduct their own experiments, which will verify the statements made in the present article and in the one published last week, issue of July 20th. Late in August or early in September the constructional details of the circuit shown in Fig. 1 will be published in RADIO WORLD. The extreme compactness and economy of the entire installation will be a surprise to many.

The circuit in Fig. 1 is preliminary, also, to the extent that some slight modifications may be expected, but the fundamentals have been worked out carefully and it is not too much to say that a circuit like this will give abundant satisfaction even to the most critical. There never was a radio-audio circuit of better tone quality, and yet the volume is plentiful.

The input to the first tube is tuned in the usual way. The volume control is a rheostat of 50 ohms. A smaller value of maximum resistance would not be suitable. The bias on the first tube is 1.7 volts negative, due to the voltage drop across part of the tapped resistor R6. The grid return of the 222 is made to negative filament of a 5-volt tube from a 3.3-volt tube, hence the bias potential is the difference, or 1.7 volts.

As the volume control rheostat is turned of course the bias on the first tube changes, but in the right direction, while the filament voltage on the other tubes becomes a little higher, in the ratio of about 1-to-7, which is not serious at all. This change is due to the greater used part of the resistance of R5 decreasing the current through the first tube's filament, hence the current through the common filament resistor. As the total current through R6 is diminished, the voltage *drop* in the fixed filament resistor is decreased, hence the applied voltage on the three remaining tubes is increased.

The antenna coil, L1, could be made movable, as a volume control, but would have a slight detuning effect. However, the adjustable antenna coupling feature is practical, because of a high starting capacity, established by CT, which may be from 70 mmfd. to 100 mmfd. maximum, and is adjusted once, to

ULL GAIN OF 222?

in 4-Tube Battery

High Strength

Bernard
Editor

equalize dial settings. The detuning effect of a moving antenna coil would be less, therefore, on account of a smaller relative change produced in the tuned circuit. But some provision would have to be made to prevent squealing, as adjustable antenna coupling has a tendency to produce oscillation at loose coupling.

The coil illustrated herewith is compact and is scientifically wound. The option of having the tuning condenser or the coil at the front panel is presented. If the condenser is to be connected to the dial, then a condenser with an extended shaft is necessary, for there must be such extension to permit coupling the condenser shaft to the coil shaft. A flexible coupler may be used, or, if rigidity of assembly is followed, a screw-machine part for coupling, which is a bushing with ¼" clearance and two set-screws, one to grip the condenser shaft, the other the coil shaft.

The difference between the two types of coupling devices is only one of price, as the metal type is much cheaper than the other, but of course is not flexible.

If the coil is put at the front panel, then any type of condenser of suitable capacity may be used. The coil itself has its shaft extended at rear, and that permits coupling to any type of condenser. On account of the desirability of highest practical ratio of maximum to minimum capacity of the tuning condenser, .0005 mfd., which is fast becoming the standard tuning capacity, is suggested, and the coil data this week and last week are for that capacity.

The lugs that afford soldering access to the terminals of the windings are at the bottom of the coil, thus shortening leads in the construction of a receiver. Two eyelets permit the use of brackets to secure the coils to the subpanel, which is necessary so that the stator form does not even budge when the tuning condenser is turned. Otherwise the whole coil would revolve as a unit along with the condenser shaft and coupling adjunct, while the intended moving coil would remain relatively still. That would spoil it.

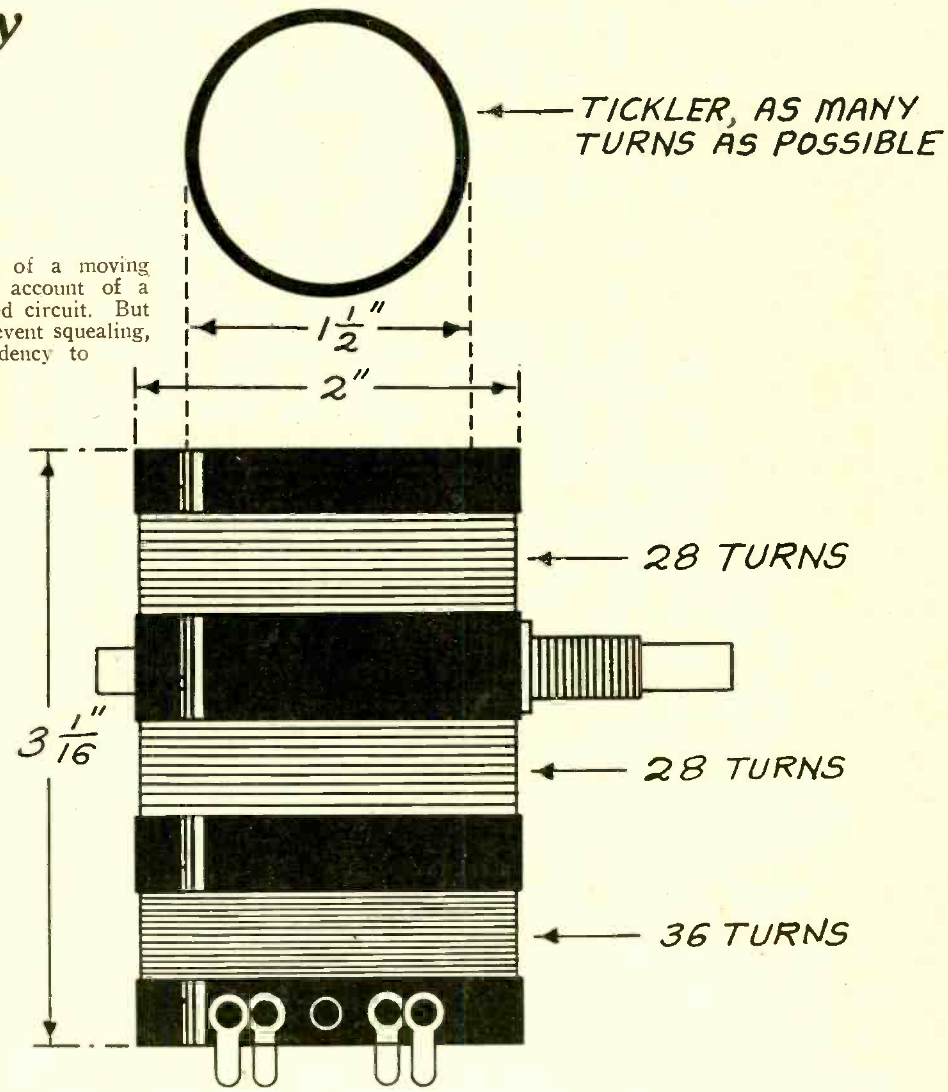


FIG. 2
TENTATIVE DESIGN OF A COMMERCIAL MODEL OF THE BERNARD TUNER, A STRIKINGLY EFFECTIVE COIL SYSTEM FOR USE IN A NEW METHOD OF TUNING, WHEREBY THE FREQUENCY RANGE OF ANY RECEIVER IS GREATLY EXTENDED, AND STABILITY GAINED AT RADIO FREQUENCIES. THE TICKLER SHOULD HAVE AS MANY TURNS AS ARE PRACTICAL WITHOUT WINDING ONE TURN ATOP ANOTHER. THE WIRE MAY BE NO. 24. IN THE COMMERCIAL MODEL ENAMELED WIRE WAS USED FOR THE TWIN WINDINGS AND SILK-COVERED WIRE FOR THE 36-TURN COUPLING WINDING.

The first tube may be regarded as being tuned twice, since the grid circuit is tuned and so is the plate circuit. This method of tuning the plate circuit, with an untuned coupling coil to feed the next stage, develops highest sensitivity by far, because the structure of the screen grid tube, 222, makes a high load impedance necessary for anything like the full obtainable gain. The impedance of a tuned circuit at resonance is infinite, so an almost ideal condition is readily developed. When the impedance is infinite it is greater than any definite value that can be assigned.

The use of the screen grid tube, with plate circuit tuned, and a high-inductance pickup coil L8 to feed the next stage, develops a high minimum capacity, and if the entire broadcast band of frequencies is to be tuned in, some method of compensation must be provided. There are only two: (a) the use of .002 mfd. or other high capacity tuning condensers, with a relatively small inductance, since the maximum-to-minimum capacity ratio is larger, and (b), the moving coil type of tuner as discussed in last week's issue, which is amplified this week as to some of its effects. Probably you never saw a .002 mfd. tuning condenser, and if you did it would be about 6" deep, and a cumbersome layout would result. But Fig. 1 will fit nicely on a 9¾"x15" subpanel, using the new tuners.

The pickup coil L8 may be any reasonable value, but the larger it is the greater the minimum capacity of the tuned circuit and the less the selectivity, so 36 turns of silk insulated wire were used on a 2" diameter tubing for the commercial sample models, as shown in Fig. 2. The other commercial winding data are given on the illustration, the two windings above and below the shaft, and the moving coil likewise, being connected in series, and the tuning condenser across the total.

Last week the winding direction were for a 2½" diameter, and either one may be followed, but it is hardly practical to duplicate the commercial coil by your own construction, since the two 28-turn windings are space-wound, requiring a threaded groove, the threads being in an already indented bed, while the 36-turn winding likewise is in a slot, but is not space-wound.

The object of space winding is to make possible the attainment of absolutely uniform tuning windings in quantity production, so that the inductance always will be the same, and to reduce distributed capacity.

(Continued next week)

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. The reply is mailed to the member. Join now!

RADIO UNIVERSITY

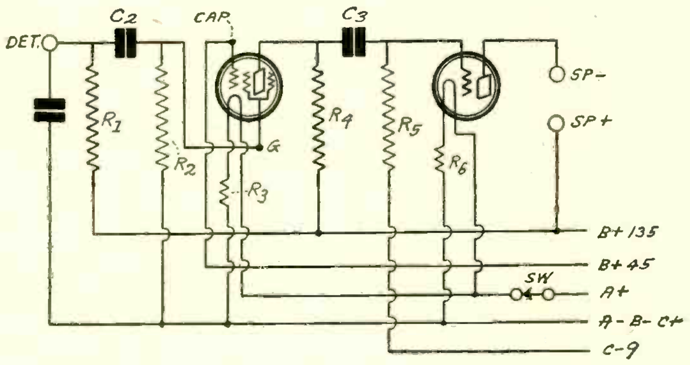


FIG. 772
A TWO-STAGE RESISTANCE-COUPLED AUDIO AMPLIFIER WITH A SPACE CHARGE SCREEN GRID TUBE IN THE FIRST STAGE.

CAN the space charge method of connecting the 222 tube be used in a resistance-coupled audio amplifier?—T. L.

Yes. See Fig. 772. A 240 is suggested as the detector tube. The resistor R1 may be 0.25 meg., R2, 2 meg. or higher, R4 experimentally determined, trying .1 to 2 meg., and R5 2 meg. or more. C2, C3 are .02 mfd. mica dielectric. R3 is a 622 Amperite, R6 is a 1A Amperite. The last tube is a 112A.

* * *

I HAVE an AC receiver that hums and doesn't hum. Let me explain. When I am listening to the set in the drawing-room, where it is permanently located, there is no hum. But when I go to the social corridor that leads to a bedroom, I hear the hum. It is not vociferous, yet there it is, a hum, nevertheless. How is it possible that a set that does not hum when you are listening to it in the room where it reposes, or that you're listening to from any other room, except in the social corridor, hums in the corridor? It seems uncanny to me. Is there any remedy?—D. V.

The corridor is a resonant chamber at a frequency approximating that of a harmonic of the 60 cycles of the AC line. Therefore you hear the hum as you would in any other such resonator. The other rooms, or parts of the house have not this particular resonance feature, hence you hear no hum there. Similar effects, though stranger by far than yours, have been noted. The hum not heard in the house where the receiver was located was plainly audible in a resonant rom in a house farther down the street. Draperies in the resonant room will help get rid of this effect.

* * *

THE drain of my AC radio receiver is 60 milliamperes of plate and bleeder current. I am using this current to measure resistances. But the results I get do not jibe with Ohm's law. Has there been any amendment of this law of late? For instance, I measure a rated 50,000-ohm resistor. The drop across this should be 3,000 volts, but it reads 50 volts. What's wrong?—K. M.

The current is 60 milliamperes when you are operating the set for reception purposes, but when you put a 50,000-ohm resistor in series with the plate voltage supply the drain is reduced to 1 milliampere. The voltage drop across 50,000 ohms when 60 ma flow is 3,000 volts, but when 1 ma flows it is 50 volts.

* * *

RATINGS of power transformers differ, and I tested out several makes, but the voltages were about the same, despite discrepancies in designations. For instance, Model A was rated at 300 volts across each half of the secondary, for a 245 supply. Model B was rated at 350 volts. Yet the voltage across the divider, at the output of the rectifier tube, was about the same in both instances. Please explain.—K. H. W.

The resultant DC voltage across the rectifier tube's output, at an average current, when the transformer was used, was the rating given to Model A, while the AC voltage across the halves of the secondaries was given in Model B. There is a voltage drop in the rectifier tube, also one due to the current drawn, that is, to regulation. Some manufacturers believe it better to state the resultant DC voltage, even on an AC device like a power transformer, rather than to designate the AC voltage, which is higher. The AC peak voltage is 1.41 times the root mean square AC voltage, and the root mean square voltage is the equivalent value of the DC voltage. Voltage dropped in the rectifier tube would have to be deducted.

* * *

WHAT is the standard way of connecting a C battery in a circuit?—O. L. K.

The usual practice is to connect C plus to A minus, and connect C minus to the grid return. However, C plus may be connected to A plus, instead of to A minus, or, again, to filament minus, instead of to either of the other points. The resultant voltages are different each way. With C plus to A minus, the actual bias is the C battery voltage plus the drop in any filament resistor used on the tube that is biased. If C plus is to A plus, then the bias is equal to the C battery voltage less the voltage drop in the filament of the biased tube. If C plus is to filament minus, then the C battery voltage equals the bias voltage. The reason for these differences is that all voltages are measured from negative filament. Obviously, three different biases are obtainable from the same C battery post by the three methods outlined. A fourth different bias would result from connection of C plus to filament minus of some tube other than the biased one, but which other tube has a higher filament voltage, while a fifth different voltage would result under like conditions, where the other tube, however, had a lower filament voltage than the biased tube.

* * *

VOLTMETERS that are particularly good are rated, I find, at their ohms per volt. Does this mean that the meter has a certain resistance for a reading of one volt, and a higher resistance in proportion to the increased voltage reading?—R. B. H.

No. The rating of a voltmeter by the ohms-per-volt emthod does not deny the fact that the meter has the same resistance at any voltage reading. It merely asserts what current the meter consumes at full-scale deflection. The smaller the current drawn by the volt meter itself, the greater the accuracy, where the regulation of the measured source affects the apparent voltage, as in a B supply. If a voltmeter has a resistance of 1,000 ohms per volt it draws 1 milliampere at full-scale deflection. If the resistance is 100 ohms per volt, the drain at full-scale deflection is 10 milliamperes. The drain is less, proportionate to the reading, although the resistance is unchanged. Take a 0-500 voltmeter. Say the current drawn by the meter at 500 volts is 1 ma. The resistance is therefore the voltage divided by the amperage, or 500 divided by .001, or 500,000 for 500 volts, or 1,000 ohms per volt. Suppose the meter reads 0-500 and draws 10 ma. The current is ten times as great, so the resistance per volt is one-tenth of 1,000 ohms, or 100 ohms per volt. The same result obtains no matter what is the full-scale deflection. Take 1,357 volts, just as an odd figure. The current is 1 ma. The resistance is 1,357 divided by .001, or 1,357,000 for 1,357 volts, or 1,000 ohms per volt.

* * *

HOW many tubes should a set have?—J. W.

Enough tubes to give the results that the set-owner demands.

* * *

MUST a bypass condenser be connected from the slider of a potentiometer to ground, where the slider moves across a resistance to take off varying voltages to apply to an RF screen grid tube for volume control?—L. R.

Yes. The capacity should be at least .02 mfd.

* * *

IS it practical to use a single choke, instead of two, in a B supply filter?—Y. T.

Yes. It is customary to use two because the hum is usually less, even if the single choke has twice the inductance of the other, and one of the two filter condensers has a capacity larger than otherwise by the capacity of the omitted condenser.

* * *

WHILE I am much interested in radio, there are other topics than screen grid tubes, indeed other tubes than these, that are interesting. Everywhere I turn it is screen grid this and screen grid that. Has the use of the screen grid tube been raised to the solemnity of a sacrament? I wish people would talk about other radio topics and magazines would print something about some other kinds of tubes. Has the

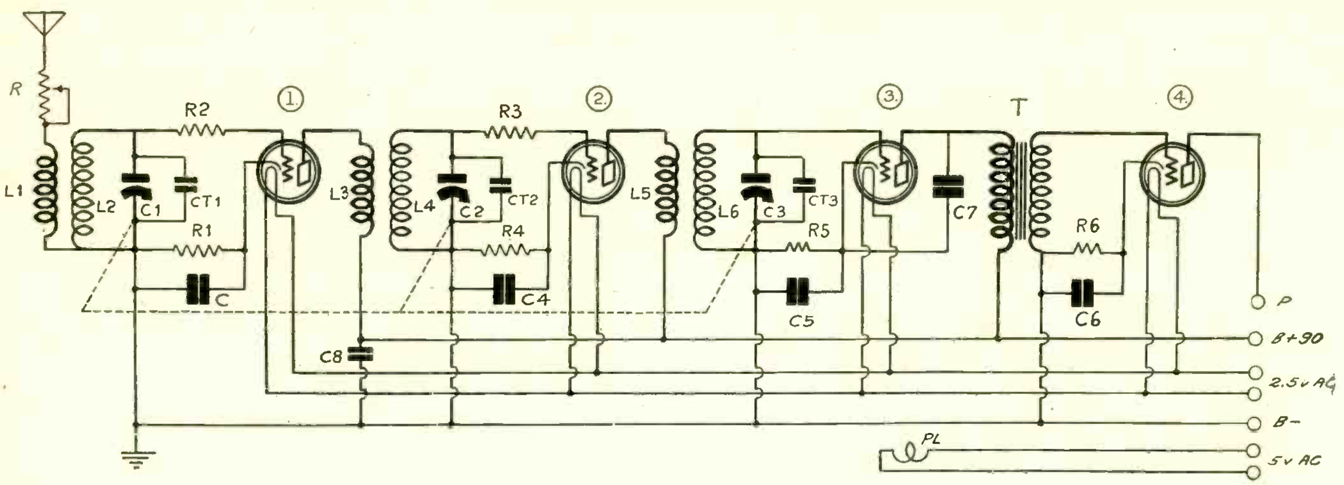


FIG. 773

THIS CIRCUIT, IF PROPERLY SHIELDED IN EACH RADIO FREQUENCY STAGE, WILL WORK A SPEAKER FAIRLY WELL WITH ONE STAGE OF AUDIO. THE PLATE P OF THE OUTPUT TUBE IS CONNECTED TO ONE SPEAKER LEAD, AND B+ MAXIMUM TO THE OTHER SPEAKER LEAD.

screen grid tube such a drop on the others that there is no comparison?—T. R.

The screen grid tube has the greatest capabilities of all amplifying tubes, is one of the newest type tubes and has won great favor with engineers and public for its immense possibilities. By the way, these possibilities have not been achieved, and research workers are trying hard to adopt methods that will work the tube up to the hilt. Besides utility, newness and fascination, the tube has much else to commend it, e.g., long life, remarkable sensitivity, fine opportunity for selectivity and extremely low price for the AC model at least. But, as you say, other tubes are interesting, even if the screen grid tube is predominant. Their uses are limited, however, so lack of variety curtails the width of discussion.

* * *

HOW feasible is the one-stage audio amplifier, to work a power tube, say, of the 245 type? Is there any special requirement in the radio channel?—A. G.

High enough amplification at radio frequencies is required to atone for the lessened amplification at audio frequencies. It is a matter of design choice which method is used. At present two stages of audio are standard. No doubt in time greater popularity will attach to the one-stage audio amplifier than at present. Probably in due course speakers will be worked right out of the detector, without any audio amplification. The sustenance of such high radio frequency amplification, even to feed a detector working into one stage of audio, requires very careful circuit design, especially in the elimination of all tendency toward squealing. See Fig. 773. R1 is 5,000 ohms, R2 and R3, 1,000 ohms; R3, R4, 300 ohms; R5, 50,000 ohms; R6, 1,200 ohms for 245; fixed condensers .02 mfd., except C7, .00025 and C6, 4 mfd.

* * *

WHAT enables a person to tell what the current drain in a receiver is, although he has not measured it? Does he rely on a sort of second sight? Or has he some inside information? I know a man who can tell to within a few milliamperes what current is flowing. He did this on a boat ride, while we were several hundred miles away from the receiver in question. When we got home and measured the current—on my meter, not his—it was only 1.5 milliamperes less than what he had prophesied.—Q. A. S.

Inside information describes it. The filament voltages and currents of vacuum tubes are known to most experimenters, for instance that the 201A draws .25 ampere at 5 volts filament. The plate current is known under the various conditions of plate voltage, grid bias and plate load. From a conversation with you your friend drew out the necessary facts and therefore could estimate closely the total current drain. By studying vacuum tube data sheets you can do as much yourself.

* * *

WHAT has happened to the space charge detector? Time was when RADIO WORLD published considerable about this, using the screen grid tube. Now little, if anything, is heard of it. Is there anything to it but wind? Did anybody ever get any results from a space charge detector? If so I never heard of it. Please enlighten one whose interest was whetted, and who yearns to know the truth.—P. S.

The space charge detector is excellent, especially if the plate load is resistive. As you must know, the screen grid tube requires research and study, and these must be carefully conducted, requiring a long period. What the screen grid tube can do, theoretically, is well advertised, but the problem is to make it do so. That constitutes the reduction of theory to practice. You will read a great deal about space charge detection in RADIO WORLD in weeks to come, especially for AC receivers. In modest battery-operated sets the 240 is suitable as detector, where the plate load is a resistor or high inductive impedance. The space charge detection series in RADIO WORLD last Spring was a valuable contribution, and the suggested receivers worked out very excellently in practice. Now with the AC screen grid tube other problems arise, and these have been solved, as will be narrated soon. Read RADIO WORLD each week and keep abreast of these developments.

* * *

WHAT should be the total resistance of a voltage divider at the output of a 280 rectifier tube, serving a regular AC set, with a single 245 output tube?—R. W. S.

The resistance to be chosen depends on how much bleeder current you desire. The bleeder current is that current which flows through the entire resistor when none of the receiver tubes is worked. Ordinarily from 20 to 40 milliamperes of bleeder current are used in a circuit as stated. If the voltage is is 300 across the total resistor, then the resistance is chosen on the basis of the desired bleeder. A resistance of 15,000 ohms would produce 20 ma bleeder current, while for 40 ma bleeder the resistance would be 7,500 ohms, at the stated voltage.

WGY OPPOSES WAVE APPEAL

Washington.

The legal fight between WGY, Schenectady, and the Federal Radio Commission over the frequency assignment and time allotment to the station has simmered down to litigants' denial of the court's legal authority to do what the opposition asks.

First the Commission challenged the authority of the court of the first instance to issue the order it did, giving WGY full time, and on the same wave as KGO. Now that the Commission has appealed to the United States Supreme Court to review the decision, WGY counters that the highest court has no such power under the circumstances.

"The decision of the Court of Appeals, having been rendered as an administrative tribunal under the Radio Act, is not subject to review by the Supreme Court," the brief argues."

On January 14th, 1928, the General Electric Company applied to the Commission, the brief declares, for a renewal of the then existing license to WGY granted by the Commission on November 1st, 1927. Under that license, the brief points out, WGY was given authority for exclusive full-time operation on a frequency of 790 kilocycles with power of 50 kilowatts.

On October 12th, 1928, the Commission acted upon this application, the brief adds, ordering that a license effective November 11th, 1928, be issued to WGY for operations on a frequency of 790 kilocycles, but denying it the right to operate full time as it had been operating.

Prior to this time, the brief continues, WGY operated from 6 o'clock until an average of 11:30 p. m., but under the order of the Commission it was compelled to close down after sunset on the Pacific Coast, or at average times varying from 7:56 p. m. during December to 10:30 p. m. during June.

An appeal was taken to the Court of Appeals of the District of Columbia by the General Electric Company, and after return by the Commission, that Court held that the restrictions imposed by the Radio Commission were unreasonable and not in the public interest. It directed the Commission to issue a renewal of WGY's former licenses which had been refused by the Commission.

26 Retailers Sued for Selling AK Sets

The Hazeltine Corporation has filed suits in the Federal Court, New York, against twenty-six firms charged with having sold of Atwater Kent radios alleged to be infringements of the Hazeltine neutralization patents. The suits followed a decision of the Circuit Court of Appeals affirming a decision of the District Court sustaining ownership of the patents by the Hazeltine Corporation.

Among the defendants named in the complaints are Gimbel Brothers; R. H. Macy & Co.; Bloomingdale Brothers, Inc.; James McCreery & Co.; John Wanamaker; Ludwig Baumann & Co.; the Commodore Radio Corporation; the Yorkville Radio Corporation; Davega, Inc., and Landay Brothers.

LATE SIGN-OFF LAID TO WNYC

Washington.

WMCA of New York City has filed a complaint with William D. L. Starbuck, Federal Radio Commissioner for the First Zone, claiming that the New York municipal station WNYC frequently delays signing off, thus interfering with the regularity of the broadcasting schedule of WMCA. Copies of letters sent WNYC complaining of the matter were inclosed. Mr. Starbuck has requested the time schedules of the two stations.

One Man to Direct Remote Orchestras

Geneva.

A new device invented by Dr. Erich Fisher, a Swiss engineer, by which several orchestras in different places can be conducted at the same time by means of radio, will be tested on Sept. 1. Orchestras in Berlin, London, Milan and Paris under Dr. Fisher's direction will then unite in playing a new hymn especially composed for the tenth assembly of the League of Nations.

INTERFERENCE CURES LISTED

The Radio Manufacturers Association has published a new booklet entitled 'The Better Radio Reception Manual, or Home-Made Static and How to Avoid It."

The booklet is the result of a survey of interference problems. It was discovered in the survey that a violet-ray machine was audible for more than a block. A break in a trolley system caused chaos within a mile.

But while serious disturbances were traced to a number of causes hitherto unsuspected and the troubles of radio ascribed to an astonishingly large number of electrical appliances, it was also discovered that in ninety-nine cases out of a hundred, the cures are simple, effective and easily applied.

A physician's violet-ray machine, for instance, may be tamed if a .25 mfd. condenser is connected across the spark gap. Elevator controls, and motors on oil burners and electric refrigerators, have proved to be easily made interference-proof. In all such cases, the remedy is to connect a bypass condenser across the contacts of the offending motors. These condensers are fairly small in the case of devices requiring low current. They run to several microfarads in the case of elevator controls. But they are silencers that function instantly and unfailingly, as they have the effect of absorbing the waste electricity generated by the motor. Thus, it is not discharged into the surrounding ether and so cannot reach radio receivers.

The Better Radio Reception Manual goes into minute details concerning the location and elimination of these causes of "man-made static" and contains a number of wiring diagrams showing exactly how filters may be installed.

The price of the booklet is 25 cents. It is distributed from the Chicago office, at 32 West Randolph Street.

A THOUGHT FOR THE WEEK

SOME radio stocks are good for the investor; some are not so good; some are very bad, indeed. If in doubt ask your banker, who should know. Then take his advice. It may save you a lot of money and many heartaches.

Forum

Guilty Is the Verdict

THERE are not many technical radio magazines for the home set builder or custom set builder to choose from, but that does not detract in the least from the compliment you deserve, that yours is the most interesting and instructive. Somebody down in your place knows something about radio and I suspect it is Anderson.

M. L. Val, Dubuque, Ia.

* * *

It Takes Our Breath Away, too

I HAVE just returned from the Cilty of Mexico, where I was surprised to find RADIO WORLD on sale at the American Book Store.

John J. Yeager, Philadelphia, Pa.

* * *

Thank You, But Why "Off"?

I HAVE read RADIO WORLD off and on for 3½ years and built a number of sets described in it. I have never had a failure in any set I have built from RADIO WORLD description and drawings. This is more than I can say for any other radio publication.

Fred Lutzke, Wauwatosa, Wis.

* * *

One Good Purpose, Anyway

I RECEIVED a request to renew my subscription for RADIO WORLD. Needless to say, I don't want your sheet at any price. As a radio magazine it would make a good press agent for some power amplifier company.

Edw. E. Wenner, San Francisco

A Surprise and a Shock

I HAVE taken, several times, the advantage of your liberal subscription offers, and bought parts for the Battery Screen Grid Diamond with blueprint. To my great surprise I was notified that there was something of interest in a certain issue of RADIO WORLD. Looking this up I found it was only my name and address in the Literature Wanted column. No doubt your intentions are the best in running this column, but I have heard from no one except gyp artists in the radio game and have come to believe that column is a sucker list for them. The worst of it is I fell for several blueprints before getting wise.

Am enclosing sample of the dope I get through the publishing of my name in your weekly. I fell for this and you should see the blueprint of this wonderful hookup. It is a darb.

I appreciate your helpful efforts but thought that you would like to learn of my own personal experiences.

A. C. Fleisch, Cincinnati, O.

PATIENCE OVER BLURBS ASKED

Washington.

The American listener should not mind the advertising announcement that interrupts a program, as that spares him paying a tax, said Dr. Julius Klein, Assistant Secretary of Commerce, in a broadcast talk. He said:

"We in the United States should not feel impatient when the broadcasting of a musical or sporting event is suspended briefly while the announcer mentions the products manufactured, or services offered, by the sponsor of the program. These moments of commercial publicity are saving you from the annoyance of renewing a license every year and paying a fee probably equivalent to the price of a new tube or so."

Estimating the popularity of radio in various countries by the number of sets per thousand of population, Dr. Klein explained, shows that the United States comes first with 83 sets per 1,000; next, Denmark, 63 sets; Sweden, 60 sets; Great Britain, more than 56 sets; and Australia and Argentina, each more than 52 sets.

Radio sets totalling 200,000,000 would be required to provide facilities for the 1,000,000,000 persons in the world within range of broadcasting stations now established, Dr. Klein stated. He gave the figures, which he said were based on five listeners to every radio set, to emphasize his conviction that there has been no approach to saturation in the radio market.

Jenkins Is Sued for $612,000 Fee

Washington.

A suit against C. Francis Jenkins, inventor of television devices, for $612,000, has been filed in the District Supreme Court in this city by Arthur D. Lord, a New York broker, who claimed that amount was due him for brokerage and agent fees in accomplishing the sale of Jenkins' interest in television patents.

The broker said that in May, 1928, Jenkins employed him to sell his interest in Jenkins Laboratories, Inc., which owned the patents, and that he interested a group of financiers who formed the Jenkins Television Corporation, which purchased Jenkins' interest for $250,000 cash and 250,000 shares of stock in the new company.

NEW INCORPORATIONS

Ames Radio Sales Corp.—Atty. S. Weinstein, 1440 Broadway, New York, N. Y.

H. M. S. Radio Corp.—Attys. Karelsen & Karelsen, 230 Park Ave., New York, N. Y.

Advance Radio Tube Mfg. Co., Kearny—United States Corp. Co., New York, N. Y.

American Broadcast Chain Studios—Attys.—Goldie & Gumm, 1540 Broadway, New York, N. Y.

Van Cronkhite, radios—Attys. Curtis, Ely & Frank, 100 Broadway, New York, N. Y.

Marti Radio Corp., Wilmington, Del.—Corp. Trust of America.

Radionic Corp., Wilmington, Del., Radio Supplies—American Guaranty and Trust Co.

Paramount Broadcasting Corp., Radios—Attys. Rubinton & Coleman, 32 Court St., Brooklyn, N. Y.

Home Radio Service—Atty. H. J. Stein, 342 Madison Ave., New York.

Radio Program Service, Advertising—Atty. J. Weil, 36 West 44th St., New York.

Radio Tube Products Co., Newark, N. J.—Atty. Arthur R. Lewis, Newark.

KDKA AND KYW ABOUT TO MOVE

Washington.

Permits have been granted KDKA, Pittsburgh, and KYW, Chicago, by the Federal Radio Commission to move these high power stations to more advantageous sites.

KDKA will be moved from East Pittsburgh to Saxonburg, twenty-six miles from Pittsburgh, and KYW will be moved to a point twenty-two miles west of Chicago.

The antenna of the Chicago station will be supported on 110-foot wooden poles directly over a natural pond. Wooden poles absorb less energy than steel towers and water is a better ground than solid earth.

WOKO Sends Out Television Regularly

Television is now a part of the daily radio program of WOKO, located on top of Mount Beacon, near Pougkeepsie, N. Y., according to the Hudson Valley Broadcasting Company, operator of the station. The images are sent out every afternoon between 2 and o'clock, Eastern Daylight Time. The wavelength is 145 meters and the call letters of the station ore W-2XBU.

The apparatus necessary to receive the images is a short wave receiver with a resistance-coupled audio amplifier, a scanning disc, a driving motor and a neon lamp.

Literature Wanted

THE names and addresses of readers of RADIO WORLD who desire literature on parts and sets from radio manufacturers, jobbers, dealers and mail order houses are published in RADIO WORLD on request of the reader. The blank at bottom may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.
I desire to receive radio literature.

Name ....

Address ....

City or town ....

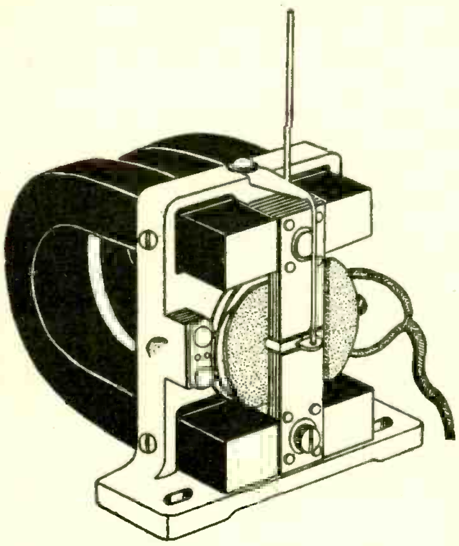
State ....

Beverly E. Jenkins, Cable Bureau, Opr. Rm. WUTCO, San Francisco, Calif.
Edwin R. Rodgers, Jr., P. O. Box 403, Asheville, N. C.
Earle M. Bigsbee, 944 Draper Ave., Schenectady, N. Y.
Radio Station W6EAI, Wade McQueen, 1411 Armacost Ave., Sawtelle, Calif.
Walter G. Schneider, Industrial Engineer, Watsessing Ave., Bloomfield, N. J.
G. C. Broun, Box 2, Leechburg, Pa.
William Nilsen, 1651 Norman St., Brooklyn, N. Y.
K. J. Custer, 1603 Poplar St., Philadelphia, Pa.
L. C. Baker, 606 E. Second Ave., Rome, Ga.
Norman Kaplan, 545 57th St., Brooklyn, N. Y.
Horace D. Westbrooks, P. O. Box 45, Trion, Ga.
D. L. Boak, 533 Cora St., Wilkinsburg, Pa.
E. F. Murphy, 1416 Jackson St., San Francisco, Calif.
R. A. Atchison, 608 So. Pearl, Denver, Colo.
J. Granderson Turner, Radio Station KFYO, Grace Hotel, Abilene, Tex.
R. H. Whipple, 1062 Lakeland Ave., Lakewood, Ohio.
Homer H. Ordung, Home Radio Service, 723 Cleveland Ave., South Bend, Ind.
R. J. Prendergast, 199 Maryland St., Winnipeg, Man., Can.
E. E. Cary, Box 533, Washington C. H., Ohio.
W. F. Heins, 1607 W. Genesee Ave., Saginaw, Mich.
Frederick Krause, 214 Belmont St., Brockton, Mass.
Millard Josenhaus, Stemmers Run, Md.
Chas. H. Anderson, 294 Main St., Reading, Mass.
John H. Pyle, 2300 So. Mich. Ave., care Engine Room, Hotel Metropole, Chicago, Ill.
Robert A. Cecchini, 726 Main St., Springfield, Mass.
S. C. Griffith, 1729 Willoughby Ave., Norfolk, Va.
Earle M. Bigsbee, 944 Draper Ave., Schenectady, N. Y.
R. R. Daigle, 1 West 67th St., New York City.
Max Frost, 174 Humbolt Ave., Wadsworth, Ohio.
John Buesing, Opr., Box 342, Grand Junction, Iowa.
T. A. Pilling, 3534 Bronx Blvd., Bronx, N. Y. City.
George Swinburne, 107 East 115th St., N. Y. City.
B. F. Leckrone, 139 Connellsville St., Uniontown, Pa.
Bernard Eveleigh, Market St., Cape Vincent, N. Y.
G. W. Sterken, 703 Henry Clay Ave., New Orleans, La.
Radio Service Co., 1831 "J" St., Lincoln, Neb.
Cooks Radio Shop, 184 So. Main St., Washington, Pa.
M. Martins, 1175 Allison Ave., Washington, Pa.
M. K. Bailey, care Dodge Elec. Co., Tulsa, Okla.
Victor E. Redding, 1116 5th St., S. E. Minneapolis, Minn.
G. A. Young, 8541 2nd Ave., N., Birmingham, Ala.
Sheldon J. Walters, 1026 Monocracy St., Bethlehem, Pa.
Samuel Hornick, 1129 Drexel Ave., Detroit, Mich.
Nat Wiener, 2357 Davidson Ave., New York City.
Walter T. Goralski, 994 Ansel Road, Cleveland, Ohio.

W. Ray Wood, Peetz, Colo.
Lytelle Duggan, 3110 Avenue J, Ensley, Ala.
Leonard H. Cobb, 35 Rand St., Ilion, N. Y.
Dr. D. O. Gillim, Dunbar & 5th St., Dayton, Ohio.
Dudolph Johnson, Box 2, Mare Island, Calif.
J. C. Ross, 316 State St., Little Rock, Ark.
Charles Schaffner, Route 5, Box 590, Houston, Tex.
James R. Sowell, Lynnville, Tenn.
C. Glenn Grover, Box 455, Magna, Utah.
W. D. Archibald, 114 Duncan Ave., Jersey City, N. J.
Wilfred Siddle, Jr., 3417 7th Court So., Birmingham, Ala.
W. E. Shaver, R. D. No. 8, Scotia, N. Y.
J. W. L. Child, 150 Easte's Road, Vancouver, B. C., Can.
R. A. Johna, Co. A, 2nd Engrs., Fort Logan, Colo.
Wm. K. Browne, Box 306, West Upton, Mass.
L. Litteken, R. F. D. 2, Box 143, Florissant, Mo.
M. F. Gunderson, New London, Minn.
A. Bonura, 247 Linden St., Brooklyn, N. Y.
Jean Marie Gift Shop, 1125 Twelfth St., Sacramento, Calif.
Harry J. Quinn, 2022 So. Opal St., Phila., Pa.
Sidney J. Smith, 24 Wagner Pl., Irvington, N. J.
D. J. Zolonowski, 11 Alpine St., Worcester, Mass.
Fred L. Young, 500 Spruce St., Charlotte, N. C.
James Page, 105 S. Wood St., Sherman, Texas.

T. G. Gibbs, A. & M. Radio Mfg. Co., 4560 Vrain St., Denver, Colo.
S. A. Kittle, c/o Garage, 1121 N. W. 29th St., Miami, Fla.
Arthur C. Thomas, Box 91, No, Birmingham, Ala.
H .B. Faria, 414 Norvell St., El-Cerrito, Calif.
Allen S. Conklin, 357 Prospect Ave., Hackensack, N. J.
Robert Morgan, 1522 Reid Ave., Cincinnati, Ohio.
Ernest Baumeister, 100 Maple Ave., Newport News, Va.
A. L. Gehrels, 401 Dakota St., San Antonio, Tex.
F. Jimenez, 1676 Broadway St., San Francisco, Calif.
D. E. Van Nostrand, 6 So. Main St., Penacook, N. H.
John R. Nelson, 184 Congress St., Milford, Mass.
L. E. McCumber, 1843 Main, Jacksonville, Fla.
W. Bannister, 60-05 44th Ave., Woodside, L. I.
S. D. MacOwen, 209 N. 3d, Memphis, Tenn.
Manuel N. Capelman, 333 E. Albanus St., Phila., Pa.
H. W. Scholow, 2855 N. Long Ave., Chicago, Ill.
Ernest Mayo, 1409 Jefferson St., New Berry, S. C.
J. E. Tryon, 2109 Ingalls Ave., Linden, N. J.
C. D. Wooley, 268 Tates Ave., Brooklyn, N. Y.
Geo. F. Holley, 1315 Commonwealth Ave., Allston, Mass.
Spokane Radio Doctor, 325 Eagle Bldg., 506 Riverside, Spokane, Wash.
H. B. Faria, 414 Norvell St., El-Cerrito, Calif.
Reginald Todd, P. O. Box 16, Caledonia, Ont., Can.
C. K. Train, 1114 Harrison, Flint, Mich.
James A. Daly, 411 4th St., Fall River, Mass.
Chas. J. Wills, 1845 Hobart Ave., Bronx, N. Y. City.
Alan Locklin, 150 Brampton, Syracuse Rd., N. Y.
Al Favalora, 594 E. 170th St., Bronx, N. Y. City.
W. H. Burman, 217 N. Warren, Saginaw, Mich.
C. G. Trotier, P. O. Box 661, Quebec, P. Q., Can.
W. H. Dowden, 248 Eddy St., Newark, Ohio.
Benjamin Goldberg, 871 East 180th St., New York City.
G. L. Stiles, 6321 Winthrop Ave., Chicago, Ill.
E. E. Wiedman, 207 W. Carolina St., Fenton, Mich.
F. A. Blake, 256 Main St., Spencer, Mass.
L. S. Goodspeed, 824 Rhomberg Ave., Onbuque, Iowa.
R. J. Russell, 102 Maine Ave., Passaic Park, N. J.
C. E. Norman, 11218 Indiana Ave., Chicago, Ill.
W. A. Sirovatka, 565 Portland Ave., St. Paul, Minn.
E. B. Bergdoll, 1358 Herlin Ave., Cincinnati, Ohio.
Wm. C. Miller, 3000 Montclair Ave., Cleveland, Ohio.

New Junior Model
POLO UNIT $4



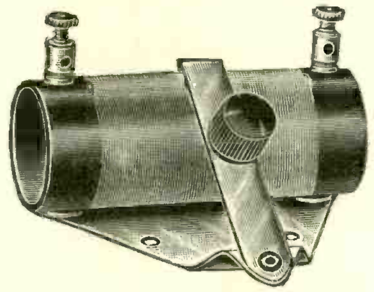
The famous twin magnet principle for double sensitivity, large magnets for great flux, permanently adjusted armature, all are in the new junior model Polo Unit. Weight, 2¾ lbs. Stands 150 volts unfiltered. Stands up to 250 push-pull filtered. Works any output tube, power or otherwise. Supplied with 10-ft. cord. Order unit now. Five-day money-back guarantee.

Acoustical Engineering Associates
143 West 45th Street
New York City
(Just East of Broadway)

HAVE AN EXPERT PUT YOUR SPEAKER IN SHAPE!

If your present speaker, no matter of what kind, is not giving proper results, send it to us, prepaid. We will test it FREE and let you know what's wrong, telling you cost of repairs. Our charges are very reasonable. Six years' experience. Loudspeakers and units repaired. Burnt-out coils replaced. Jaynxon Laboratories, 57 Dey Street New York City.

AERIAL TUNER
Improves Summer Reception



Remove aerial lead from set. Connect aerial instead to one of the binding posts of the Aerial Tuner. Connect the other binding post of the Aerial Tuner to antenna post of your set. Then move the lever of the Aerial Tuner until any weak station comes in loudest. The lever need not be moved for every different frequency tuned in. The Aerial Tuner acts as an antenna loading coil and puts the antenna's frequency at any frequency in the broadcast band that you desire to build up. It makes high wavelengths come in loud as low wavelengths. It helps separate stations and clear up reception. Makes great improvement in Summer reception. Price, $1.00.

GUARANTY RADIO GOODS CO.
145 West 45th Street
New York City
(Just East of Broadway)

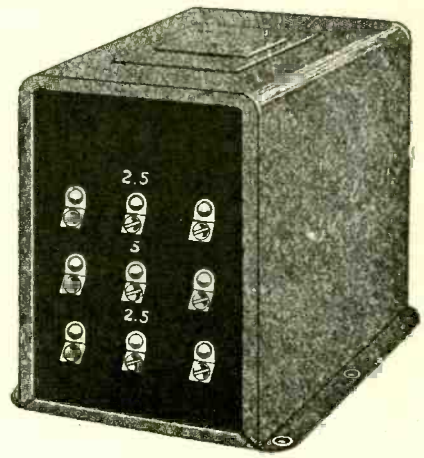
SUBSCRIBERS!

Please look at the subscriptios date stamped on your last wrapper, and if that date indicates that your subscription is about to expire, please send remittance to cover your renewal.

In this way you will get your copies without interruption and keep your file complete.

RADIO WORLD
145 WEST 45TH ST., N. Y. CITY

Filament Transformer



The heater type tube draws 1.75 ampere at 2.5 volts. If several such tubes are used a heavy-duty filament transformer is necessary. The top 2.5-volt winding of this filament transformer easily carries **NINE AMPERES**, or enough current for five heater type tubes. The bottom 2.5-volt winding stands four amperes, or enough current to heat **TWO MORE** such tubes, a total of **SEVEN TUBES!** The power tube, if of the 5-volt type, may be heated from the 5-volt central winding. 5-volt power tubes in push-pull may be heated from this winding.

All three windings are tapped at the exact electrical center. This precision location, made with the aid of an impedance bridge, accounts for absence of hum otherwise caused by the last tube when heated directly with AC. The heater type tubes are *indirectly* heated by AC, since the filament that glows is fed by AC but communicates heat to the cathode or electron emitter.

The heater type tube is represented by the 227, excellent as radio amplifier and audio amplifier, and the exclusive type of AC detector tube. Also the new AC screen grid tubes, with the same filament voltage and current, are of the heater type.

The transformer is beautifully finished in crackled glossy black, with bakelite front, and comes equipped with 52-inch AC cable with plug. Six riveted mounting holes for baseboard or subpanel. Size, 3¾ in. high, 2⅝ in. wide, 3 in. deep. Shipping weight, 6 lbs.

Cat. F226A, for 50-to-60 cycles, 105-to-120 volts AC, Net Price $6.00

Guaranty Radio Goods Co.
145 West 45th St.
N. Y. City

Twice as Much for Your Money!

Send $6.00 for one year's mail subscription for RADIO WORLD (52 numbers, one each week), and you will be given **one full year's subscription for any one of the following six magazines:**

Radio News (monthly)
Science and Invention (monthy)
Radio, San Francisco (monthly)
Radio Engineering (monthly)
Youth's Companion (weekly)
Boys' Life (monthly)
☐ **Citizens Radio Call Book and Scientific Digest**

SPECIAL **TWO-FOR-PRICE-OF-ONE** COUPON

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

Enclosed please find $6.00, for which send me RADIO WORLD each week for one year. 52 numbers, and also send me, without exrta cost, for one year ONE of the following magazines as indicated:

☐ RADIO NEWS
☐ SCIENCE AND INVENTION
☐ RADIO (San Francisco)
☐ RADIO ENGINEERING
☐ YOUTH'S COMPANION
☐ BOYS' LIFE
☐ CITIZENS RADIO CALL BOOK AND SCIENTIFIC DIGEST

[Put a cross in the proper square above. Fill out coupon and send $6.00. If you are a subscriber for RADIO WORLD or for the other magazine you select, or both, check off squares below, at left.]

Present RADIO WORLD subscribers may renew under this offer. If renewing, put a cross here ☐.

If renewing for the other magazine you select, put a cross here also ☐.

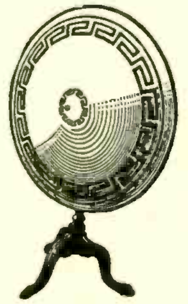
Name..

Street Address..

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

THIS OFFER EXPIRES AT NOON, AUGUST 30TH, 1929

BUILD A 36-INCH CONE—LOWEST COST FOR FINEST TONE!



NEW POWERTONE UNIT
with 5-ft. cord
Designed Front Sheet
Plain Rear Sheet
Radio Cement
Mounting Bracket
Apex
Chuck
Nut
Tri-Foot Pedestal
Instruction Sheet
ALL FOR ONLY
$6.00

24" KIT, SAME PRICE.
Build the speaker. If not overjoyed at results, return the built-up speaker in five days and get ALL your money back!

GUARANTY RADIO GOODS CO.
145 WEST 45TH STREET
N. Y. City Just East of Broadway

Leaders—224 and 245!

What These Marvelous Tubes Do

224 *AC-SG Tube,* $3.00

The Radio Trade Show in Chicago established the 224 AC Screen Grid Tube and the 245 AC Power Tube, both new, as by far the leading tubes for 1930. The master designers of circuits have chosen these tubes, the 224 for radio frequency amplification, the 245 for output tube. They merely confirmed what experimenters already had established—extreme sensitivity, great distance and fine stability are possible with the 224, while maintaining needle-point selectivity.

The 224 is capable of RF amplification of a higher order than engineers are able to capitalize in full. The tube can easily be worked at a gain of 60, as compared with 8 for the 201A.

Indirect heating is used. The filament, called heater, requires 2.5 volts and draws 1.75 ampere. The plate voltage should be 180, the screen grid voltage (G post of socket) 75 volts. The control grid connection is made to the cap at top of tube. The cathode is the electron emitter. Negative bias, 1.5 volts. Type of socket required: UY (five-prong).

Ordinary coils may be used with this tube by doubling the number of turns on the primary.

If still greater amplification is desired a larger primary may be used, and if still greater selectivity is desired, the primary may be reduced, but should have at least one-third more turns than for ordinary tubes.

"Look for the Green Box"

The 245 has a low filament voltage, 2.5 volts, at a relatively high current, 1.25 ampere. This eliminates the objectionable hum. The tube requires only 250 volts on the plate to be able to handle about as great undistorted power as the 210 does at 350 volts. A single 245 output tube will handle, without overload, the largest input to a last stage as would be required in any home. It works well into a dynamic speaker, or, by filtering the output, into a magnetic speaker. In push-pull two 245s give superb tone at doubled power handling capacity. The 250 requires 50 volts negative bias at 250 volts on the plate and draws 32 milliamperes under those conditions. The direct filament heating method is used. Type of socket, UX (*four*-prong).

There never was a power tube so excellently suited to home use—one that **handles such large** input without strain, yet which operates on a plate voltage now regarded as in the "medium" class. Use this power tube and know supreme performance. 245 *Tube, Price* $2.25

OTHER SPECIAL PURPOSE TUBES

222 Screen Grid, for battery or AC eliminator operation; 3.3 volt filament, @ .132 ampere; 135 volts plate 22 to 45 volts screen grid; negative bias 1.5 volts..$3.50

240 high mu tube, for detector or audio circuits, where a resistor or impedance coil is in the plate circuit; amplification factor, 31. Filament 5 volts, @ .25 ampere; plate 135 to 180 volts, negative bias 1.3 to 3 volts..$1.25

280 full-wave rectifier, 125 mils at 300 volts or less; 5-volt filament @ 1.25 amperes $1.75

281 half-way rectifier, 7.5-volt filament............$3.50

227 detector and amplifier for AC circuits, indirect heating type; 2.5 volts filament @ 1.75 amperes; 90 to 180 volts plate, negative bias 1.5 to 0 volts; excellent for power detection $1.50

226 AC amplifier; 1.5 volts filament @ 1.05 amperes; 90 to 150 plate volts; negative bias 2.5 to 4.5 volts..$0.95

112A output tube for battery or AC operation; filament 5 volts @ .25 ampere; 135 plate volts; 9 volts negative bias $0.95

171A power tube for battery or AC operation; 5 volts filament @ .25 ampere; 180 plate volts @ 40 volts negative bias $0.95

250 power tube, 7.5-volt filament @ 1.25 amperes; 450 plate volts; 80 volts negative bias $6.00

210 power tube $4.50

GENERAL PURPOSE TUBES

201A, 5-volt filament @ .25 ampere; 45 to 135 volts on plate, 5-volt positive for detector to 4.5 negative bias, for amplifier $0.65

199, 3.3-volt filament @ .06 ampere; 45 to 90 volts on plate; 3.3-volt positive bias for detector, to 4.5 negative for amplifier..$1.25

PUSH-PULL PAIRS

The 250, 245, 171A and 112A are sold in matched pairs for push-pull, insuring balanced, symmetrical circuits. Order MP 250, MP 245, MP 171A or MP 112A. The matched tubes are of equal mutual conductance. They are boxed together and bear "Matched Pair" identification stickers. No extra charge for matching.

Kelly Tube Co., 8718 Ridge Boulevard, Brooklyn, N. Y.

Gentlemen: Please send me the following tubes:

Quantity	Type	Quantity	Type	Quantity	Type
□	224	□	222	□	280
□	245	□	201A	□	281
□	226	□	240	□	250
□	227	□	199	□	210
□	112A	□	171A	□	MP.

If ordering C.O.D. put a cross here □

If enclosing remittance with order put a cross here □

On prepaid orders we pay cartage. On C.O.D. orders you pay cartage plus post office money-order fee.

Name ....

Address ....

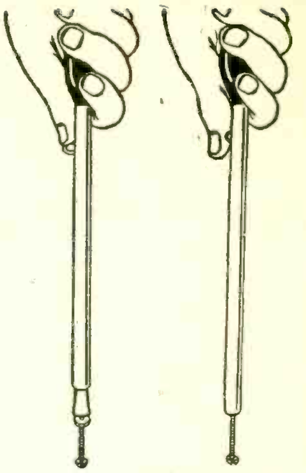
City .... State..............

Kelly

RADIO TUBES

SOCKET WRENCH

FREE



Push out control lever with knob (as at left) and put wrench on nut. Push down on handle only (at right), then turn nut left or right.

ONE of the handiest tools for a custom set builder, service man or home constructor is a BERNARD socket wrench.

It consists of a 6½" long metal tubing in which is a plunger, controlled by a knob. The plunger has a gripping terminal (called a socket, hence the name "socket wrench") that may be expanded or contracted to fit 6/32, 8/32 and 10/32 nuts, the most popular sized nuts in radio.

Use the knob to push out the plunger, press down on the handle to grip the nut, then turn the nut to left for removal or to right for fastening down. Total length, distended, including stained wooden handle, 10". Gets nicely into tight places. Send $1 for 8 weeks' mail subscription for RADIO WORLD and get this wrench FREE.

No other premium with this offer. Present subscriber may extend subscription by stating he is one, and entitle himself to this FREE premium, making $1 remittance.

RADIO WORLD
145 WEST 45TH ST., N. Y. CITY

Fourteen Circuits

Each Shown in Colored Picture Diagram, Colored Schematic Diagram and Front Panel Layout

Get This FREE Book!

Complete AC electric receivers, with B eliminators included, also AC receivers without B eliminators, also battery operated models, all easy-to-build circuits, using your own parts.

RADIO WORLD, 145 W. 45th St., N. Y. City.
(Just East of Broadway)

Gentlemen: Enclosed please find $1.00 for which please send me Radio World each week for eight weeks (regular price, $1.20) and besides send me a FREE copy of the 1929 edition of The Radio Blueprint Library of AC and Battery Hookups.

Name ....

Address ....

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

Note: Present mail subscribers may take advantage of this offer by putting a cross in this square. □ Your subscription will be extended eight weeks.

PANEL AC VOLTMETERS

(Panel meters take 2-5/64" hole)

No. 351—For reading 0-15 volts AC..........$2.20
No. 352—For reading 0-10 volts AC.......... 2.25
No. 353—For reading 0-6 volts AC.......... 2.25

(See No. 348 under "Pocket and Portable Voltmeters.")

PANEL VOLTMETERS

No. 335—For reading DC voltages, 0-8 volts, $1.00
No. 310—For reading DC voltages, 0-10 volts, 1.00
No. 316—For reading DC voltages, 0-16 volts, 1.00
No. 326—For reading DC voltages, 0-6 volts, 1.00
No. 337—For reading DC voltages, 0-50 volts, 1.00
No. 339—For reading DC voltages, 0-100 volts, 2.25
No. 342—For reading DC voltages, 0-150 volts, 2.25
No. 340—For reading DC voltages, double reading, 1-8 volts, 0-100 volts...................... 1.50

GUARANTY RADIO GOODS CO.,
145 West 45th Street, New York City.
Just East of Broadway

All Parts

for

MB-29

as described and specified by J. E. Anderson—$40.

Thrill Box, Complete Parts, all 6 coils, cabinet—$33

GUARANTY RADIO GOODS CO.
145 West 45th Street N. Y. City

Aluminum Subpanel

The best appearance of the New Diamond of the Air results from using the official aluminum subpanel, 10 x 20 inches, with the four sockets built in, and with self-bracketing front. Hardware and insulating washers supplied with each sub-panel. The aluminum sub-panel is exactly the same as the one used in the laboratory models of the battery operated and the AC Screen Grid Diamonds. Holes are drilled for mounting parts, but as this aluminum drills like bakelite you can drill any holes you want.

RADIO WORLD, 145 W. 45th St., N. Y. City.
(Just East of Broadway)

☐ Enclosed please find $3.00 for which please send one aluminum subpanel 10x20" for the new battery model 4-tube SG Diamond of the Air, with sockets built in, and with self-bracketing front and side and rear supports; also send hardware and insulating washers.

☐ Enclosed please find $2.35 for which please send 7x21" drilled Bakelite front panel for the new battery model Diamond.

☐ Enclosed please find $3.25 for the 10x20" aluminum subpanel, etc., for the new AC Screen Grid Diamond.

☐ Enclosed please find $2.35 for the 7x21" drilled Bakelite front panel for the new AC Screen Grid Diamond.

☐ Enclosed please find $5.00 for both the aluminum subpanel, etc., and the drilled Bakelite front panel of the battery model.

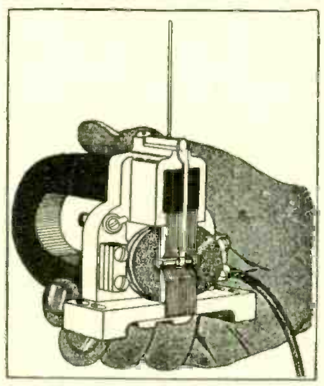
☐ Enclosed please find $5.25 for both the aluminum subpanel, etc., and the drilled Bakelite front panel of the AC model.

Name ....

Address ....

City .... State ....

FREE!



Send $6 for year's Radio World Subscription And Obtain Unit FREE!

Radio World for one year (52 numbers, one each week) will keep you abreast of latest circuits and news. Act now. Offer revocable without notice.

☐ If renewal put cross here.

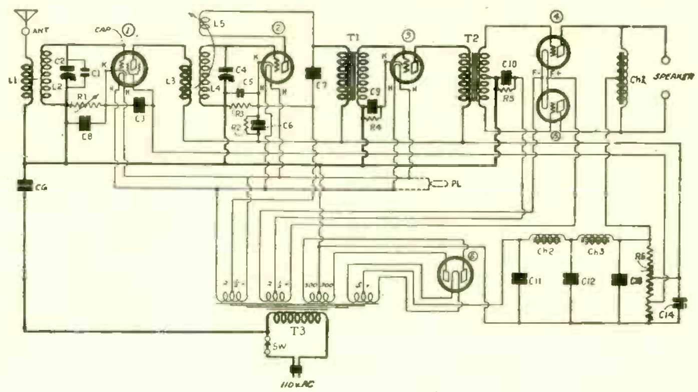
Radio World, 145 West 45th St., N. Y. City.
Enclosed please find $6 for one year's subscription for Radio World (52 numbers). Send your "superb unit" free.

Name ....

Address ....

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

PARTS FOR PUSH-PULL DIAMOND



Circuit Diagram of AC Screen Grid Push-Pull Diamond of the Air

L1, L2—One antenna coil (Cat. AC5).........$1.50
L3, L4, L5—One SG 3-circuit tuner (Cat. SGT5) 2.75
C1—One Hammarlund equalizer, 70 mmfd.... .35
C2, C4—One Hammarlund dual condenser, .0005 (Cat. MLD23)........................ 5.50
CG, C3, C5, C6, C8, C9—Six Aerovox .02 mfd. fixed condensers.......................each .80
C7—One Aerovox .0005 mfd. fixed condenser .20
C10—One Aerovox 4 mfd. bypass condenser 1.50
C11, C12, C13, C14—Mershon 8-18-18-8........ 5.76
R1—One Electrad Royalty variable resistor, 5,000 ohms, with 110-volt AC switch..... 1.50
R2, R3—One 25,000 ohm Electrad resistor type B (with 3 terminals)...................... .75
R4—One 1,000 ohm Electrad resistance strip .20
R5—One 800 ohm Electrad resistance strip.. .20
R6—One Aerovox Pyrohm type B (750, 750, 2,800, 3,000) 1.00
T1—One National A100 audio transformer.... 5.70
T2—One National push-pull input transformer 5.70
T3—One power transformer (5, 2.5, 2.5, 300, 300v.) 10.00
Ch1—One push-pull output choke............ 5.00
Ch2, Ch3—One S-M Unichoke 331............ 4.80
Ant., Gnd., Speaker—, Speaker+—four binding posts ....each .15
One 7 x 21" front panel...................... 1.65
One flat type dial, with dial pointer.......... .95
Two knobs ....each .20
One roll Corwico Braidite...................... .35
One 2.5v AC pilot light, with bracket......... .60

Above is complete, less baseboard, sockets, tubes and cabinet.

GUARANTY RADIO GOODS CO.
145 West 45th Street, New York City (Just East of Broadway)

New Diamond

PARTS FOR BATTERY MODEL DIAMOND

C1—Aerovox .0005 moulded fixed.................. .25
C2—Hammarlund .0005 mfd. Midline.............. 3.30
C3, C4—Two Aerovox moulded .006 mfd. @ .50 ea.. 1.00
C5—Hammarlund .0005 mfd. Midline.............. 3.30
C6—Aerovox .00025 moulded fixed with clips...... .30
C7—Aerovox .0005 moulded fixed.................. .25
A1—622 Amperite with mount...................... .85
A2, A3, A4—Three 1A Amperites, three mounts @ .85 .... 2.55
R1—50-ohm Frost rheostat 1.00
R2—5-meg. Lynch metallized leak .... .40
T1, T2—Two National A100 audios @ $5.70 ea.... 11.40
Ant., Gnd., Sp. —, Sp. + posts @ .10 ea......... .40
P1—Yaxley jewel window bracket .35 with pilot lamp .20 .... .55
Sw—Yaxley No. 10 A battery switch .... .35
7 x 21-inch front panel 2.35
10 x 20-inch official battery Diamond subpanel, self-bracketing, with four sockets affixed; subpanel hardware, insulated bushings, washers............ 3.00
Front panel and subpanel together................ 5.00
Two dials with pointers 2.00
Two knobs @ .20................................ .40
One roll stranded Braidite .... .30
Hammarlund 70 mmfd. Equalizer .... .40
Four Kelly tubes: one 222, two 201A, one 112A or 171A 7.00

GUARANTY RADIO GOODS CO.
145 WEST 45th STREET
(Just East of Broadway)
NEW YORK CITY

All Parts for
PUSH-PULL DIAMOND

Mershon Electrolytic Condensers, four in one Copper Container

8-8-18-18 mfd. List price, $9.60 — **$5.76** Net

10-10-10-10 mfd. List price, $7.75 — **$4.65** Net

Filament Transformer, 2½, 5, 2½ v., net $4.00
Power Transformer, 2½, 5, 2½, 300, 300 v., net..................................10.00
S M Unichoke 331, net................ 4.80

Guaranty Radio Goods Co.
145 West 45th Street
New York City
(Just East of Broadway)

MARVELOUS NEW pick up for phonograph. Only twelve left, all pippins. Money-back 10-day guarantee. Send $3.75.—P. Cohen, Room 1214, at 143 W. 45 St., N. Y. C.

FILL OUT AND MAIL NOW

SUBSCRIPTION BLANK

RADIO WORLD

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

Please send me RADIO WORLD for .... months, for which please find enclosed

SUBSCRIPTION RATES:
Single Copy..........................$ .15
Three Months.............. 1.50
Six Months.................. 3.00
One Year, 52 Issues........ 6.00
Add $1.00 a Year for Foreign Postage; 50c for Canadian Postage.

RADIO WORLD, a weekly paper, published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y. Phone: BRYant 0558 and 0559 15c per copy, $6 per year. This issue is dated July 27th, 1929, and is Vol. XV, No. 19. Whole No. 383. Entered as second-class matter, March, 1922, at the post Office at New York, N. Y., under Act of March, 1879.