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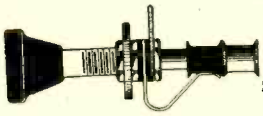

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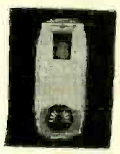

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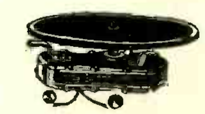

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No Quality from Pentodes?

Many Condemn Tube Though Cause Lies Elsewhere

By Henry B. Herman

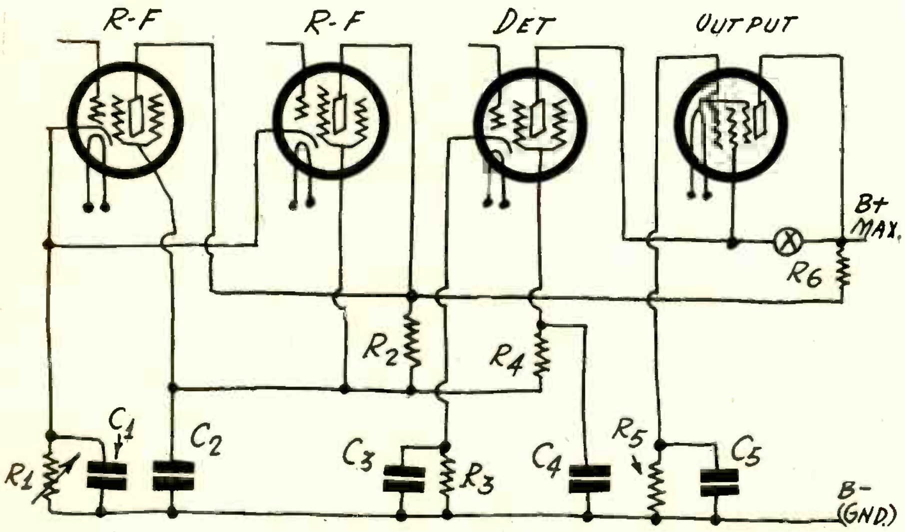

FIG. 1
Fundamental plate-screen-cathode circuit of a five-tube midget receiver (280 rectifier and plate and grid loads omitted). Why such circuits are very likely of poor tone quality is explained in the text.

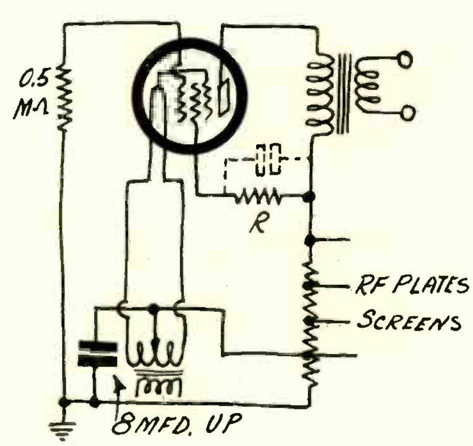

FIG. 2
The fundamental circuit of a 247 pentode, with bias resistor bypassed.

THERE is a lot of talk going around that good quality is not possible with the pentode. At the same time there is a large sale of midget sets of inferior design, where the output tube is a pentode. Quality's absence is the fault of the too-economical midget set, rather than the pentode. For as good quality is possible with the 247 and its companion pentodes as with the 245, 171A and other tubes previously used in large quantity.

The trouble may be traced down to too much economy and too little bypassing. Let us see what the fundamental voltage circuit of the midget receiver is. Fig. 1 portrays that, with plate and grid loads omitted for clarity of the fundamentals.

It can be seen that a high-current voltage divider is not used, but instead low wattage high resistances are used to drop the voltage from maximum to that required for the screens and plates of the tuner. The only resistor that carries any appreciable current is that marked R5, for the pentode plate current, 32 milliamperes, and the suppressor-grid (screen), 7.5 milliamperes, flow through R5. The total is 39.5 milliamperes. The power equals 0.65175 watt, and on the basis of a 50 per cent. minimum margin of safety a commercial resistor of 2 watts may be used. The rest are fractional-watt resistors, and these are very inexpensive, being of the pigtail grid leak type.

Detector Stumbling Block

Now, this system indirectly affects the quality of the reproduction. The variable biasing resistor, R1, and the condenser across it, C1, do not enter, as radio frequencies alone are concerned, and any rheostat that controls the volume is satisfactory, and the condenser capacity for radio frequency bypass may be small, of any value encompassed in the mica dielectric group, which does not usually exceed 0.02 mfd.

The next highest voltage after the cathodes of the radio frequency tubes, is the voltage on the detector cathode, assuming negative bias detection. To provide the necessary bias a resistor of high resistance is used, somewhere between 15,000 and 35,000 ohms. This is R3. Likewise, the screen voltage for the detector tube is dropped through a series resistor that is tied to the screens of the r-f tubes, which themselves depend on a resistor (R4).

The biasing resistor for the detector and the limiting resistor for the detector screen constitute the first stumbling block. The same situation obtains here as in circuits using other type tubes, and even regular voltage dividers, that is, where you put audio frequency through a high resistance you will certainly attenuate the low notes unless the resistors are properly bypassed. And that means very large capacity across them. For R3, the detector biasing resistor, and R4, its screen voltage limiting radiator, bypass condensers of 8 mfd. would not be a whit too large, as the impedance at 60 cycles would be around 600 ohms for the common circuits (condenser and resistor in parallel).

Need of Large Bypass Capacities

It will be found, no doubt, on examination of a circuit from which not enough energy is radiated in the low audio frequency region, that the condensers (if any) across these resistors are of the order of fractions of 1 mfd., say 0.1 or 0.25 mfd. It would

(*Continued on next page*)

247 Performance Expounded

Large Bypass Capacities and Proper Loads Advocated

(*Continued from preceding page*)

make virtually no practical difference to audio frequencies if condensers of such low capacity were left out, although they serve all right as radio frequency bypass condensers. However, the tone quality consideration as affecting the detector has to do with audio frequencies, for the detector is also an audio tube. The bypassing for radio frequency purposes has to do with sensitivity.

It should not surprise those familiar with the necessity of large bypass capacity to find that with the trivial capacities in an actual circuit the set sounds shrill and sharp, something like the phonograph records in the old days. What happened to the bass response? Why, it got sidetracked in the two resistors just mentioned.

Now we consider a resistor of equal importance, the one biasing the pentode. Fortunately, this is a lower impedance—around 400 ohms—than the two others, but in a tube of such high amplification the necessity for bypassing is even more greatly pronounced. The feedback through the three resistors—detector cathode, detector screen and pentode filament-plate circuit—is negative, and the greater the mu of the tube, the greater the negative feedback. The pentode is a high mu output tube, so again 8 mfd. would not be at all too large, for the effective impedance of the combination resistor and condenser then would be around 240 ohms.

Applies to All Audio Circuits

So we have used up three 8 mfd. condensers, and we have not yet considered the need of the rectifier, which will require at least two 4 mfd., or one 4 mfd. and one 8 mfd., or may have two 8 mfd.

Five large condensers!

The need for a large bypass capacity is a fact concerning any audio tube where the bias is obtained through the voltage drop in a resistor. The pentodes for battery operation usually do not come in for the adverse comment on tone quality, because batteries are used for biasing, and these require no bypass condenser.

While the bias is obtained, in Fig. 1, through the drop in a plain resistor, in fact the 300 ohm value may be part of the winding of the B supply choke, which then would be in the negative leg, but then the choke should be considered as a resistor alone, and the same value of bypass capacity included as of it were not a choke but just a simple resistor.

A consideration that does concern the pentode alone is that the suppressor grid voltage (cathode connection on socket for most other tubes) actually may be higher than the effective plate voltage.

Reduced Screen Voltage

This would be true although both plate return and suppressor are tied to the same point, maximum B plus. The reason is that the load on the pentode plate (primary of an output transformer) may be of such high, direct current resistance that there is a drop of, say 16 volts. That would be true if the d-c resistance were 500 ohms. If it is 1,000 ohms the difference in voltages would be 32 volts.

If the proper type of output transformer is used, the voltage drop may be high, because the pentode requires a much higher output impedance as its load than does the 245. The solution would be to put a resistor at point (X) in Fig. 1, to equalize the voltages. If the resistor is large, bypass it, because the feedback through it is negative.

Certain aspects of the case prompt the omission of a bypass condenser here, for it is argued that the suppressor grid current and voltage will swing, in the right direction, with the signal. Therefore a stability of voltage is established. But this does not take into consideration the negative feedback through the limiting resistor, which has the same effect in screen circuits of all tubes used as audio amplifiers. When the condenser is put across a high resistance the volume goes up. If the resistor is less than 200 ohms only a very large condenser would help much. It may be assumed, therefore, that the screen currents are somewhat out of phase from the plate currents, though perhaps not more than 90 degrees so.

If the resistor is of low value a condenser need not be used, as otherwise the condenser would not be so fully effective because the capacity couldn't well be high enough.

The value of the resistor for (X) may be selected by measuring the voltage across the primary of the output device with a voltmeter (1,000 ohms or more per volt), choosing a resistor of a value equal to about 133 ohms for every volt to be reduced.

It is certainly to be expected instead of much voltage difference existing between plate and screen of the pentode, that there is small voltage difference, because the primary of the output transformer is not as large as required. The primary, to be large, would have to be wound of thousands of turns of fine wire, and would have a very appreciable d-c resistance. If it hasn't such appreciable resistance it is fairly safe to assume that the transformer primary is not of the type required for the purpose however the device may be marked. The words "pentode output transformer" imprinted on the case do not change the primary impedance.

Effect of Small Baffle

Therefore poor tone quality may be due to the output transformer not having a high enough primary impedance, as well as to the omission of large bypass capacities in necessary places. When both shortcomings exist certainly the tone will be sharp and shrill, and certainly the low notes that we have grown used to hearing in radio will be missing. Even the boominess of cabinet, as with some consoles, will not be present in the midget to render doubtful assistance, because the baffle area is small. That is another point—small baffle. It is not overwhelming. Good tone quality can be obtained from a midget despite this baffle handicap, but it can not be obtained without the necessarily large bypass capacities, and is merely hampered by a low impedance primary on an output transformer and by a limited baffle area.

The best solution for the difficulty is to use a high-current voltage divider, from B plus to ground, and tap off the desired voltages. By raising the bias on the r-f tubes their plates and the detector and pentode plates may be returned to maximum B plus, around 270 volts. The applied voltage is the total voltage less the bias voltage, hence for the pentode, at 270 volts source, the proportion would be 16.5 volts for bias, 253.5 for plate. For the r-f tubes the plate voltage may be apportioned, 5 volts minimum for bias, 265 volts for plate. As the bias is varied for volume control, perhaps up to 20 volts, the apportionment would reach 20 and 250 volts. So long as the current is within limits, say 5 ma for plate and screen per tube, the 235 will stand the high plate voltage all right. It is really high current not high voltage that harms the tube, as the insulation of the elements can easily stand 300 volts. But the current must be kept down.

The Starting Voltage

The screens, all of them, could be returned to another point on the divider, except for the pentode tube, and the bias for the detector obtained independently, as diagrammed. (C3, R3). R5 could be part of the divider, for biasing the pentode, in which case the resistance would be around 300 ohms, for around 55 milliamperes will flow through it.

Although it does not primarily concern tone quality, another point about the system of series resistors to drop the high voltage is that when the set is turned on the full maximum voltage is applied to all points served, just as if the limiting resistors were not there. This applies to the r-f and detector tubes in Fig. 1.

The reason is that the lower voltage depends on current flow through the resistors. If the tubes themselves be considered as resistors, then at the moment of the turning the set on the resistance in them is virtually infinite, so the circuit through which current is supposed to flow consists of a tube resistance in series with a limiting resistance, or, say, an infinite effective resistance.

Only when the heaters start to warm up a little does cathode emission begin, and current then is flowing, and the voltage to the intermediate points begins to go down. However, it may not go down fast enough, yet the emission may reach a point satisfactory for operation. Then the set squeals mercilessly for half a minute or so, or if high wavelengths are tuned in, the set seems to have miraculous pep. It is simply a case of very high voltages temporarily effective until the full current is flowing.

Thus the chain of small resistors makes for unstable starting conditions. And where audio tubes are concerned, including detector, there may be severe preliminary motorboating, until the current becomes nearly normal, and the voltages nearly what were intended.

Fig. 2 shows a circuit where the pentode has a limiting resistor, R, to make the screen and effective plate voltages the same. Substantial discrepancy will result in the plate current not faithfully following the signal. Where the resistor is 200 ohms or less the condenser (8 mfd.), shown in dotted lines, would not be needed, but otherwise should be included.

The bias here is obtained through the drop in the lowest section of the voltage divider, which is to be favored over the independent resistor circuit, because of resultant stability (due to the augmentation by steady bleeder current of about 20 ma) and because of the lower impedance of the biasing adjunct, the

(*Continued on next page*)

Leeway as to Constants

Many Instances Offered of Choice of Values

By Roland Tookle

IN the design of a circuit it is usual to give the values of capacity, resistance and inductance, or their equivalent, e.g., turns of wire on a given diameter, etc., so that the result is definitive. It therefore is assumed by many that the very values specified must be used. For instance, the filter condenser next to the rectifier may be specified as 4 mfd.

It would be assured by some to be ruinous to use 8 mfd., yet they have an 8 mfd. condenser, perhaps, and not a 4 mfd. One to serve the purpose of the set. But the reason for specifying 4 mfd. probably was that it proved a sufficient capacity to keep the hum low. Yet if 8 mfd. were used the hum would be still less, in all probability. The capacities recommended for bypassing and filtration, particularly where radio frequencies are concerned, scarcely ever can be too high, whereas for radio frequency bypass the same general thought holds true, although a condenser of around 1 mfd. across a radio frequency line will tune out or bypass all the modulation, so you hear nothing. It approximates a short circuit.

B Supply Choke

Take the direct current resistance of a B supply choke, which is sometimes given. All the current through the set will flow through this choke, in most circuits, therefore if the set draws a total of 60 milliamperes, therefore there will be a drop of 6 volts for every 100 ohms resistance in the choke, and the designer had in mind the drop so that the d-c filtered output voltage would be a certain value, say, 270 volts for the 247 pentode.

However, a choke of twice that amount of d-c resistance would make a difference in result of only 24 volts, and that would not be serious, nor would a choke of 200 ohms d-c resistance be taboo, as the voltage would be 12 volts higher, which means next to nothing. So there is considerable leeway. The only point to be cautious about is that the choke will stand the current, and that it has something like the prescribed inductance.

What the inductance of a choke coil is or may be depends a great deal on the amount of iron in the core, as well as on the number of turns. The choke should be worked well below its saturation point, for that point marks the spot where the choke begins to fail to act as a choke at all. That is, it does not produce the change it is intended to produce. That change consists of arresting the flow of alternating current, to create a time lag between the current and the voltage, with the current lagging.

Inductance of Choke

When a choke coil is designated as 30 henries it is hard to tell just what its inductance is, or is supposed to be, for without a statement of the current the designation of inductance means little. At 1 milliampere a choke may have an inductance of 100 henries, whereas at 10 milliamperes the inductance may be 25 henries. In general it is to be supposed that the inductance stated is that present under the conditions of use.

If a choke is marked 30 henries in a circuit carrying 60 ma the inductance may be supposed to mean just that at that current. However, choke coils are made commercially for uses whereof the manufacturers know not, and the purchaser or others devise the uses. So a choke marked 30 henries may in fact have that inductance at a drop of 2 volts across its terminals, but won't have anything like that inductance with a drop of 24 or 30 volts across it.

So the commercial rating does not always impart any information. There is always the question to ask—30 henries inductance at what current In general practice the 30 henry choke, so-called, may be expected to have an inductance around 10 henries or so at the liberal current passed through it.

Tuning Condenser

In other particulars strict regard to specifications is essential. If you have a 0.00035 mfd. tuning condenser and are told that you should put 135 turns of No. 40 wire on the secondary for tuning in the broadcast band, if you haven't enough wire to fill the requirement you won't tune in the band. That is one instance particularly where strict adherence is imperative. Also, the capacity of the tuning condenser should be no less than specified. If the cap, for the prescribed number of turns. However, it may be of greater capacity. For instance, if a 0.00035 mfd. condenser will tune in the wave band with a given number of turns, so will a 0.0005 mfd. condenser, because a 0.0005 mfd. condenser is 0.00035 mfd. and then some.

The only limitation is that the minimum capacity of the higher capacity condenser should not be much in excess of that of the smaller capacity condenser. Practically, the stations will not be in at the most desirable dial positions, because there will be 15 or 20 degrees of the dial unused, at the higher capacity end. That is why, if you have a higher capacity condenser than specified, you can use it, but may put on fewer secondary turns. In such an experimental circumstance it would be well to wind for the 0.00035 mfd. directions, and then take off turns until 550 kc comes in at some point near the end of the dial.

Fixed Trimmers

The capacity of fixed trimming condensers, which are small adjustable capacities put in at one value and left thus, is not critical, since none are available for tuning condensers at radio frequency levels in excess of 100 mmfd., and due to the adjustable feature much less than that may be used. So if 35 mmfd. or 50 mmfd. or some such value is prescribed, you may use that or higher, and adjust accordingly.

If a manual trimmer is to be used, it should be of less capacity than that stated, but may be more. the only difference being that not so great a sweep of the knob will be effective, since part of the turning will be outside the useful area, which is in no sense harmful.

Speaker and Baffle Also Affect Tone

(*Continued from preceding page*)

higher current requiring a smaller amount of resistance to produce the required biasing voltage.

The detector must be independently biased, also a first audio tube (if there are two audio stages).

Another consideration of course is the speaker. If it is so utterly tiny as to suggest a toy, then it can hardly be expected to give much of an output on low notes, or any other notes. There are speakers for midget sets that have diameters around 6 inches that sound very well indeed, but it is hard to expect much in tone from the 4.5-inch diameter type, particularly as the very tiny type also has the disadvantage of being tiny throughout, including output transformer. The combination works toward easy overload of the speaker, and such overload causes one of the vilest types of distortion.

A De Luxe Dyna

Short-Wave Device Includes

By Herman

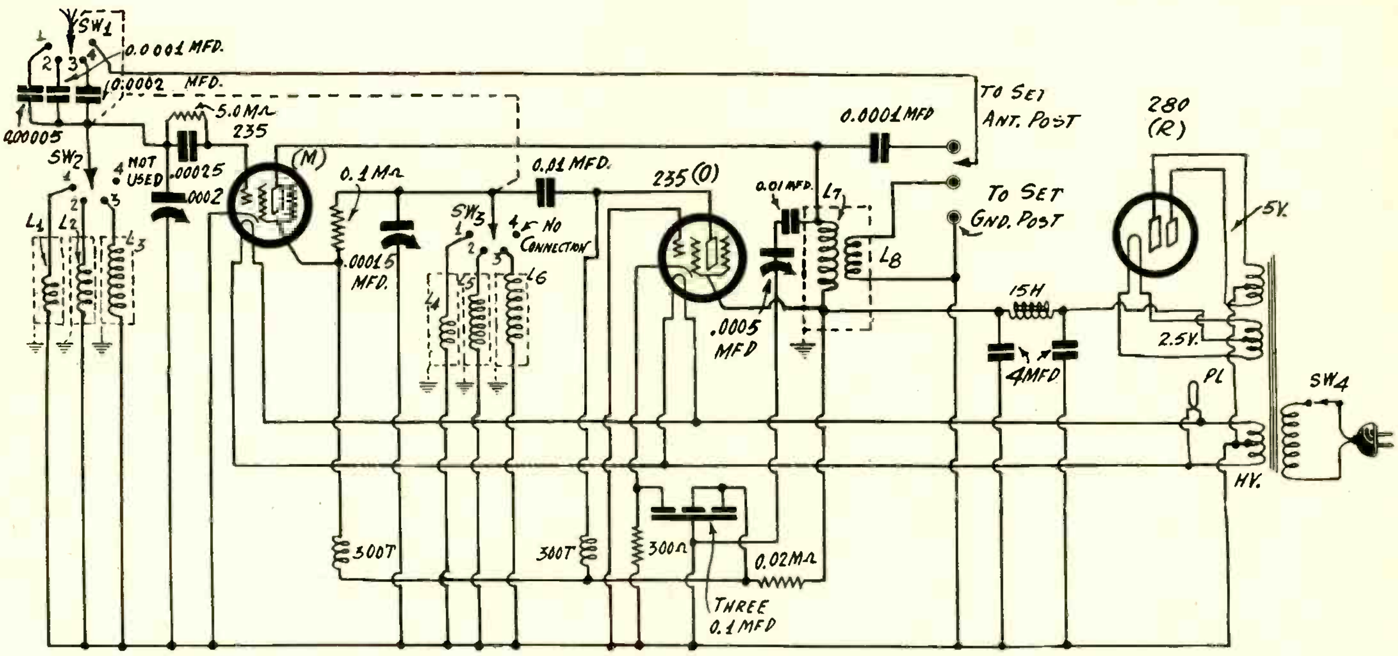

Fig. 1

A short wave converter diagram used for inclusion of highest grade parts, to constitute a de luxe model. A dynatron oscillator is used.

A DE LUXE model short-wave converter is diagrammed in Fig. 1. The modulator is a 235, so is the oscillator, which is used in dynatron fashion, while the rectifier is a 280 tube. Besides the feature of antenna switching, so that set alone, or set and converter, may be worked with switching from the converter, there is the inclusion of different values of series condensers in the aerial circuit. The higher the frequencies, the smaller this capacity.

The series condenser affects the tuning of the modulator. The situation may be viewed as the reduction of the maximum capacity effective across the first tuning condenser, in the modulator grid circuit. For this reason the coils have to be proportioned accordingly. How great the reduction is will depend on what is the inherent capacity between antenna and ground. Suppose it is 0.0002 mfd. Then the antenna switch, thrown to position (3), reduces it to 0.0001, for there are two 0.00002 mfd. condensers in series. So we have to contend with 0.0001 mfd., as if in parallel with the tuning condenser.

Works in Right Direction

The next step is to include 0.0001 mfd. as the series condenser, so the effective capacity is 0.000066 mfd., in parallel with the tuning condenser. The final step is to include 0.00005 mfd., whereby the parallel capacity across the tuning condenser is 0.00001 mfd. This works in the right direction, for as higher frequency bands are tuned in, a given capacity difference makes a much greater frequency difference.

Four equalizing condensers of 20-100 mmfd. (0.00002 to 0.0001 mfd.) may be used for this purpose, two at maximum in parallel to constitute the condenser for position (3), one at maximum for position (2), and one at less than full setting for 0.00005 mfd. or thereabouts for position (1). The capacities need not be set exactly as stated, but may be adjusted so that tuning is equalized. For position (1) and (2) the circuits will tune virtually in step, but for position (3) there will be an angular difference, compared to the oscillator dial. However, tracking is not vital, for the modulator is tuned by a knob, and the oscillator by a vernier dial. Here is a true vernier dial, permitting readings as fine as one-tenth of one division, is suggested.

Oscillator is Sharp Tuner

The oscillator settings must be sharp. The modulator permits considerable leeway, at least on strong signals. As to some signals, they can be heard no matter what the capacity used in the modulator circuit, within the limits as set down, for the condenser acts something like a detuning volume control. On weak signals, however, the modulator knob must be closely set.

The coils in the present instance are shielded. Each coil is separate, and in a separate shield, but one shield may be placed below and another on top of the chassis, directly above. So seven shields and seven coils are used, as the output transformer also is shielded.

The power transformer is the largest part.

Voltage on Plates

On the front panel must be the coil switch—a four-point triple-throw instrument, with shaft insulated from everything—and the modulator knob, while the output tuning condenser may be there, too, if a 0.00032 mfd. midget. The AC line switch may be a toggle switch at rear.

The circuit is in line with one published last week (September

Coils
- **Six shielded coils on six forms as described (L1, L2, L3, L4, L5, L6), and one shielded output (L7L8).**
- **Two 300 turn honeycomb coils.**
- **One B supply choke coil, 15 henries or higher inductance, 20 ma or higher rating.**
- **One power transformer.**

Condensers
- **Five 20-100 mmfd. equalizing condensers.**
- **One 0.00025 mfd. grid condenser with clips.**
- **One 0.00015 mfd. straight frequency line tuning condenser.**
- **One 0.0002 mfd. midline tuning condenser.**
- **One 0.01 mfd. mica fixed condenser.**
- **Three 0.1 mfd. fixed condensers in one block (black lead to ground; two reds interconnected).**
- **One 0.00032 mfd. tuning condenser.**
- **Two 4 mfd. electrolytic condensers in one case; bracket.**

Resistors
- **One 5 meg. grid leak.**
- **One 0.1 meg. pigtail resistor.**
- **One 300 ohm flexible biasing resistor,**
- **One 0.02 meg. pigtail resistor.**

Other Parts
- **One 7x10-inch front panel.**
- **One cabinet.**
- **Two UY and one UX sockets.**
- **One AC cable and plug.**
- **One AC toggle switch.**
- **Five binding posts.**
- **Two grid clips.**
- **One dial with pilot lamp.**
- **One four-point triple throw switch and knob.**
- **One extra knob to match.**

tron Converter

the Latest Improvements

Bernard

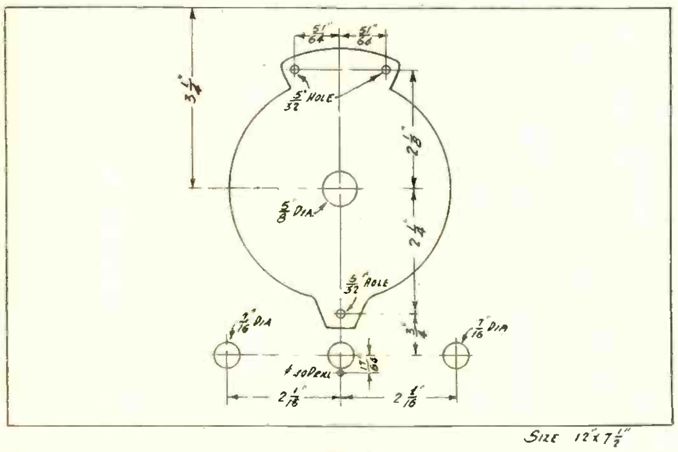

FIG. 2

Layout for a front panel, with three knobs besides the dial. The coil switch would be at lower center, the modulator tuning condenser at right and the intermediate frequency (if a midget 0.00032 mfd.) at left. The a-c switch would be at rear.

5th issue), where a 227 rectifier was used, and the other selections gaited to a correspondingly more modest scale.

With the 280 of course there will be a larger output, due to the higher voltages applied. If a 180-volt direct current output is obtained from the secondary, that may be used, or if the output is larger, the biasing resistor of the oscillator may be increased to around 1,000 or 1,200 ohms, and the high plate voltage on the modulator may be compensated for, on an overload basis, by reducing the value of the grid leak, shown now as 5 meg. on the assumed basis of 180 volts applied. As low as 0.05 meg. may be used, and even the grid condenser value may be as low as 0.0001 mfd. in the instance of higher plate voltage than 180 volts.

How to Wind the Coils

Only a single coil is needed to tune each circuit. L3 and L6 are for the band beginning just above 200 meters, and tuning down to around 60 meters. For a 1-inch diameter tubing, using No. 28 enamel wire, 3 may consist of 55 turns and L6 of 40 turns of the same kind of wire. L2 and L5 may be nearly alike, consisting of 20 turns of No. 18 wire for the first and 18 turns for the second. The third pair, L1 and L4, would consist of 7 turns each of No. 18 or larger wire, to get down to 15 meters. The reason for the contraction of difference between the number of turns as the frequency ranges increase is that the intermediate frequency becomes a smaller percentage of the received carrier frequency.

By the system of independent tuning the same station may be brought in at two different oscillator settings, but this gives an option of the more selective, sensitive and interference-free setting. Besides, only on the large coils are the two dial settings more than a few degrees apart. In many instances reception is possible only at one setting. Repeat tuning does not bother so much on short wave work.

Selection of Preferable Coupling

The output of the converter may be closely or loosely coupled to the set. Which method to use depends on the type of load on the intended antenna circuit of the set. Of course when the converter is used the antenna is loaded on that, and the set's input takes the converter's output. Therefore the question arises which type of coupling gives the better results, and two posts on the converter will enable you to make your own trial, and permanently connect set antenna post to the position that gives better results. An arrow in Fig. 1 designates the choice.

One way the coupling is loose through a small condenser, the other way it is tight, due to parallel connection to a rather large output secondary. Besides tightness and looseness, the question of matched impedances arises, and the two posts give you an option as to a relatively high impedance and a lower one.

The two 300 turn coils are choke coils and are of the honeycomb (duolateral) type.

The output transformer may be tuned by a 0.0005 mfd. condenser, as shown, or by 0.00035 mfd., as depicted last week, or by a midget 0.00032 mfd. to be worked from the front panel, depending on which type of condenser you have or prefer. The tuned winding for 0.0005 mfd., using 1 inch diameter, may have 107 turns of No. 38 enamel wire, for the 0.00035 capacity, 135 turns, and for 0.00032 mfd. 147 turns. These directions satisfy the requirements for L7. For L8 a coil of about one-third the number of turns on the tuned winding may be put over the secondary, insulating fabric in between, the winding being connected finally in the converter near the B plus end of the tuned primary. The coil is used in inverted fashion. The primary is tuned, the secondary is not.

As for parts, the dial used is made by National Company, of Malden, Mass., and is known as type N-VNE. The oscillator tuning condenser is National's type EC-150. The 0.0002 mfd. modulator condenser is Hammarlund's junior midline.

[*Readers desiring to ask questions about short wave converters may address their inquiries to Converter Editor,* RADIO WORLD, *145 West Forty-fifth Street, New York, N. Y. Questions should be plainly written in tabulated form, with room left after them for the replies to be written in. Those desiring particular kinds of diagrams will be referred to the dates of issues of* RADIO WORLD *containing such diagrams, but the general run of questions not requiring diagrams as part of the answers will be answered directly. Write your name and address plainly at the bottom of your letter.*—EDITOR.]

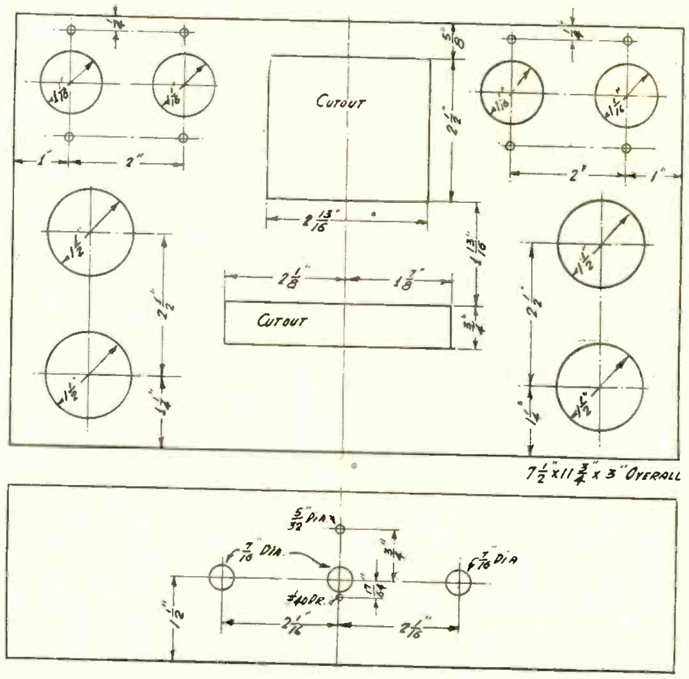

FIG. 3

Constructional plan for the chassis of the converter, to correspond to the front panel dimensions given in Fig. 2.

List Prices of Tubes

The following table gives the prevailing price lists of the various tubes:

Tube	Price	Tube	Price	Tube	Price
227	@ $1.25	551*	@ $2.20	240	@ $3.00
201A	@ $1.10	224	@ $2.00	WD-11	@ $3.00
245	@ $1.40	171A	@ $1.40	WX-12	@ $3.00
280	@ $1.40	112A	@ $1.50	200A	@ $4.00
230	@ $1.60	232	@ $2.30	222	@ $4.50
231	@ $1.60	199	@ $2.50	BH	@ $4.50
226	@ $1.25	199	@ $2.75	281	@ $5.00
237	@ $1.75	233	@ $2.75	250	@ $6.00
247	@ $1.90	236	@ $2.75	210	@ $7.00
223	@ $2.00	238	@ $2.75	BA	@ $7.50
235	@ $2.20	120	@ $3.00	Kino	@ $7.50

*This tube comparable to the 235.

Design of an Advanc

Excellent Frequency Respo nse from

By Herman

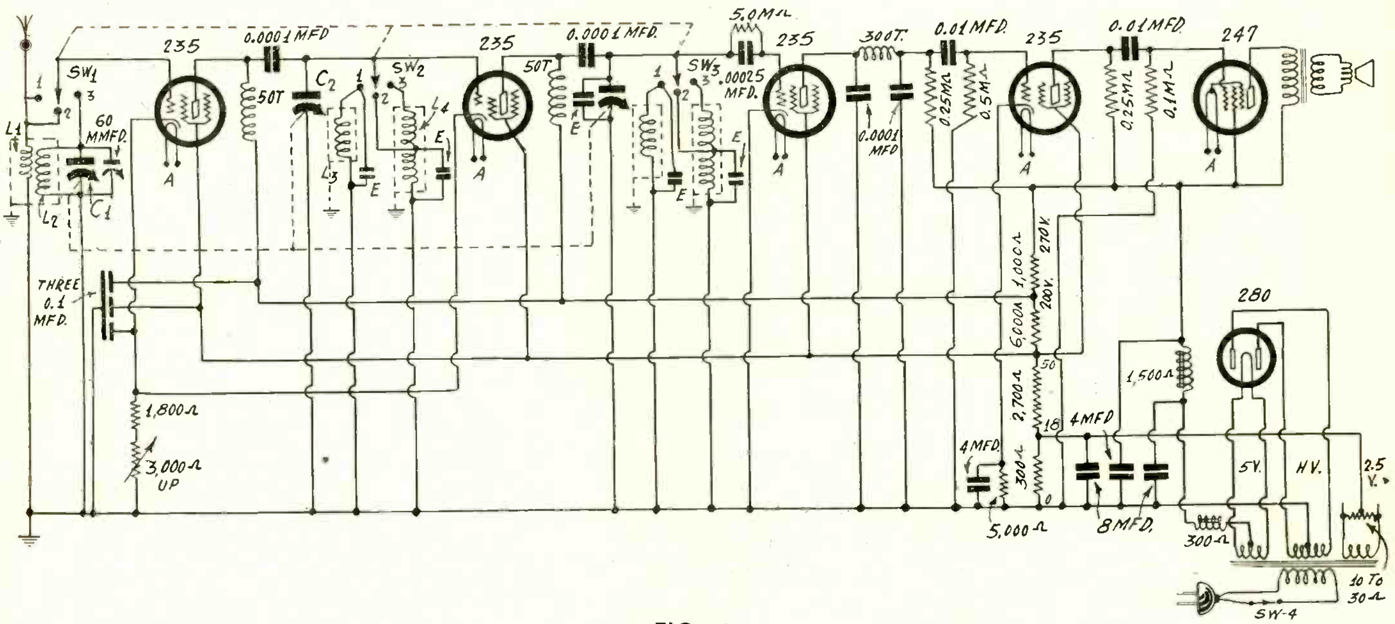

FIG. 1

A substantial circuit for the midget type of construction, not only affording good audio frequency response, but also enabling all-wave coverage, 15 to 550 meters. Note the special method of antenna input switching, so that for broadcasts the first circuit is tuned, but for short waves it is not tuned.

[The following is an article carrying forward to an improved design the six tube midget circuit discussed last week, issue of September 5th, and presenting also a new all-wave feature. Readers interested in midget sets are welcome to send questions about such circuits to Midget Set Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.*—EDITOR.]

THE coil switching arrangement of the all-wave midget diagrammed in Fig. 1 has not been heretofore presented, and it is one embodying commendable features.

The radio channel consists of two stages of tuned amplification and a tuned input to a leak-condenser detector. That holds for broadcasts and represents a familiar and well authenticated circuit.

Now, when short waves are to be received, the simultaneously operated coil switch is thrown from position (3) to position (2) whereby only the primary of the first stage is connected to aerial and grid and thus that stage becomes untuned. The number of turns of wire in the two tuned circuits is about one-third that used for broadcasts, the unused part remaining open, or dead-ended. This is all right in a frequency range that extends from above 200 meters to about 60 meters.

Three Positions for 15-550 Meters

At position (1), the antenna connection remains the same as at the previous position, but the grids and tuning condenser sections of the two consequent stages pick up another set of coils, because from 60 meters down it is better to have independent inductances. Thus you can reach to about 15 meters, and have 15-550 meter coverage with only three coil switch positions. But the switch must be of the insulated type as to all three sections.

By putting a trimming condenser in the stage ahead of the detector, frequency discrepancies on the short waves can be compensated, because the detector has a naturally high input capacity, and does not really require an equalizer (E), although it is common practice to include one. The detector always runs ahead of the antenna stage on a minimum capacity basis, where leak-condenser detection is used, and nearly always for bias detectors, too.

The success of the system of switching depends largely on the inductance of the primary of the antenna coupler. It is almost standard practice to have this winding consist of several turns of wire fairly closely coupled to the tuned secondary. However, recently the practice of using a choke coil here, of an inductance of around 1 millihenry, has spread, because for broadcast reception the result is stronger input for the lower radio frequencies, so that the set it lively all over the dial, instead of becoming weaker and weaker in response as lower and lower frequencies are tuned in.

Loosely Coupled Primary

For effective use of the choke primary it is advisable that the coupling be rather loose. For instance, the choke might be so made as to fit inside the tubing on which the secondary is wound, and would be at least half an inch up from the secondary. The two coils would be parallel, that is, not at an angle.

Then for short waves the antenna load is a choke coil, one of comparatively high inductance, considering the frequencies, and the sole requirement is that the distributed capacity shall not be large. If the choke is of the honeycomb variety, and has 200 or 300 turns or so, the distributed capacity will be fairly low, because with this type of coil, the more layers of wire on it, the lower the distributed capacity, since the capacity between layers is a series capacity. In solenoids the distributed capacity depends largely on the diameter, and increases slightly as the number of turns increases.

The Limiting Resistor

The tuning coils used in the present circuit are shielded. It is therefore possible to get some stability on short waves, although it should be remembered that for the required sensitivity it is advisable that some regenerative effects be present, though under control. The volume control that affects the grid bias takes care of that. The only uncertainty surrounds the value of the limiting resistor in the common cathode leads of the radio frequency amplifiers, which are 235 variable mu tubes. This is marked as 1,800 ohms on the diagram, Fig. 1, and the resistance should be increased to such value as will get rid of oscillation on the broadcast band. Then there will be some oscillation, under control, however, on the short-wave bands.

What the value shall be will depend somewhat on the degree of completeness in shielding, for if the shielding is utterly effective, 800 ohms will be sufficient, affording 4 volts bias. However, in the midget sets the shielding usually is not completely effective, so the extra resistance is called into play. A value of 2,000 ohms (affording 6 volts) was found to work out satisfactorily in several circuits built, since there was no oscillation at broadcast wavelengths, but it was apparent that a lower value, estimated at 1,800 ohms, could be substituted to

ed All-Wave Midget

Audio Channel In a Sensitive Receiver

Bernard

small advantage. Since very little current is concerned, the limiting resistor may be of the small flexible biasing type.

Power Type Voltage Divider

The maximum voltage obtainable from the B supply, after filtration, is around 270 volts, which permits of 250 for the pentode output tube and 20 volts negative bias for that tube. The voltage divider is designed to give about 18 volts negative bias, so the plate-suppressor grid voltage would be 252 volts. The voltage for the screens is 50 volts and that for the plates is 180 volts. While it is practical to use more than 180 volts, even up to 250 volts, on the plates of the 235's, if the negative bias is large enough, as it would be here, there is no purpose in it if already attention must be given to eradication of feedback.

The different voltages are better obtained from a voltage divider across the entire B supply output, as the current starts to flow at once through this divider, and the starting voltages are stabilized.

In midget set designs it is cutomary to omit this type of high-current voltage divider, and quite a few sets apply 250 volts to the 235's to avoid use of such a divider, and therefore have to take care of only the screen and biasing voltages, for the detector also gets 250 volts application. Effective on the detector plate is a much lower voltage, due to the drop in the plate load resistor. However, the voltage is not so low as a meter reading would seem to indicate, as the current drawn by the meter (even a 1,000-ohms-per-volt instrument) may be almost as great as that flowing through the resistor when the meter is across it, or may be even greater. A meter therefore will read too low, or, to tell the truth, will not read the voltage. A vacuum tube voltmeter, which draws no current from the measured source, would be the instrument to use.

Determination of Effective Voltage

This problem comes up so often, and repeatedly mystifies radio workers, that it is well to emphasize the fact that even a good, standard meter will not read this voltage. It is suggested that the current in the plate circuit be measured, that the resistance of the load be measured, and that the voltage drop be computed (voltage in volts equals resistance in ohms multiplied by current in amperes).

To the same effect, the resistance of the load and tube may be computed, for it equals the applied voltage divided by the current. The voltage drop is directly proportional to the resistances.

In the first case, suppose the plate current is 0.5 milliampere, equals 0.0005 ampere. The applied voltage is 180 volts, therefore the combination resistance (tube and plate load) equals 360,000 ohms, and the tube resistance is 250,000 ohms less, or 110,000 ohms. The effective plate voltage therefore is 110,000—360,000 of 180 volts, or 55 volts. The drop in the load is 250,000—360,000 of 180 volts, or 125 volts. If the current and the load resistance are known, the voltage drop can be computed and then deducted from the applied voltage (180 volts minus 125 volts, or 55 volts) to give the effective voltage.

The same method applies to the first audio tube, except that there is a biasing resistor to consider. The plate current is read, the biasing and load resistors measured, the voltage drop across them computed, then added, and the sum subtracted from the applied voltage to give the effective plate voltage.

Empirical Values

These problems do not arise practically in the present circuit, unless defective parts or incorrect wiring or bad tubes cause trouble, as the values actually were determined experimentally. Even the voltage divider was designed on that basis, a large divider with ten movable arms or sliders being put in circuit and adjusted until the desired readings obtained. Then the voltage divider's total resistance was measured, likewise the resistance between taps.

The detector has a grid leak of 5.0 meg., because with the applied plate voltage of 180 volts this produced the best output from a frequency consideration, although lower values may be used, with some low note suppression. This type of detector, with lower plate voltage and higher leak, is usually rated to produce a good output at 2 volts input, but the increased voltage applied and the high leak value permit a higher value of output voltage without overload, and the plate current better follows the grid voltage changes. Thus is a form of semi-power leak detection.

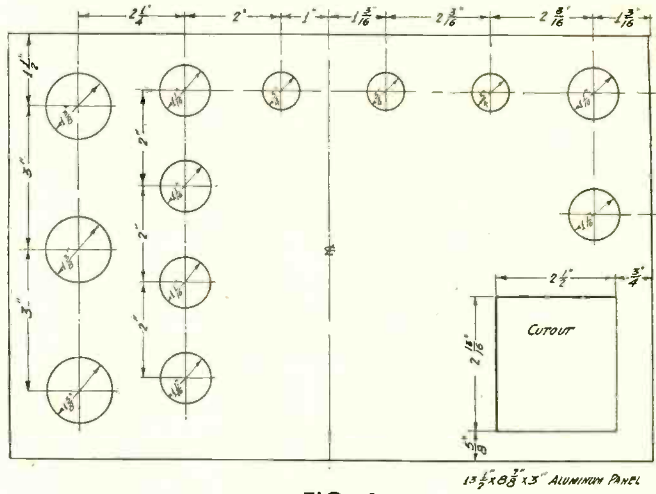

FIG. 2
Constructional plan of the chassis top.

The screen of the detector is returned to the same point as are the screens of the radio frequency amplifiers. Actually this results in the screen voltage being about 25 volts less than the effective plate voltage. The detector plate current assumed in the theoretical discussion of effective plate voltage determination is not the actual current in this circuit.

How Quality is Achieved

If a resistor is placed in series with the screen and the applied screen voltage it constitutes an impedance to both radio frequency and audio frequency current, as the detector handles both. A relatively small value of condenser across the resistor—a mica dielectric type, for instance—would be entirely suitable for radio frequency bypass, but not for audio frequency. Instead, the same value of condenser would have to be used as across any other high resistance. For instance, if the impedance of the screen load resistor is 100,000 ohms, something like 8 mfd. would be required to rid the screen resistor of the damping effect of negative feedback at audio frequencies. Any doubt as to whether the screen current is modulated may be resolved by making the test of large condenser present and omitted. The effect of the 8 mfd. (impedance about 630 ohms at 60 cycles, less at higher frequencies) is so pronounced that both the modulation presence, and the negative direction of the feedback through the resistor, are confirmed. Thus the screen load resistor would be of the same general effect as a negative biasing resistor, which carries modulated current and the direction of which is negative in respect to the input.

Also, when the large condenser is used, the principal purpose of the resistor in the screen is eliminated, that is, the screen voltage does not shift with the signal voltage, for the modulation has been removed.

An Impractical Resistor

It is therefore impractical to use the screen load resistor in an audio circuit, or a detector (which is of course an audio tube), unless there is sufficient amplification after the detector to atone for the loss, and even then the effect on frequency distortion has to be considered, for the resistor is a low-note suppressor. Hence the screen voltage for the detector was selected at the voltage divider itself, where it could have a bypass condenser of smaller proportions. There is not enough positive feedback through the voltage divider to cancel the effect of the relatively low resistance between screen and ground in the divider. The screen voltage was made 50 volts instead of 75 further to reduce the impedance.

The grid leak for the first audio tube is 0.5 meg. The bias for this tube can not be obtained from the voltage divider without severe motorboating, none of which, severe or mild, is present if the independence of the bias is established, and the pentode leak is 0.25 meg. Nor can the screen voltage for the detector be the reversed application of the bias voltage for the 247, for the same reason.

To sustain the low-note response, the bypass condenser across the 0.02 meg. (20,000 ohm) first audio biasing resistor should be 4 mfd. or higher. The difference between 4 mfd. and 8 mfd. is hardly noticeable, because of the limitations of baffle size in

(Continued on next page)

Circuit's Voltage Readings

Tabulation of Values to Guide Experimenters

(*Continued from preceding page*)

midgets, and because of other limitations surrounding the speaker.

Good Audio Quality

However, despite the shrill effect of so many midgets, particularly those using pentodes, very excellent response is obtainable from a midget, including low frequencies, and the tone is highly satisfactory indeed. This end is achieved through the use of proper voltages, proper means of establishing them, and adequate bypassing of biasing resistors.

The field coil of the dynamic speaker is used as B supply choke, and may be of any resistance from 400 ohms up to 2,000 ohms, the only difference being that the lower resistance fields will afford higher voltages than those stated. However, the proportion will be correct, and although the set is intended for an 1,800 ohm field coil, those having speakers with lower resistance field coils may use them.

It is not practical to make up the difference with a resistor of 1,400 ohms from center of the rectifier filament to the field coil and 8 mfd. filter condenser, because then the set will hum, due to the unfiltered ripple voltage in the limiting resistor. A resistor, if used, should be of at least 25 watts rating, and put between the other end of the field coil, and the juncture of the 4 mfd. condenser, 247 plate and suppressor grid feed. The suppressor grid corresponds to the socket connection for cathode of 227, 224, 235 and similar tubes.

Pentode and By-pass

The lower section of the voltage divider is used for obtaining the negative bias for the 247 tube. In this way the impedance is lower than otherwise, as the bleeder current helps in reducing the amount of resistance otherwise required. Instead of 400 ohms or so some 300 ohms may be used. The condenser across the section should be at least 8 mfd. for the previously stated reasons. It is nothing individual with pentodes that they require the bypassing of the biasing resistor, but the requirement is greater simply because the mu is greater, thus the amount of negative feedback is higher.

The four capacities—two 8 mfd. and two 4 mfd.—may be in three units, of which two are the separate 8 mfd. and the third consists of two 4 mfd. These are electrolytic condensers. The wet type often requires reverse mounting, as to the 8 mfd., whereby the anodes (positive) are at bottom. The two 4 mfd. in one case have one 4 mfd. lug at top and one at bottom, so the bottom one (under the chassis) would go to the high voltage, leaving the exposed lug for the 1.5 volts or so biasing the first audio tube.

Coil Data

As for the coils, these are in shields. The antenna primary has been discussed. If the tubing diameter for the secondary winding is 1 inch and the condenser is 0.00035 mfd., then the secondary may have 135 turns of No. 38 enamel wire. The same is true of the impedance coils that follow. the tap (T) being at two-thirds the way down, from the grid connection, based on number of turns. Thus for 135 turn secondary the tap would be at the 80th turn from grid end, except that it is usual to allow an extra turn for the smaller winding, hence put the tap at the 79th turn.

For 0.00045 mfd. the tuned winding would consist of 120 turns tapped at the 79th turn, also, while for 0.0005 mfd. the number of turns would be 107, tapped at the 70th turn.

The two separately shielded small coils for shortest waves, L3 and L5, would have a total of 10 turns for all three capacities, the wire being larger, say, No. 22 to No. 18 enamel.

Be sure to ground the shields in all instances, and so far as practical, where any grounding is to be done for radio frequencies, run the lead direct to the ground post. and do not make a common ground lead for branching to the respective destinations.

Voltage and Other Measurements

The measurements taken on the voltage divider are as follows:

Resistance in Ohms	*Voltage across that resistance*	*Current through that resistance*	*Voltage to Ground*
300	18	60 ma	18
2,700	32	12 ma	50
6,000	150	25 ma	200
1,000	70	70 ma	270

The reason for the small current through the 2,700 ohm section is that no current for the tubes flows through this part, and the only current through it therefore is bleeder current.

Instead of using 75 volts on the screens, 50 volts is used, because this is a better voltage for the detector and the first audio amplifier. and the result is low-note aid. The fact that only 50 volts is applied to the screens of 235 tubes used as radio frequency amplifiers is not detrimental, because of the bias-changing method of volume control, which in itself is tantamount in effect to a screen voltage change. For instance, in some circuits volume is controlled by screen voltage change, so 75 volts on the screen are not adamant, and can't be used on the basis of the voltage divider apportionment previously given.

The introduction of 1,800 ohms fixed resistance as a squeal checker may give a minimum bias voltage of 5 volts, with the maximum running up to around 15 or 20 volts, depending on the resistance of the rheostat used for volume control. The most both r-f tubes will draw under those conditions is a trifle more than 2.5 milliamperes, for plate and screen currents combined. So a plate current reading of around 0.8 or 0.9 or 1 ma for one of these tubes will not mean there is anything wrong with the tube.

The detector bias is zero, the plate current above 0.5 ma. The first audio bias is about 1.5 volts at 0.5 ma.

Drumming Cured

Ordinarily, when the set is turned on it would produce a drumming sound for about half a minute, which would subside swiftly and not reappear during operation. This is not a detriment to reception in any way, as the heaters are heating up during this time, and no program would be heard then. However, it can not be said that the drumming is musical or attractive, so a means had to be found to get rid of this trouble. It was entirely cured when the choke input method was used in the rectifier filter. The dynamic speaker has an 1,800 ohm field coil, tapped at 300 ohms, and if the 300 ohms section is put next to the rectifier, and the first filter condenser put at the juncture with the 1,500 ohm section, a time leg is introduced in the charging up of the electrolytic condenser, and no drumming is present.

The first r-f stage needs a trimmer, for the antenna capacity, as well as the reduced secondary inductance and the extra capacity resulting from the use of the antenna choke coil primary, will make it next to impossible to provide resonance all over the band without manual trimming. Therefore the first stage requires a trimmer, and when the switchover is made for short waves, this trimmer and its associated circuit are cut out, and another trimmer is necessary for short waves.

Trimming Effect

Readers will observe that when the switch-over is made to short waves the erstwhile antenna trimmer is out of circuit, and surely if a trimmer was needed for broadcasts, one will be needed for short waves, because of the much greater frequency difference caused by slight capacity difference. The need for the second trimmer is present even though two similar circuits are concerned, that is, two feeding out of plate circuits, and not involving the unknown quantity of the antenna capacity.

As a test, a condenser of 64 mmfd. was used in the antenna secondary as trimmer, and a station tuned in at 570 kc, which is only two channels removed from the lowest broadcast frequency. The setting of the trimmer was at 50 mmfd. Then a station was tuned in at 810 kc, near the middle of the band, and the setting was equal to 40 mmfd. To bring in a station at 1,400 kc with greatest volume, the setting was 22 mmfd. It can be seen therefore that the variation was very considerable, a total of 28 mmfd. The sensitivity loss is just too terrible for utterance if the trimmer is omitted, as it is done in both instances in circuits intended for "price" appeal, and was done in one instance even in last week's "price" circuit.

WHILE the first audio tube may be either a 235, as shown this week, or a 227, as in last week's diagram, the differences are that the 235 provides greater amplification, whereas the 227, requiring no screen voltage, requires no resistor to provide this voltage, hence no large bypass condenser. It is therefore simpler to get fine quality from the 227, and also more economical, even though the volume is less. It is deemed worth while to show the method of using the screen grid tube as first audio amplifier for those who want the extra volume, although another way of attaining it would be to use two stages of preliminary audio, both 227's.

The circuit last week, reprinted herewith as Fig. 4, was in the "price" class, as everything in it is relatively inexpensive, except the bypass capacities and the power transformer. It contains limitations, however, as already pointed out indirectly in the discussion of this week's circuit.

Again it must be emphasized that the bypass capacities across the biasing resistor in the pentode stage and across the screen resistor in audio or detector stages, must be very large, and 4 mfd. or 8 mfd. is simply a minimum.

Negative bias detection was not used because across the biasing resistor that would be required—around 20,000 ohms—another very large condenser would have to be placed, and finally all

(*Continued on next page*)

227 and 235 A-F Compared

Volume Difference and Cost Are Two Factors

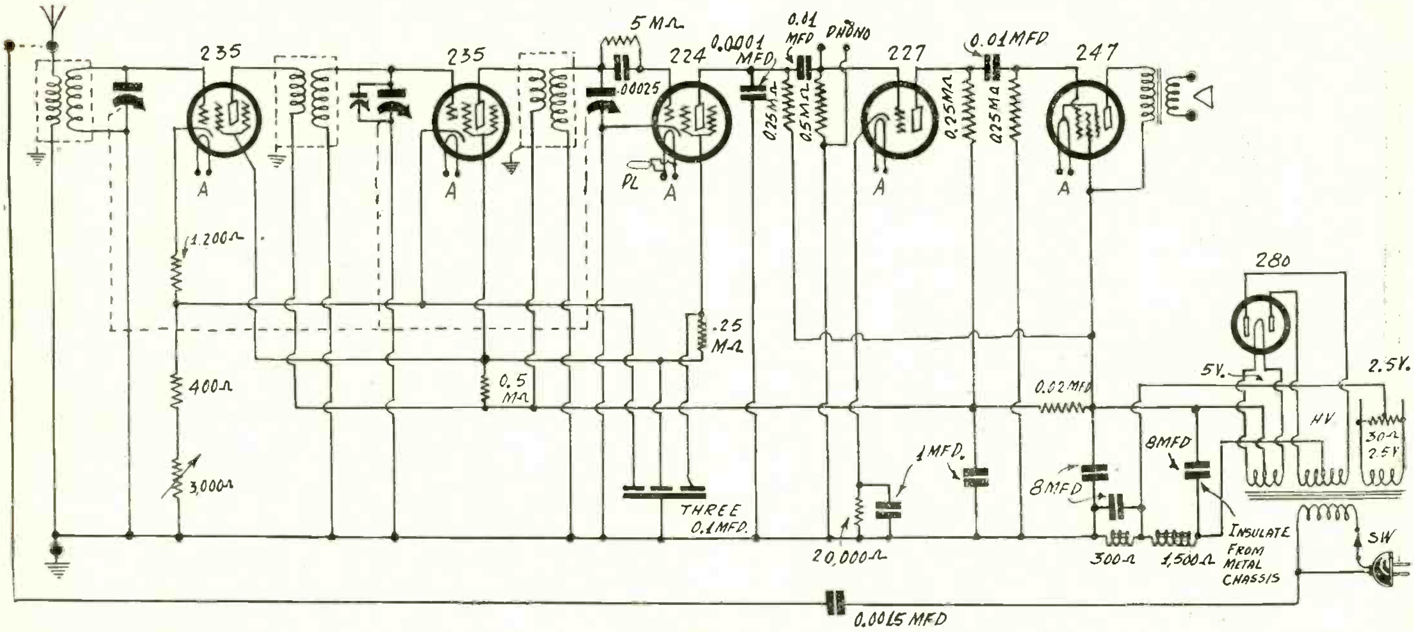

FIG. 4

A six tube a-c receiver intended for the midget type of construction, discussed in detail last week. The tuner is approximately the same as the one shown this week, but the first audio stage is a 227, while the by-pass capacities are somewhat differently distributed, the series resistor method of voltage dropping is used for economy, and the B choke is in the negative leg, with pentode bias through part of it.

(*Continued from preceding page*)

hands would agree that there is no end to the prescription of very large capacities. The grid leak method works very well, and the large leak value is a strong assistant to lownote response. And, as said before, you will get good quality from Fig. 1.

Each week names of new members of the Short-Wave Club are printed. There is no repetition. Here is this week's list:

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Mixing Circuits for Pu

Coupling Data Applying to Microp

By Bruns

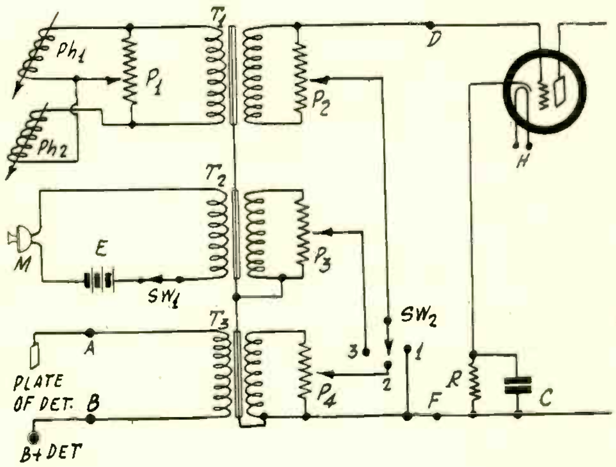

FIG. 1

The diagram of a mixing circuit for two phonograph pick-ups, a microphone, and a radio tuner to be used in front of an amplifier. The circuit is arranged so that the phonograph may be used with either the microphone or the detector.

LAST week we presented an amplifier suitable for public address systems for small assemblies. This amplifier contained three stages, one single sided and two symmetrical or push-pull. To complete this circuit we now present mixing arrangements, for which we have had many requests.

In Fig. 1 we have an arrangement of two phonograph pick-ups, a microphone, and a radio receiver. The object of this circuit is to enable an operator to select either phonograph, the microphone, or the radio receiver. An additional requirement is that the arrangement should be such that the operator should be able to leave the phonograph in the circuit while either the microphone or the radio is functioning, but so that the phonograph music appears as a background. Thus there may be two of the devices feeding the amplifier at the same time.

This seems to call for series connection of the secondaries. That is, voltage from the phonograph, or a part of it, should be introduced into the grid circuit in series with the voltage from either the microphone or the radio set. The switching arrangement provides for this. Let us examine the circuit in detail.

Details of Circuit

We have two pick-up units Ph1 and Ph2. The output of either of these may be wanted, and the change from one to the other should be gradual. The potentiometer P1 makes this possible. As the slider is at the bottom of P1, Ph2 is short circuited and the entire output of Ph1 is impressed across P1 and hence across the primary of T1. When the slider is at the top of P1, Ph1 is shorted and the output of Ph2 is impressed on the transformer. As the slider is moved the change from one phonograph to the other is gradual. If it is not desired to make this provision of continuous change, it is possible to dispense with P1 and substitute a single pole, double throw switch which will short one or the other. The ends of the potentiometer would then be the switch points and the slider on P1 would become the movable blade on the switch.

The output of either phonograph is faded out by means of potentiometer P2. When the slider of this is at the bottom end the entire voltage generated is impressed on the grid of the tube and when the slider is at the top end the voltage from the phonograph is entirely eliminated.

Now, it may be that it is only desired to play the phonograph electrically, that is, not to use either the microphone or the radio simultaneously with the phonograph. This choice is made by switch Sw2. When it is set on point (1) the slider of P2 is connected directly to ground and only the phonograph is in the circuit.

Using Microphone

Suppose now we want to use the microphone. We set Sw2 on point (3), which connects the output of the microphone in series with the output of the phonograph. If we want the phonograph alone we only have to move the slider on P2 up to the grid end of P2. Then we can vary the output of the microphone by moving the slider on P3. We can put the entire voltage across P3 on the grid of the amplifier or any portion. We can do the same with the output of the phonograph so that when the microphone is full on we can have the phonograph play softly in the background.

The microphone requires a polarizing or actuating battery E. the voltage of which depends on the particular microphone used, and should be supplied by the maker of the microphone. A switch Sw1 is connected in series with the circuit to break it when the microphone is not in use. The microphone transformer T2 should be what is known as a microphone-to-tube transformer.

Using Radio

If it is desired to use the radio receiver on the audio amplifier, this may be done by setting switch Sw2 on point (2). The output of the detector, or part of it, is then connected in series with the output of the phonograph, but as before either may be had in any amount in relation to the other by manipulating the sliders on the two potentiometers P2 and P4. The full output of the radio and no signal from the phonograph may be had by setting P4 at the top end and P2 also at the top. Or it may be reversed by setting both sliders at the bottom.

The transformer T3 is an ordinary tube to tube coupling transformer as used in the majority of receivers. This type of transformer may also be used for T1, but better results would probably be obtained if a special transformer is used here. It should have a lower primary impedance than one designed to be connected to the plate circuit of a tube. An audio transformer of high ratio might be just the thing in case a special coupling transformer cannot be obtained. The transformer recommended by the pick-up manufacturers should be used if possible. But the circuit will work with any audio frequency coupling transformer.

Objections to Circuit

In Fig. 1 the phonograph is always in the circuit while the switch enables the selection of either the microphone or the radio. It may be a better and more logical arrangement to wire the circuit so that the microphone is always in the circuit and so that either the radio or the phonograph can be selected by means of the switch. For example, the circuit may be used for broadcasting on a small scale. The radio could be used for rebroadcasting and the phonograph for sending out recorded music. The microphone should be left in for announcements. This arrangement is shown in Fig. 2. The microphone now occupies the position the phonograph did before while the phonograph takes the position that the microphone held. In other words, the two have simply been interchanged.

LIST OF PARTS

Coils

Ch—One 100 henry choke coil.
T—One output transformer.
One 2.5 volt filament transformer.

Condensers

C—One 2 mfd. or larger condenser.
C1—One 0.01 mfd. condenser.
C2, C3—Two 8 mfd. or larger condensers.

Resistors

R—One 7,500 ohm resistance.
R1—One 4,500 ohm resistance.
R2—One 25,000 ohm resistance.
R3—One 250,000 ohm resistance.
R4—One megohm grid leak.
R5—One 400 ohm grid bias resistance.

Other Parts

Six binding posts.
Two UY type sockets.
One 235 tube.
One 247 pentode.
One B supply of 266.5 volts, approximately.
Suitable subpanel.

blic Address Systems

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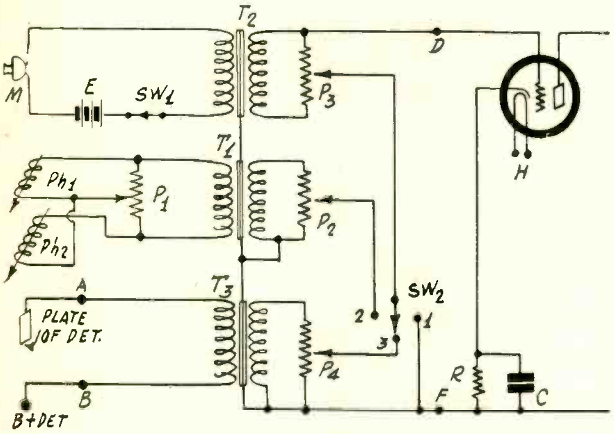

FIG. 2

In this mixer the phonograph and the microphone have been interchanged, as compared with the circuit in Fig. 1, so that the microphone may be used with either the phonograph or the detector.

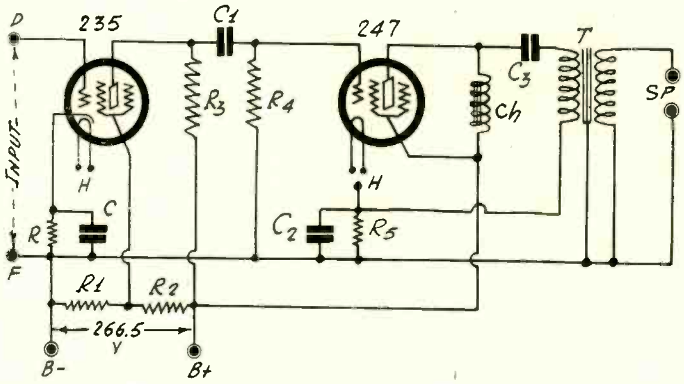

FIG. 3

The circuit of a two-stage amplifier utilizing one 235 variable mu tube and one 247 pentode. The undistorted output of this amplifier is approximately 2.5 watts. The design is such as to make the circuit as stable as possible without much attenuation of the low notes.

It is still possible to have the phonograph play in the background while announcements are made in the microphone. All that is necessary is to set Sw2 on point (2), turn the microphone on full by means of P3 and turn the phonograph down by means of P2. In this case the microphone is turned on full by sliding down on the potentiometer and the phonograph is reduced in volume by sliding down on potentiometer P2.

Coupling to Amplifier

The tube in either Fig. 1 or Fig. 2 is shown merely to illustrate the method of coupling the mixer circuit to the amplifier. It will be noted that the two lower devices in each case are connected in parallel and that the upper is connected in series. These statements apply only to the secondaries; the primaries are quite independent. Point F in each circuit is the ground side of the amplifier and point D the grid side. Points A and B are the output terminals of the detector of the radio receiver.

In the public address amplifier published last week the microphone is shown. In that circuit input transformer T1 corresponds with transformer T2 in Figs. 1 and 2 of the mixer arrangement, and potentiometer P of that circuit is P3 of the present. To get the connection shown in the public address amplifier Sw2, in Fig. 1, is set on point (3) and the slider of P2 is set at the top. In Fig. 2 the circuit becomes like of last week by setting Sw2 on point (1), or by setting Sw2 on (2) with the slider of P2 at the bottom, or by setting Sw2 on (3) and the slider of P4 at the bottom.

Resistance Coupled Amplifier

It may be desired to use a simpler amplifier after the mixer circuits, for example, the amplifier shown in Fig. 3. This consists of only two tubes, a 235 variable mu tube and a 247 pentode. This circuit has been designed so that it will be relatively stable, although resistance coupling is used.

The two input terminals have been marked D and F to correspond with terminals in the mixer circuits. R and C are also the same as the corresponding parts in the mixers. The values of these naturally depend on the tube and the type of plate circuit. For a 235 tube, a coupling resistance of 250,000 ohms, and the usual plate voltage of 250 volts, the grid bias on the 235 should be about 3 volts, which will be obtained with a grid bias resistance of 7,500 ohms. However, there are so many variables involved that this should be varied to fit the conditions. A condenser of at least 2 mfd. should be connected across this resistance, so that C should have this value, or a greater value. If we wish to reduce the effective impedance of the RC combination at 50 cycles per second to 0.05 of the value of the resistance alone. the capacity of the condenser should be 8.5 microfarads. That is, an 8 mfd. electrolytic condenser may be used.

The coupling resistance R3 has already been specified at 250,000 ohms. C1 should have a capacity of 0.01 mfd., and R4 a value of one megohm. In case motorboating sets in at a very low frequency, C1 may be made smaller, as may also R4.

Screen Voltage

It is assumed that total voltage applied to the first tube is the same as the total voltage applied to the second tube, namely, 266.5 volts. While this is higher than the voltage ordinarily recommended for the 235 tube, it is not too high, because of the high resistance of R3. Although the voltage on the plate is so high it is necessary to make the screen voltage quite low, say of the order of 22.5 volts. If this is not done there will be distortion in the first tube. A voltage divider consisting of R1 and R2 is used to cut the voltage down. The voltage drop in R1 is to be 22.5 volts and that in R2 244 volts. The current through R1, which is the same as that through R2 for practical purposes, may be taken at any convenient value. Let us take 5 milliamperes. Then the value of R1 should be 4,500 ohms. This will require that R2 be 24,400 ohms. If we make R2 25,000 ohms we have to make R1 4,600 ohms. It is not advisable to use R2 alone, because the current to the screen is variable and very small, so that the screen voltage would not be definite.

Bias for Power Tube

R5 is a resistance of 400 ohms, rating at least one watt, which serves to bias the pentode power tube. A word must be said about the by-pass condenser C2 across this resistance. It is well known that the pentode is rather deficient in amplification of the low notes, a fact which is usually referred to as an over-emphasis of the high notes. Lack of adequate by-pass capacity is one of the main factors which contribute to the suppression of the lows. As always when a tube is self-biased, there is a reverse feed-back which under certain conditions will convert the tube from the amplifier to a de-amplifier. The reverse feed-back in the pentode is very strong because of the high amplification factor. The only way to reduce the reverse feed-back is to shunt the resistance with a condenser and make the capacity so large that the impedance is negligible.

The effectiveness of the by-pass condenser depends not only on the magnitude of the resistance across which it is connected, but also on the frequency. For a resistance of given value, the higher the frequency the smaller the condenser may be. Hence if there is to be negligible feed-back at the lowest audio frequen-

(*Continued on next page*)

Plate Supply

Choice of Constants and

By Einar

PLATE current supply circuits are always in demand. Sometimes they are needed for operating audio frequency amplifiers, sometimes for radio frequency amplifiers, sometimes for measurements and sometimes for still other purposes. Requests are made for diagrams and lists of parts to give a B supply that will give certain voltages. Quite often questions are asked only about certain phases of these circuits. Unfortunately, it is seldom possible to answer the questions, for they really don't ask for any information at all, but merely indicate that some is desired on something pertaining to a B supply.

The old typical question: "How much resistance is necessary to reduce the voltage 300 volts to 180 volts?" is asked just as often now as it was before a hundred or more articles had appeared in various radio journals explaining in effect that the only answer was: "Now we'll ask one." The idea that it takes resistance to drop voltage seems to have met with general acceptance and recognition, but that it also takes current through this resistance if there is to be any voltage drop is ignored in many instances. It would seem that it is always ignored, but that is not so, for those who recognize it, and they are many, are not likely to ask the question, or they are not likely to ask unanswerable questions on the subject.

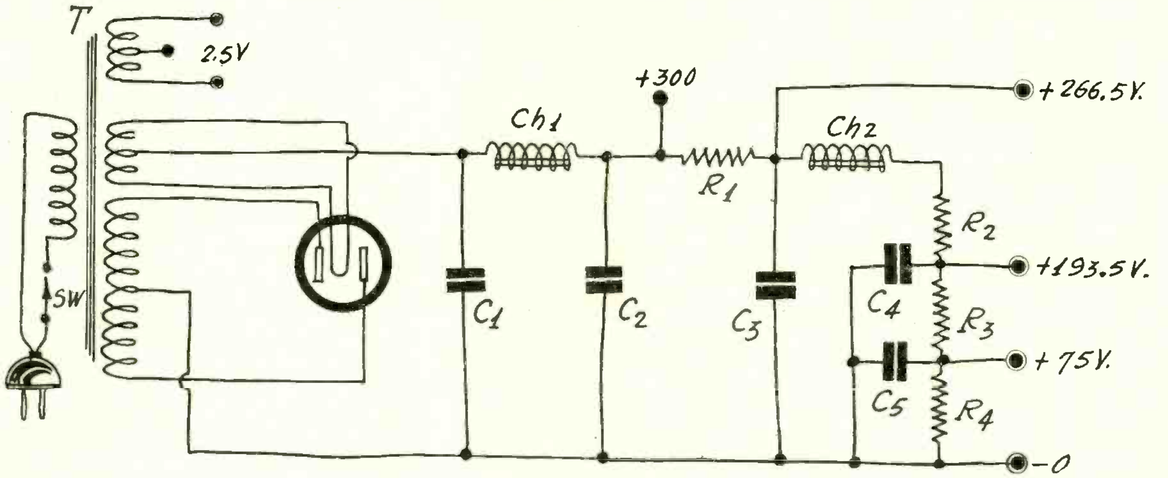

FIG. 1

The circuit of a B supply suitable for a circuit using 224 and 235 screen grid tubes and 245 or 247 power tubes. The computation of the resistances in the voltage divider depends entirely on the circuit served.

Every Job Different

Every job is different from every other. Each requires its own design. And there is no way to tell what the design is to be unless all the facts are available, either by measurement or assumption. When a question is asked about a specific circuit assumption will not do, because it may be entirely unreasonable. Only the one who asks the question can supply the facts about his circuit.

"Please send me a circuit diagram with list of parts for a B supply which will give 300, 250, 180, 135, 90, 75, 45 and 22.5 volts." A request of this kind is very easily complied with, but it would not do a particle of good to comply with it. The chances that the design sent would fit the case are overwhelmingly against a fit. Therefore there is no point sending anything until more facts about the circuit with which the B supply is to work are available. Judging by the different voltages requested in this particular case, the circuit was meant to be a sort of general utility. That makes any kind of answer particularly pointless. B supply units involving rectifiers, filters and voltage dividers are not general utility devices, but each is a complement of a particular amplifier or a receiver. If the B supply is not designed to fit the amplifier the fit will be about the same as the right boot on the left foot.

Process of Design

Let us consider the problem of the design of a B supply for a receiver containing 224, 235, 227 and 247 tubes, with an alternative of 245 tubes for the pentodes. How shall we go about it? First we must get an estimate of the power that will be used. This is necessary in order to select a power transformer that will handle the circuit.

To estimate the power we first add up the filament power of each tube. The filament power of a tube is the filament current multiplied by the filament voltage. A 235, 224 or a 227 takes 1.75x 2.5. 4.375 watts. Count the number of tubes of these types and multiply by the number to get the total power. Then consider the power tube. One 247 takes 2.5 volts and 1.5 amperes, or a power of 3.75 watts. Suppose, then, we have five of the former tubes and one of the power tubes. Then the total filament wattage is 25.625 watts.

Having determined the filament or heater wattage, determine the plate current wattage. This is obtained by taking the total d-c current in the rectifier and multiplying it with the highest voltage. Then, suppose the total current in the receiver or amplifier is 60 milliamperes and that the highest voltage is 300 volts. The power is 18 watts. We add this to the filament wattage. We obtain 43.625 watts. The rectifier tube also takes power in the filament. The 280 tube takes a filament current of 2 amperes and a voltage of 5, or a power of 10 watts. So far our accumulated wattage is 53.625 watts. To this we might add 20 per cent. for losses in the transformer and in the rectifier tube not taken account of so far. This will make the total power 64.35 watts. We would therefore choose a transformer rated at 75 or 100 watts. For some other circuit we might have reached another conclusion.

Input Circuits for

cies the condenser must have a very high capacity. Experiments at the standard test frequency of 400 cycles per second and a bias resistance of 330 ohms have shown that the by-pass capacity should not be less than 6 mfd. If we want the same by-passing at 50 cycles per second with a bias resistance of 400 ohms we must use a condenser of 48.3 microfarads. If a condenser of this capacity is not used there will be considerable suppression of the low notes and the output will be relatively too strong on the high notes.

A noteworthy improvement in the low note reproduction can be effected by shoosing the right kind of output circuit. Suppose, for example, that the plate of the tube is fed through a high inductance choke Ch, say of 100 henries. This will very effectivly stop the signal plate current from going into the B supply and hence also from going through the bias combination C2 and R5. Nearly all the signal current will flow through condenser C3 and the primary of transformer T, provided C3 is large enough. Now if the primary of the transformer T is returned to the cathode, the larger part of the signed current will return to the cathode without flowing through R5 at all. Hence there is no feed-back. But even with this arrangement of the output circuit the capacity of C2 should be large.

There is a danger of motorboating if the amplification on the low notes is too high. The remedy for this is exactly the opposite of that required for high gain. The values of C1, C2 and C3 should be small. Also, the resistance R4 should be small. But this is only if the circuit motorboats. There should be verv little danger of motorboating in an amplifier containing only two plate circuits like the present. The remedies are only mentioned in case it should appear. Another remedy for motorboating would be to return the primary of T to ground instead of to the cathode of the tube. However, the connection shown in the drawing should be used whenever it is possible to do so.

If the condenser C3 is to pass the low notes down to 50 cycles per second, its capacity should not be less than 8 mfd.

Requirements

Power Rating Analyzed

Andrews

Frequency Must Be Given

But the wattage alone is not sufficient in selecting a transformer. We must also know the number and type of windings, and the voltage of each winding. First we must know whether the primary is to be connected to 110 or 220 volts, and to a 60-cycle line or to a line of some other frequency. These things must be specified in ordering the transformer. Also, do we need more than two low voltage winding, one 2.5 and one 5 volts? Each winding must be rated at the current which it is to deliver, or it must be rated at a higher current. Suppose we can get along with a single center tapped 2.5 volt winding and that this is to serve one 247 and five 2.5 volt heater tubes. The single winding must then deliver 1.5 1.75x5, or 10.25 amperes. It is all right to specify a transformer with a 2.5 volt winding that will handle 13 amperes.

We have assumed a single 280 rectifier tube, which takes 2 amperes. Therefore the 5-volt winding supplying the rectifier tube should be rated at least 2 amperes, and preferably 3 amperes.

The high voltage winding should be specified as to root mean square voltage across each half of the winding and also as to the current that may be drawn. In our illustrative case we have assumed that the highest restified voltage will be 300 volts and that the total current will be 60 milliamperes. A voltage of 375 volts, root mean square, may be specified to allow for decrease in the output voltage as the current increases. Loss of voltage will occur in the high voltage winding, in the rectifier tube, and in the filter chokes, and this loss will be greater the higher the d-c current. Hence it is well to have a little in reserve, and the 375 volt specification is all right.

Of course the power transformer may be specified to give a certain rectified current at a certain voltage.

Choice of Filter

It is always best to provide plenty of filtering in the output side of the rectifier. We might select a 4 mfd. condenser for C1 and a 30 henry choke for Ch1. This should be the inductance of the choke under full current and not when a very small current flows in it. In other words, this choke should be built on a generous core. On the right side of this choke there is a condenser C2, which may be an 8 mfd. electrolytic. The main part of the load current is taken off at either the 300 or 266.5 volt tap. Therefore the second choke Ch2 will not have to carry as much current. If it is of the same design as Ch1 it will be more effective in filtering because it is working much farther from saturation. The third condenser, C3, can also be an 8 mfd. electrolytic.

The arrangement of the chokes and the high voltage taps is especially suitable when the last stage is push-pull, but it will also work well when the last stage contains a single power tube.

Voltage Divider

It is not intended that both the 300 and the 266.5 volt taps should be used simultaneously. The 300 volt tap should be used when the output tube is a 245 and the 266.5 volt tap when the output tube is a 247 pentode. The 193.5 volt tap should be used for the plate returns of tubes requiring about 180 volts on the plates and 13.5 volts on the grids. This is the normal operating conditions of a 227. But a total of 193.5 is also permissable on 224s and 235s. The 75 volt tap is intended for the screens of the tetrodes.

We have now come to the question of selecting resistances for the voltage divider. It is impossible to select any one of them without knowing the currents involved. The current in R4 we can always assume in any case for we may choose whatever we wish. Or we may choose any value for R4 and then compute the current so as to give 75 volts at the first tap. If we choose a comparatively large current the voltages at the various taps will not vary so much. Therefore it is advantageous to select a large current, which means that R4 should have a comparatively low value. But if we let the bleeder current, that is, the current in R4, be too large we take too much current from the source and the voltage falls and the filtering becomes poorer. Hence we must compromise.

Method of Computing Resistances

Let us compromise on 15 milliamperes for the bleeder current. That assumption fixes R4, for it must be 75/.015, or 5,000 ohms. But we cannot proceed with the determination of R3 without knowing the current that flows into the 75 volt tap. We might allow 11.35 milliamperes. This is the current to the various screens, excepting that of the power pentode. The current in the case of our assumed circuit is probably less than this but it is always possible to arrange the circuit so that this current flows, for example, by putting in a shunt of suitable value. If the current to the 75 volt tap has this value, the total current in R3 is 26.35 milliamperes, for the bleeder current also flows through R3. Now the voltage drop in R3 is the difference between 193.5 and 75 volts, or 118.5 volts. Thus R3 equals 118.5/.02635, or 4,500 ohms. If it had been necessary to assume a lower value of current to the 75 volt tap, the value of R3 would have been larger.

To obtain the resistance value of R2 we must know the current that flows into the 193.5 volt tap, for the current in R2 is the sum of this current and the current in R3. Let us assume that the current to the 193.5 volt tap is .03405 milliamperes, so that the total current in R2 is 0.0604 milliamperes. The voltage difference between the 266.5 and 193.5 volt taps is 73 volts. Hence the value of R2 should be 73/.0604, or 1,210 ohms. This includes the resistance of Ch2, which may be 40 ohms. Hence the resistance of R2 alone should be 810 ohms. Of course, it is not necessary to consider the 10 ohms, an even 800 ohms being all right. To get R1 we note that the same current flows in that as in R2 plus the current taken by the 266.5 volt tap. It is reasonable to assume that this current is 39.5 milliamperes. Hence the current in R1 is 99.9 milliamperes. The drop in R1 is 33.5 volts. Hence R1 should be 33.5/.0999, or practically 335 ohms.

Another Computation

It may be that this computation is not suitable, and it is sure not to be because it was made to fit a particular case and fits that case only. So let us try again. There is no need of changing R4 or the bleeder current. But if we have three screens each drawing 1.5 milliamperes and one plate of a 227 drawing 6 milliamperes, we have a current of 10.5 milliamperes to the 75 volt tap. Thus we have a total of 25.5 milliamperes in R3. This makes the value R3 exactly 4,650 ohms.

The three screen grid tubes take about 18 milliamperes, or 6 each. Hence the current to the 193.5 volt tap is 18 milliamperes and the current in R2 is 43.5 milliamperes. Hence R2, including the resistance of Ch2, should be 73./.0435, or 1,680 ohms. If Ch2 has a d-c resistance of 400 ohms, R2 should have a resistance value of 1,280 ohms.

We are still justified in assuming that the current to the 266.5 volt tap is 39.5 milliamperes, so that the total current in R1 is 83 milliamperes. The voltage drop in R1 is 33.5 volts. Hence R1 should have a value of 403 ohms.

Power Amplifiers

It will be noticed that there is a certain self-adjustment in respect to feed-back that might cause motorboating. Whatever value is chosen for C2 it will be less effective and the low notes and the reverse feed-back at the frequency where motorboating may occur will be greater. Hence the likelihood of motorboating is reduced. The same applies to the output circuit. The lower the frequency the more signal current will flow through Ch. Whatever flows will tend to stabilize the circuit by the reversed feed-back. Also, the lower the frequency the more effective C3 will be, which will force more through Ch.

In case the loudspeaker used has a transformer built in that fits the pentode tube, this transformer takes the place of T. One side of the primary of this built-in transformer would be connected to C3 and the other to the cathode of the pentode, the cathode being represented by the center tap of the filament winding H. If the speaker used has no transformer one suitable for the tube and the speaker should be used. A magnetic speaker can be connected directly between C3 and the center tap of H.

The B supply for this circuit is supposed to maintain a voltage of 266.5 volts between ground and B plus, but the circuit will work with a total as low as 250 volts, and no harm will result if it is made 300 volts. If the voltage should be in excess of 300 volts it may be cut down by an appropriate resistance. The total plate and bleeder current is close to 50 milliamperes for this circuit alone, and therefore to cut the voltage down one volt a resistance of 20 ohms is necessary. In any case, multiply 20 by the number of volts by which the voltage is to be reduced to get the total resistance. This resistance should be placed between B plus and the high side of R2.

The heater winding H may be one of the windings on a power transformer used for the radio frequency part of a receiver, or it may be the secondary of a special filament transformer. Of course the voltage of the winding should be 2.5 volts and there should be a center tap. If there is no center tap one may be provided by connecting a center tapped resistance of 30 ohms across it.

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

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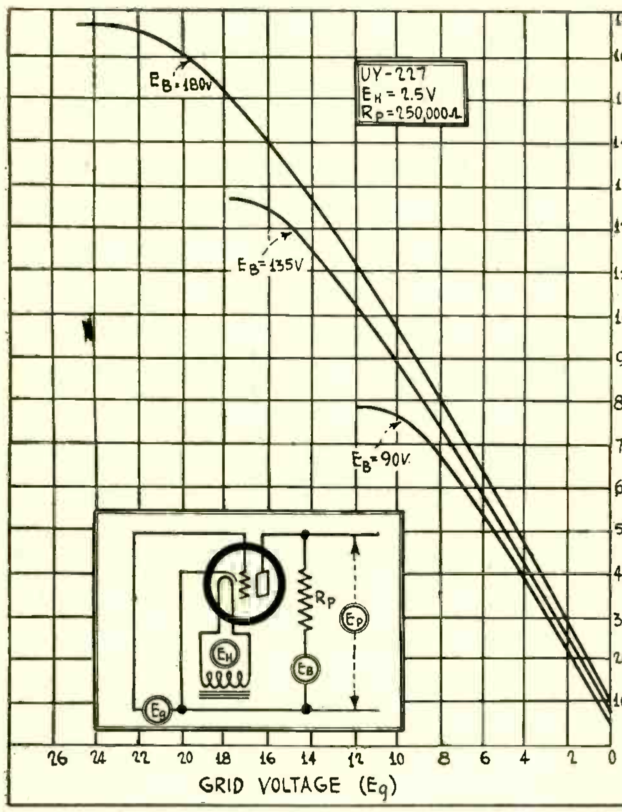

FIG. 950

Three plate output voltage, grid voltage curves for a 227 tube in a resistance coupled circuit.

Effect of Baffle Boards on Speakers

A FEW years ago there was a flare for large cones and large baffle boards. No speaker that did have a large sound radiating surface was regarded as having good quality. Now tiny speakers set in almost as tiny cabinets are popular, and they seem to give good reproduction. It would seem that there is no need for large baffles or large cones. Just what is the true situation?—E. W. J.

You can test the matter in a few minutes and thus learn the true situation for yourself. Take a large sheet of cardboard of the corrugated or packing box type. In the center cut a hole which is just a little bit smaller than the diameter of the cone. Hold this baffle in front of the speaker, tight against the front rim. Note the reproduction. Then tip the baffle back. The demonstration is very convincing and it is in favor of using a baffle, that is, unless you don't want the low notes to be reproduced.

* * *

Metals For Photo-Electric Cells

WHICH are the metals used in photo-electric cells and what are the advantages of the different ones?—R. L. E.

The active metals used in photo-electric cells are the so called alkali metals. The principal ones used in photo-electric cells are sodium, potassium, and caesium. Cells made of sodium are most sensitive in the yellow, or in the wavelength range to which the human eye is most sensitive. Potassium cells are most sensitive in the violet, or in the wavelength range where most photographic materials are most sensitive. Caesium cells are most sensitive in the red or orange range of wavelengths.

* * *

Amplification of a 227 Tube

HOW much amplification can be expected from a 227 tube in a resistance coupled circuit with 250,000 ohms in the plate circuit? What should the grid bias be when the applied voltage is 180 volts in the plate circuit? If convenient will you kindly publish some curves showing the amplification?—I. C.

If the grid bias is made 8 volts the mean amplification of a signal the amplitude of which is 8 volts is 7.5 times. If you follow the tube with a 245 power tube the signal voltage on the tube should be 50 volts, peak value. This will require a bias of about 6 volts on the 227 tube. At this bias the amplification is 8.5 times. Therefore if a 245 tube is to follow the 227 the bias should be between 6 and 8 volts. If a pentode of the 247 type follows the tube the output need only be 16.5 volts. This is more than provided for if the bias on the 227 is 3 volts. At this bias the amplification is 9 times and the distortion is much less than at the higher bias values. If you want to use self bias 3 volts require 5,320 ohms, 6 volts, 13,000 ohms, and 8 volts, 20,000 ohms. In Fig. 950 is a set of curves showing the relation between the effective output voltage and the grid bias for three different plate battery voltages, all for 250,000 ohms in the plate circuit. The above statements were based on the information contained in the highest of these curves.

* * *

Light Ray Telephony

I AM about to experiment with light ray telephony and want to use a neon glow lamp as the source of light, which I intend to modulate by means of an amplifier and microphone. What kind of photo-electric cell do you recommend for this purpose? I may also try an arc lamp as the source of light. In that case what kind of photo-cell do you recommend and how can I modulate the light beam when it comes from an arc lamp?—W. A. A.

When the source of light is a neon glow lamp the best photo-electric cell is a caesium. This cell is sensitive to red light and light of other long wavelengths. When the light source is an arc lamp a potassium photo-cell is better for this cell is sensitive to blue and violet, and the arc is rich in this light. The light beam from an arc can be modulated by means of a Kerr cell.

* * *

Short Wave Super Design

I HAVE heard it said that a short wave superheterodyne cannot be built satisfactorily with a low intermediate frequency, for example, a frequency below 100 kc. If this is a fact will you kindly explain the reason why.—H. C. J.

It depends on what kind of short wave receiver is built. If there is a radio frequency tuner in addition to the oscillator tuner, and one is necessary for good sensitivity and selectivity, the intermediate frequency cannot be low because the two circuits will interlock. That is, they will act as one tuned circuit. One possibility is that the oscillator will not function because the other tuned circuit introduces a higher resistance in the oscillator circuit. Then nothing can be received. The other possibility is that the oscillator will oscillate at the frequency of the radio frequency tuner. It is then necessary to detune the r-f tuner in order that the oscillator generate the proper intermediate frequency. The signal input is then weak and the superheterodyne insensitive. If the intermediate frequency is high the two circuits are so far apart in resonant frequency when both are tuned in that there is no interaction. The r-f tuner can be accurately tuned to the signal and the oscillator to that frequency which produces the beat frequency to which the IF selector has been tuned. The set is then both sensitive and selective. The higher the signal frequency to be received the higher the intermediate frequency should be. Successful short wave superheterodynes with an intermediate frequency of 250 kc have been built.

* * *

Biasing Battery Tubes

I AM building a small receiver using the 2-volt tubes. There will be three tuned circuits all of which are tuned with a gang condenser with common rotor. The first two tubes require a bias of 3 volts and the detector a positive bias. How can I arrange the circuits so that I will not short-circuit the grid battery and at the same time ground all the rotors?—H. E. H.

Ground the rotors. Then connect the low potential terminal of each tuning coil to a 0.1 mfd. condenser and ground the other side of each of these. Also, join the two low potential terminals of the coils for the first two tubes and run this common lead to C minus for these tubes. Connect the low potential terminal of the coil ahead of the detector to the positive end of the filament.

* * *

A Clock a Regenerative Device

A CLOCK keeps ticking just as long as the spring or the weights are wound up. The force exerted by either the spring or the weight is always in the same direction. In this respect the force is like the d-c electromotive force in an electric oscillator. The pendulum or balance wheel oscillates. Therefore it seems to me that a clock is essentially the same device as an electric oscillator. Am I right? If the two devices

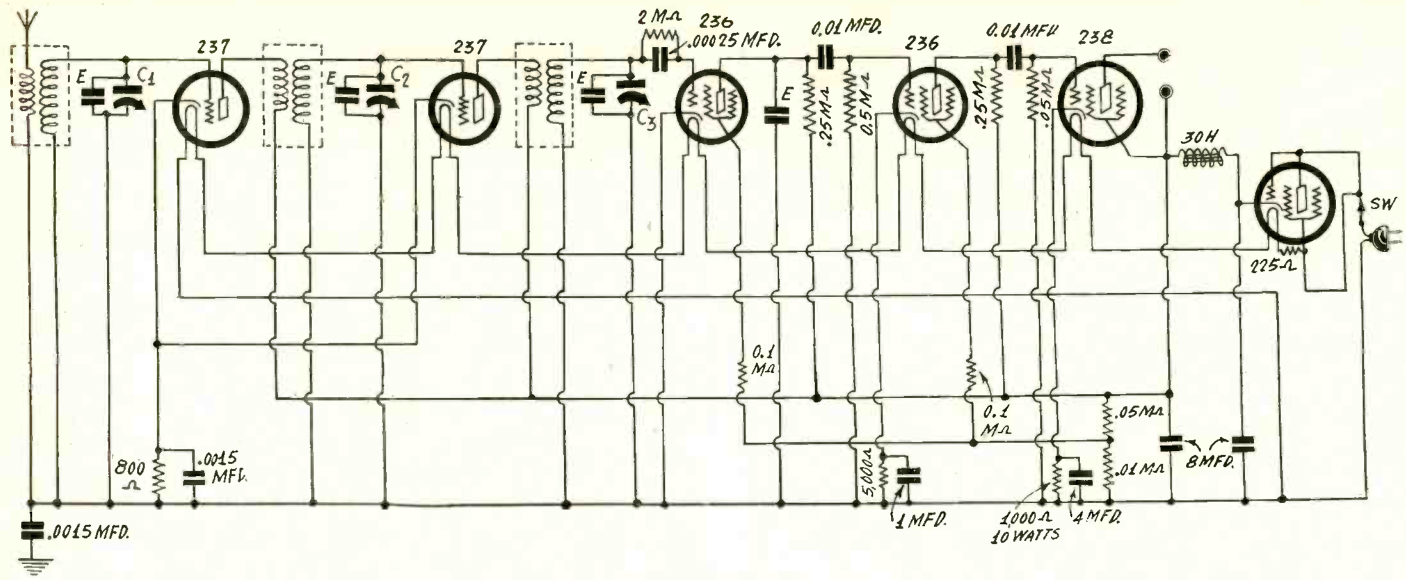

FIG. 951

A circuit designed primarily for alternating current operation, but which may be used on direct current of the same voltage, 110 volts, as well. The control grid of the 238 is at top, comprising a cap as outlet; therefore as grid and plate are tied to screen, the high voltage is exposed.

are similar, the clock should have some kind of feedback. What is it?—W. H. T.

The clock is an oscillator and there is feed-back. For every swing of the pendulum or the balance wheel a little of the energy stored in the weights or the spring is released and the amount so released is just enough to overcome frictional losses in one swing. In the same way a little energy is released from the battery in the circuit to sustain the oscillation for one cycle. The difference is that the energy in the electrical case is released continuously while in the clock it is released in spurts, and it is the escapement that controls the amount and the duration of the spurts. In the electrical case the electrical mass, that is, the inductance of the coil, and the "stiffness" of the tuning condenser determine the period of one oscillation, or the frequency. In the pendulum clock it is the length of the pendulum and the force of gravity which control the period and in the spring clock it is the moment of inertia of the balance wheel and the stiffness of the hairspring.

* * *

Reception of Harmonics

MY broadcast receiver is exceptionally selective for I can tune out any high power station in about one degree of the dial. Notwithstanding this I can receive certain strong stations on two places on the dial. Presumably, I am receiving these stations on harmonics, but the stations are high class and they are supposed to be almost free of harmonics. Certainly the harmonics they are sending out are weaker than the fundamentals of certain small stations in the same frequency range as the harmonics, and these I can tune out easily. Do you suppose there is something wrong with my set which causes the harmonics to come through? If so, what can I do to eliminate the interference.—L. W.

The correct explanation is undoubtedly that the fundamentals of the strong stations enter the first tube and that the frequencies are doubled in this tube. The second harmonic of any station thus produced is amplified in the radio frequency amplifier and it is selected by all the tuners after the first. It is possible that the third harmonics could be received in the same manner if the r-f tuner would reach it. This would require that the tuner reach 1,650 kc and higher. The remedy is to put in exponential tubes, like the 235, in the radio frequency amplifier, or at least one of them in the first socket.

* * *

Power Transformerless A-C and D-C Set

IS it not possible to construct a set that does not use a power transformer at all, and that may be worked either on alternating current of the same voltage, any frequency, as well as direct current? Some such idea was broached in your columns recently, I believe.—T. L.

Fig. 951 shows the diagram. The circuit is built around the automotive series tubes, of which the 237 is the general purpose type, the 236 the screen grid amplifier and detector, and the 238 the output screen grid tube (pentode). The 238 is also used as singlewave rectifier, for a-c operation. The line voltage is introduced into the rectifier tube, and the resultant d-c voltage at the filter output, with a choke of about 400 ohms resistance for filtration, is about the same as the root mean square a-c input. The heater voltage is reduced so that when the heaters are in series each tube gets about 6 volts. For d-c operation a switching arrangement would be necessary, to bring the high side of the line over to the choke coil, where the cathode connection of the rectifier now is.

Lower Bias for Pentode

THE modest set I am operating has a pentode output tube. The bias is around 17 volts negative. I realize that the resistor that produces this bias when the current flows is around 420 ohms, therefore I was wondering whether it would not improve the low-note response if I reduced the bias to, say, 10 volts, as I really do not need full 17 volts bias. I don't believe the tuner loads up the pentode, anyway, beyond 10 volts. Is this practical? J. H.

Yes, it is. The usual method is to put a high capacity condenser across the biasing resistor, 8 mfd. being the minimum, but full realization of the condenser's effect coming out when 16 mfd. is used. Of course, the effect of the condenser is to reduce the impedance of the circuit. The impedance also is reduced when the bias is made less, by using less d-c resistance. The impedance and the resistance are approximately the same in a resistor such as is used for biasing, so the difference can be determined directly. The low-note response will gain considerably if the bias is reduced.

* * *

Bring Out the Lows

PLEASE suggest some simple remedy for removing the shrill effect from a midget set that I bought. The set works, but I am afraid that the tone is not all that it should be.—D. M.

You may increase the capacity of the isolating condenser between plate of detector and grid of the first audio tube.

RADIO WORLD

The First and Only National Radio Weekly
Tenth Year

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New Tubes, Old Troubles

WHEN new tubes come along the tube manufacturers are nearly finished with their problem when production begins, but then the set builders' problem has just begun. Engineers are kept busy trying out methods of using the tubes, and finally something worthwhile emerges. Not always, unfortunately, the right way to use the tube is known when the tube first appears on the market. Even the advance information, and indeed the delivery of sample tubes to design engineers in set-making establishments, does not always make possible the complete solution of the problem before set production begins with use of the new tubes in mind.

When the screen grid tube appeared—the *222* and the *224* particularly—much emphasis was laid on the greatly increased amplification, and of course it was a fact. Far more sensitive sets could be built using fewer tubes. Plate circuit tuning was freely encouraged. As high an impedance as possible was to be put on the plate circuit of radio frequency tubes, and it wasn't possible to get a higher impedance than that obtained from a resonant circuit. So plate circuits were tuned, but not for long. It was found that another requirement, that of selectivity, was even more important than great amplification, and since in a sense the two work at cross purposes, the amplification was reduced, by special circuit formation, and the gain taken up in selectivity. So the selectivity became much higher, but the amplification did not greatly exceed that previously obtained from general purpose tubes.

A Troublesome Tube

There is no doubt the screen grid tube proved troublesome. The amplification that was possible could not be put to practical use, the difference was taken up in selectivity, and yet there was trouble from cross-modulation. The tube had a bad knack of detecting when it was intended that it should serve as a radio frequency amplifier. A sort of detection by shock excitation made the cross-modulation problem one of severe proportions, especially as the early remedy was to use two tuned circuits, a kind of band pass filter, ahead of the first tube, for more selective input. Making two somewhat dissimilar circuits behave as if they were identical gave rise to another problem, and so engineers looked around for a better solution.

Finally it came along in the variable mu tube. If a tube could be so made that the amplification would be greatest when the bias was low, and would be less as the bias was increased, and if this ratio was of a logarithmic nature, a tube would exist that did not jump into the detecting class the moment the bias was shifted a bit more negative. Stuart Ballantine produced such a tube, and after some seesawing it came upon the market as a welcome addition to the tube family. And it is one tube that has stood up from the start, presenting no special or annoying problems, and raising the selectivity of receivers to a most appealing degree.

As a companion entrant into the tube class came the pentode output tube, fashioned somewhat along the lines of the pentode tubes that have been popular in Europe for years. As it was an audio tube it was to be expected there would be some problems, and these concerned principally the tonal response.

But there was nothing about the pentode that presented any new or intricate problems. It had enormous amplification, compared to any other American output tube, so there was danger of motorboating in multi-stage amplifiers, but since the mu of the tube was so high, the detector could be fed into the output stage, or one intermediate stage of audio used, if the tuner was of more modest design. Even the two-stage audio channel, with screen grid or variable mu tube in the first audio position, easily could be stabilized.

Pentode Popularity

However, the pentode leaped into popularity during a depression, when there was not so much money in people's pockets, and sets were made to sell at very low prices, particularly midgets. It is to be assumed that the engineers knew what the single-sided pentode output needed—very large condenser across the biasing resistor. If any respectable response was to be obtained at the lowest radiated frequency of modulation, some 50 mfd. of capacity would be appropriate. Now, imagine a puny midget, designed to sell at $37.50 (including tubes) having anything so imposing within its Gothic exterior as a 50 mfd. bypass condenser!

And if a screen grid tube is used for detector or for any audio purpose whatever—and that includes detection—any resistor interposed between screen and a positive B voltage, or between screen and ground, likewise would require a very large bypass capacity. This would be true whether the screen ran to 75 volts positive through a high resistance, or were connected direct to a tap on a high current voltage divider across B plus maximum and B minus. The only difference would be that in one instance there would be a few thousand ohms, and in the other a few hundred thousand ohms, but an impedance of around 50 ohms would be plenty to tolerate, so very high capacity would be needed, for only the condenser would lower the impedance to desirable values for low note response paramount to 1,000 cycle response.

The largest capacities are admittedly expensive, and therefore it is extremely doubtful if they ever will find their way into commercial sets, or many sets, no matter whether commercial or otherwise.

A Field for Experimenting

This opens a new field of experimenting. It is possible to shift the phase by introducing another tube for this special purpose, and tubes are cheap. It is possible to take part of the signal voltage drop from an antecendent stage and put it into a succeeding stage for similar purposes of eliminating negative feedback. It is of course practical to introduce push-pull, where a bypass capacity would not be needed, or desirable, across the biasing resistor of the pentode stage, because the signal current would be zero in a balanced stage. It is therefore a case of push-pull or the solution of a single-sided output without resort to very high capacities, and engineers are reminded of the problem—for they know full well of its existence—in the hope that better sets will be produced.

During the past year radio has been lapsing more and more noticeably into careless sets, sets to sell at a price, but it would be a shame to see the industry collapsing under the burden of its own shortcomings, when engineering talent certainly produce the solution. The set manufacturers should insist that their engineers turn the trick consistent with required economy. Then it will be found that the solution was no great difficulty, after all.

It is a pleasure, therefore, to record once again how successful the variable mu tube has proved from the start, and also is it gratifying to feel high confidence in the set designers that they will come forward with the tone-quality assistance that the present crop of low-priced receivers surely needs.

Competition on Air

THE most striking difference between the British and the American systems of broadcasting is that theirs has no artistic competition and ours has plenty of it. Chairman Saltzman of the Federal Radio Commission says that the American public is satisfied with the type of programs it gets, and we are inclined to agree with him. Therefore we get what we want and we like what we get.

With so many stations on the air, it is easy to assume that stations not furnishing the desired type of programs could not long endure. Either listeners will tune out the station or the Commission will find a way to get the station off the air without resort to technical censorship. While ousting for bad judgment in putting on programs never has been practiced, if the station fails to serve the public interest, convenience and necessity, and lends itself to questionable tactics, of which there have been plenty, doom may result.

In Great Britain there can be no questionable tactics, for the government-chartered British Broadcasting Company is IT all the way through. The diverse agencies that choose talent for American broadcasts are as a myriad compared to an individual.

The rivalry existing among stations here is very intense, and usually form such rivalry something good enures to the public. England has no rivalry. If the public takes to Amos 'n' Andy, why an apposing chain puts on talent intended to win the audience away, and in a given instance, succeeds at least partly. Now, it takes a first-class attraction to divert attention from an avowed favorite, so the public comes in as beneficiary, and does not have to foot the bill.

In England there is a tax on sets, and from the income thus derived the broadcasting structure is maintained, and artists are paid. What they get over there is not discussed, but you can imagine. Over here the figures of the favorites run so high that chains are not always too bashful to let out an inkling of what they are. One tenor, for instance, appearing nightly for fifteen minutes (not singing quite all the while), receives $6,000 a week.

On the whole we prefer the American system, Americans visiting abroad, even those most diplomatic and considerate of their hosts, prefer the American method, and about the only ones who advise us to change to the English system are the officials of the British Broadcasting Company, who now and then pay us a visit that is mutually enjoyable. Some American methods have gone big in England—for instance, the department store—but it isn't often that our way of doing things appeals to them, and more seldom still does their way seem satisfactory for us. So by each nation following its own chosen course probably both nations are getting what they want and should have. As for ourselves, with petty reservations put aside for a more quarrelsome day, we're satisfied.

Sparkles

By Alice Remsen

A REVERIE

(Don Voorhees' orchestra and John Charles Thomas)
WJZ Thursdays 9:30 P.M.

Blue smoke drifts lazily upward.
A tall, graceful figure raises a slender baton.
Muted violins breathe dreamily.
A golden fanfare of trumpets
Pierces the aromatic mist.
A silver voice trickles through
The magic harmony of woodwinds.
A cymbal crashes!
A mad cacophony of delirious discord
Disperses the mystic spell,
And I awaken from my reverie.

* * *

Our old friend and co-worker, Walter Winchell, is to be back on the air again, commencing September 15th. Walter will be the feature of the new Gerardine program, over the Columbia Broadcasting System, every Tuesday, at 8:45 p.m., EDST. Very glad to know it, because he has an enjoyably distinct and snappy style on the air; and also because he always succeeds in luring interesting personalities to participate in his broadcasts.

* * *

Columbia has two new announcers in the persons of Fred Uttal and Carlyle Stevens. Uttal used to be special announcer at Jones Beach, N. Y., and Stevens was formerly associated with WLTH, Brooklyn.

* * *

Another of our favorite broadcasts returns to the air on September 17th, over an NBC-WEAF network—"The Adventures of Sherlock Holmes." Once again we shall listen to the delightful nonchalant utterances of Dr. Watson, and the clipped sentences of Holmes, the characters being portrayed by Leigh Lovell and Richard Gordon. The "Adventure of the Speckled Band," which inaugurated the earlier series, has been again selected for the opening episode. Thereafter the series will assume a different form of presentation. Instead of giving a separate adventure each week, the producers will select longer stories and present them in serials of varying length. The first of this group will be "The Hound of the Baskervilles."

* * *

Singing Sam (Harry Frankel) sang "Waiting for the Sunrise" on a recent program. At the piano was Emil Seidel. In the studio sat Emil's relatives, bunches of 'em. Emil was nervous, and when he played the introduction of "Waiting for the Sunrise" he forgot to transpose it down. Singing Sam looked surprised, but gamely tackled the song and managed to struggle very creditably through the verse, when Emil realized his mistake, he turned from a healthy tan to a sickly white. He quickly modulated down to the right key and the song was finished in a blaze of glory.

* * *

The NBC has signed Sophie Braslau, one of America's leading contraltos, as guest artist on four Sunday programs. Miss Braslaus' first concert was last Sunday, September 6th; her next will be on September 13th; then the 20th and 27th. An orchestra under the direction of Phil Spitalny supports her.

The singer returned this Summer from a concert tour of Europe where she created a tremendous impression.

Our own Maria Cardinale, prima donna of "Footlight Echoes," has been selected, in company with our diminutive pal, Beth Challis, to represent the pulchritude of WOR in the forthcoming radio beauty contest in connection with the Radio-Electrical World's Fair at Madison Square Garden, New York, week of September 21st. Maria has a dark-eyed Italian beauty that is bound to react favorably on the beauty judges; and Beth is the cutest little trick you ever saw, petite and pretty, with the biggest blue eyes.

I wish my two dear colleagues the best of luck and may the prettier one win.

* * *

Glad to learn that "The March of Time" will be back on the air again this Fall over the Columbia networks. I consider these programs as among the outstanding productions of last year.

* * *

BIOGRAPHICAL BREVITIES

Cliff Hammons

Promised a couple of weeks ago to give you some facts about Mr. Hammons, so here goes: Cliff Hammons, who broadcasts his "One Man Show" over WOR each Saturday evening at 9:45, was born on a plantation in Louisiana, and as a youngster was brought up by a negro mammy, and from her and the negroes on the plantation he learned the negro ways of thinking and speaking.

Made his stage debut at the age of fifteen as end man in a minstrel show, ran away from home to do it, as a matter of fact. Followed that work until he married, then gave it up so that he could make a home for the bride. Has never been back on the stage since, but has done lots of radio work.

The genesis of his popular program "The One Man Show" came about in this manner. When Cliff decided to try radio work he knew that unless he developed something different he didn't stand much chance. At that time there were no double voice exponents on the air. Cliff had experimented with various voices until he had developed that gift to an extraordinary science. When preparing his material for his first audition he studied it in five different voices. While he was giving the audition several persons listened in the next room. When he finished he was asked to do it again while one man watched through the glass partition. They did not believe he was doing all the voices himself. Was on the air three days later and has since perfected his talent until now he has more than fifty voices. He doesn't know himself just how many voices he really possesses.

Never missed a broadcast for a year and a half until August 15th when he had to take his little son to the hospital with infantile paralysis. Even then he rushed to the studio prepared to do his skit, but the studio staff arranged the program so that he would not have to go on, although he was ready to carry out the old tradition of the trouper—on with the show.

His little son recovered and is at home with no after-effects of the malady.

Cliff has a seven year old daughter who has been working for Paramount pictures for the past year. She is his worst critic, correcting all his mistakes and giving him wise advice as to how to put his stuff over.

Writes all his own scripts. Invites listeners to send him funny situations they'd like to hear on the air and incorporates them into his skits. Every character he portrays, with the exception of one, is from his memory of the days spent on the plantation. Can't bring himself to think of them as unreal. To him they are living and breathing people. The one exception was a visitor to the studios. Cliff thought his voice so funny that he put it in his next week's program. Remember Mr. Pertell, who whistles when he talks? that's "him!"

Never had stage fright, but always has mike fright. Likes to have people in the studio while he works. Makes him feel that he is playing to an audience.

When writing his material he is in a trance. Never knows what he has written until he reads it over. Is never without worry. "What shall I write? Will it go over? How did it go over? What shall I write about next week?"

Can see something funny in almost anything. Always wanted to be a dramatic actor. A few months ago while rehearsing his skit at home, he let his enthusiasm get the best of him, raising his voice he cried, "Fire! Fire!" Someone heard him and the next thing he knew a fire truck drew up outside. Since then he's done all his rehearsing in a sound-proof room.

Gets three kinds of fan mail; one asking for a copy of the script; one asking for his picture; and one asking if he's white. He is.

* * *

Sundry Suggestions for Week Beginning September 13th

Sunday Sept. 13th The Moderns....WOR 4:00 p.m.
Sunday Sept. 13th Harbor Lights...WJZ 8:30 p.m.
Monday Sept. 14th Lanny Ross....WEAF 12:00 N
Monday Sept. 14th Singing Sam..WABC 8:15 p.m.
Tuesday Sept. 15th Eddy Brown....WOR 9:30 p.m.
Tuesday Sept. 15th Ann Leaf & Ben Alley........ WABC 12:30 a.m.
Wednesday Sept. 16th Lee Morse.WEAF 7:30 p.m.
Wednesday Sept. 16th Footlight Echoes .... WOR 9:15 p.m.
Thursday Sept. 17th Sherlock Holmes .... WEAF 9:30 p.m.
Thursday Sept. 17th Morton Downey .... WABC 7:45 p.m.
Friday Sept. 18th Paul Whiteman..WJZ 10:00 p.m.
Friday Sept. 18th RKO Theatre of Air .... WEAF 10:30 p.m.
Saturday Sept. 19th Street Singer .... WABC 2:00 p.m.
Saturday Sept. 19th Alice Remsen.WOR 10:00 p.m.

Forum

Circuits That Will Not Work

CAN it be that some people have a genius for picking out circuits to build that do not work, or which they do not have the ability to make work? It would seem so if we are to take literally the complaints of those who say they have only found one circuit in RADIO WORLD that worked. I have built hundreds of circuits from RADIO WORLD and I have yet to find one that does not work. It is true that some of them do not work as well as I expected but on consideration I usually find that I had no right to expect any more than I got. I have long since lost the idea that miracles can be accomplished with tubes, and coils, and condensers.

No doubt, RADIO WORLD is up against the same difficulty that have bothered me a great deal, the fellow who can't hook up the simplest circuit without blundering. Just the other day a man came to me and asked for a circuit diagram of a battery operated, portable receiver. I copied one which I had taken from RADIO WORLD and which I had built with success. Within a week the man came back and said I had given him the wrong diagram, one that did not work and one that I knew did not work. He claimed it was my fault that he had burned out a set of tubes. In checking his receiver over I found he had connected the C battery in series with the filament battery and that he had put 6.5 volts in series with the filaments that should have had 2 volts. That error was not in the diagram I gave him, which I had copied correctly. It never occurred to that man to blame himself.

I am for you and wish you good luck and prosperity.

Atlanta, Ga.

* * *

A Real Heaviside Layer

I WAS interested in reading the comments by Mr. Gabus on the effect of meteors on radio reception in the Sept. 5th issue of RADIO WORLD. However, I cannot agree with his theory. In the first place he dispenses with the hypothetical layer of ionized gas and substitutes a real layer of material particles. Is not this another hypothetical layer? He does not make clear how the canopy of meteoric particles inside the earth's atmosphere can remain there. Centrifugal force will account for that part which is a long way outside the atmosphere, but the centrifugal force depends on velocity and if the particles are inside the atmosphere the velocity would soon be reduced by friction to the point where the particles would fall to the ground.

The theory of lowering and rising of the layer with respect to the earth because the solid earth is more strongly attracted does not seem to hold either for the density of meteorites is always greater than the density of the earth as a whole. Usually meteorites are of iron or nickel, the density of which is of the order of 8 whereas the mean density of the earth is 5.5. The tides in the ocean occur because of attraction of the sun and the moon, and water is less dense than the mean density of the earth. Therefore if it is a matter of density should not low tide occur when the sun or the moon is directly over? Also, should not the moon have a greater effect on the shift of the reflecting layer than the sun? It has a greater effect on the tides. The ionization theory does not have nearly as many objections as the gravitation theory.

* * *

Good Short-Wave Reception

I HAVE tried many short-wave converters and my luck was so uniformly poor that I had almost concluded that they would not work at all. But I finally built one that brings in plenty of short-wave stations. They work all right when they are built correctly. I use a stage of r-f amplification only to isolate the antenna from the r-f tuned circuit. Although the first tube is a screen grid tube it does not seem to add much to the sensitivity, but it simplifies the r-f tuning so I retain the tube. The r-f tuning is between the r-f amplifier and the first detector. This tuner makes all the difference in the world as I can easily pick up ten times as many stations with the detector input tuned as with it untuned, or by leaving the tuning condenser at zero.

One of my chief difficulties at first was that I could not co-ordinate the r-f and oscillator tuners. There seemed to be no consistency about either tuner until I got the r-f coils proportioned properly. I was surprised to find that the r-f coils had to be much larger than the oscillator coils, especially when receiving stations in the 100-200 meter band. It was the fact that I could get best results with a small oscillator coil and a larger r-f coil that led me to the correct combination. I made a set of r-f coils from data published in RADIO WORLD and then I adjusted an oscillator coil for each r-f coil so that the dial readings of the two tuners were about the same when set at the minimum frequency, or lowest wavelength. This I did when the broadcast set was tuned to approximately 530 kc. or when it was set at zero on the dial. I found that if I changed the setting of the broadcast set my coils would no longer match. However, I have found one setting for each pair of short-wave coils that gives the best matching of the shortwave dials.

I put stage of amplification between the first detector and the input to the broadcast set, which increased the sensitivity greatly. To do this, however, I had to tune the plate circuit of the first detector. Although this complicates the circuit it is well worth while. Ordinarily I leave the tuner at about 550 kc and tune the broadcast set to it. This upsets the matching of some of the short-wave coils but this does not matter now that I know how to set both dials to get maximum results. And does it not bring in signals!

Seattle, Wash.

* * *

More on Light Telephony Desired

IN the Aug. 29th issue you had an article on Neon Lamp Telephony. This was interesting to me because I am trying to learn all I can about the uses of neon lamps and photo-electric cells and the various applications of these devices. Why not publish a series of articles on the uses of these and related devices and their applications to color organs, communication, control of industrial devices and processes? Another thing in which I am interested is in the matching of colors by the use of photo-electric cells. If this is not too far removed from your field why not give us some information on that subject?

Television and talking movies seem to be in line with your own work and there are many of us who should like more information about these subjects. One thing in particular in which I am interested is the cause of the distortion which is so often heard in talking movies. Some of it I recognize as overloading of tubes, but there are other unpleasant effects which, I am sure, are not caused by faulty operation of tubes. Discussion of these defects as thorough as your discussions of distortion in amplifiers would be helpful to your readers.

Cleveland, Ohio.

* * *

Short-Wave Superheterodyne

I AM convinced that a superheterodyne is the best all-around receiver, not only for broadcast reception but also for the reception of short waves as well as for the long European broadcast wave. Undoubtedly, there are many in this country who would like to have a receiver of this type that will cover the range from about 2,000 meters to 10 meters. If a superheterodyne like this is practical, and I am sure that it is, you would make a hit with many of your readers by publishing the details of such a circuit. Naturally, it should be as simple as is consistent with the required sensitivity and wave coverage.

New York, N. Y.

Pointed Opinions

GEORGE ENGLES, director, National Broadcasting Company's Artist Service: "Advance bookings for the coming season indicate no falling off in demand for entertainers. Concert artists alone, of which our organization represents 120, already have 60 per cent more bookings waiting for them for the season of 1931-32 than they had last season. There seems to be money available for what people really wish to spend it on. The public is not economizing on entertainment. It is spending more for amusement than ever before. Perhaps this is due to an effort to find temporary relief from worry. "Only first-rank artists and entertainers are enjoying continued prosperity. In return for what it spends, the public demands the best of whatever variety of entertainment is offered. No one type of entertainment seems to have precedence just now. There are audiences to be found for every variety of entertainment, providing it is good. However, there seems to be a tremendous revival of interest in speakers—not of the old-fashioned variety, but distinguished persons who have achieved fame in some special field."

* * *

DR. C. G. ABBOT, Secretary of the Smithsonian Institution: "The Smithsonian Institution has no evidence which it considers to prove that the fortunes of individuals can be told by fortune tellers, spirit mediums or astrologers. The institution believes that the fortunes of individuals primarily depend on their own exertion and secondly on the influence of future environment, and are in general not predictable."

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At a Glance

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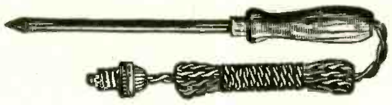

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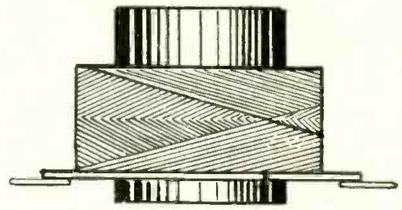
RF CHOKES

HONEY COMB TYPE



800-turn duolateral wound radio frequency choke, inductance 60 millhenrys, DC resistance 75 ohms. The distributed capacity is so low as to be negligible. The choke, therefore, may be used as plate circuit or grid circuit load, even in short-wave sets and converters, and will provide extremely high sensitivity with a low order of noise level, due to filtration by the choke. Suitable for antenna input (grid of first tube to ground) or for filtration of plate and screen grid circuits with condenser of 0.1 mfd. to ground (extra).

The choke is wound of green silk cevered No. 38 wire on a pierced dowel, with bakelite base accommodating two riveted lugs. Contact is perfect. The dowel diameter is ½ inch, the hole through it (which may be used for mounting device) passes 10/32 screw. The extreme coil diameter is only ¾ inch. The distance between lug tips is 1¾ inches. The dowel protrudes ⅛ inch beyond the bottom to prevent shorting where mounting is done on a metal sub-panel. No particular polarity of connections need be observed.

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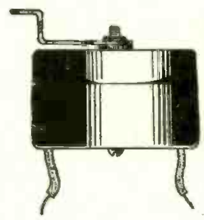
DETECTOR TYPE



For detector circuit filtration, to choke the radio frequency, so it will not go through the audio channel, use a 50 millihenry copper-shielded RF choke. This is supplied with mounting bracket and two insulated wire leads. No particular polarity need be observed. This choke is wound of extra heavy wire, and its DC resistance will not show up on the usual type ohmmeters. Order Cat. SH-RFC (25 ma maximum current rating) @ 57c

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Where a receiver is to be built to incorporate automatic volume control, the shielded choke, consisting of two closely coupled separate windings, may be used. Connect one winding (yellow leads) from detector plate, to the audio input. Connect the two other leads (red and black) as follows: Black to the slider of a potentiometer (400 ohms up, without limit), red to the joined grid and plate leads of a 227 tube used as automatic volume control. Connect cathode of that tube to ground (B minus), and the grid returns of coils in controlled tube or tubes to arm of the potentiometer. Put 1 mfd. from arm to ground. Order Cat. DW-SHCH (maximum current rating, 25 ma) @ 67c

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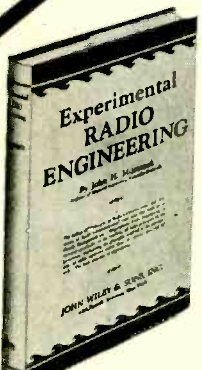

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It behooves every radioist to possess all three books by Prof. Morecroft, but if he can choose only one at a time the experimenter of course wants to start with "Experimental Radio Engineering."

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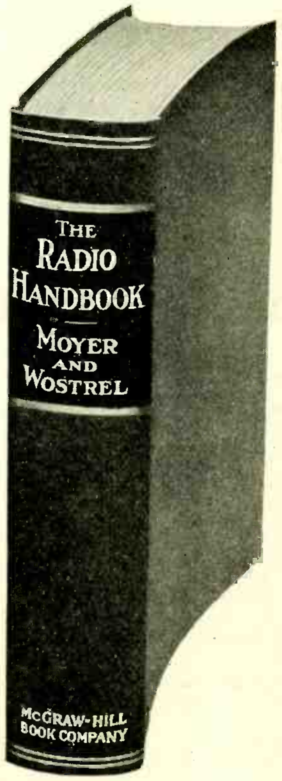

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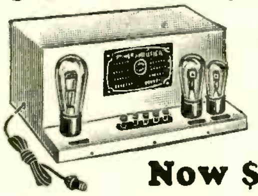

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CONTAINS 2 STAGES SUPER POWER A.F. AMPLIFICATION

This famous amplifier is provided with input and output transformers for working from a phonograph pick-up into a 2000-ohm transmission line or into the coupling transformer furnished with most dynamic reproducers. The tubes required are one '26, one '50 and one '81 rectifier. Where maximum output is not required a '10 may be substituted for the '50 in the output. Automatic adjustment takes care of the discrepancy in voltages. The undistorted power output is 2.5 watts—**enough for four small dynamic reproducers.** This degree of power output provides satisfactory coverage for auditoriums having a volume of 25,000 cubic feet. The input voltage necessary to provide maximum output is but .025 volts.

Ideal for theatres seating approximately 3,000 people, dance halls, schools, lectures, hospitals, auditoriums, outdoor gatherings, etc., etc. The gigantic power is at all times within control—for that matter, it can be used in any home, as the volume can be regulated down to a whisper.

A PHONOGRAPH AMPLIFIER—PUBLIC ADDRESS AMPLIFIER SYSTEM, ETC.

Use of the '26 tube in the input stage makes the long "warming up" period unnecessary. Shipping weight, 30 lbs. Overall size, 16 x 9½ x 6¾" high. List Price, $90.00.

No. 1925—Pacent Model 250 Power Amplifier (less tubes). Your Price $8.75

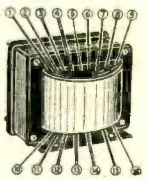
BRAND NEW !

RADIO MIRROR PENLITE

The Latest and Cleverest Tool for Radio Serviceman. The only device that enables you to LOOK AROUND CORNERS or UNDERNEATH inaccessible spots. Your vision is ONLY in a straight line, but with the Mirror-Penlite you can look around a 45 degree angle. You can now look **under** the whole chassis and see every nut, every wire, every socket, behind condensers, transformers, etc. This is made possible by the powerful pocket flashlight to which is attached a **GENUINE DENTAL MAGNIFYING MIRROR.** Mirror clips on or off so flashlight can be used alone if desired. The cleverest device yet. Complete with battery and bulb. Shipping weight 6 ozs.

No. 1695—Mirror-Penlite. List Price $2.50. YOUR PRICE............. 85c

Earl Power Transformers



Make money revamping the old battery set. This power transformer used in Earl Model 22 receiver supplies "A," "B" and "C" potentials for: two '27's (or screen-grid '24's), three '26's, two '71A's and one '80 rectifier; total current output of high-voltage winding at maximum output (about 200 volts) is 80 ma. High-voltage secondary, filament winding for '27's and for '71A's are center-tapped. Size, 3¾ x 3 x 2¾ inches. 16 long leads and full wiring directions. Shipping weight 5 lbs. **List Price, $7.50.**

No. 1410—Earl Transformer (without brackets). YOUR PRICE.... $1.73

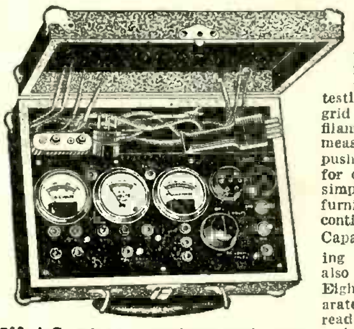
No. 1411—Earl Transformer, the same but with mounting brackets.. $1.98

SPECIAL !

Baldwin RIVAL Speaker Unit

A loud speaker unit bearing the world famous Baldwin mark. Designed for use with horn type speakers or with old style phonographs. Complete with cord. Shipping weight 1 lb. **POSITIVELY LOWEST PRICE THIS UNIT HAS EVER BEEN SOLD.**

No. 1520—Baldwin "Rival" Unit. YOUR PRICE 45c



NEW READRITE Analyzer

This three-meter analyzer has selector switch for checking all parts of tube circuits by connecting to the set sockets. Selection for testing voltages of plate, grid, cathode and screen-grid done quickly and accurately. Plate current, filament volts, line and power supply volts are measured. Grid swing test for tubes used. Just push one button for screen-grid and other button for other tubes. Makes testing of all type tubes simple and thorough. 4½-volt grid battery is furnished. Battery is used for grid test and continuity testing of transformers, chokes, etc. Capacity and resistance charts furnished showing use of instruments for testing condensers, also measuring resistances up to 100,000 ohms. Eight scale readings of meters may be used separately with the jack terminals provided. Scale readings are 0-60-300-600 D.C. volts, 0-10-140-700 A.C. volts and 0-20-120 milliamperes. A.C. and D.C. filament voltages are accurately measured on the one meter. Strong case with leatherette covering. Attractive. Compact. Size 10¾x3½x8 inches. Shipping weight 15 lbs. **List Price $25.00.**

No. 700—READRITE ANALYZER. YOUR PRICE........................ $14.70

New 36 page Summer Edition No. 23

75 New Hook-Ups, etc. 350 Illustrations.

The new Summer Edition of our greatly enlarged RADIO SERVICE TREATISE has just come off the press. If you liked the Winter Issue, you will like this one a hundred-fold. It contains some 75 new hook-ups, circuit diagrams; and some 350 illustrations. **POSITIVELY THE GREATEST BOOK EVER PUT OUT BY ANYONE.** Among the new matters listed are:

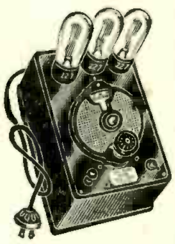
VACUUM TUBE TREATISE, with many illustrations; full page Vacuum Tube Average Characteristic Chart: How to Take Care of Your Tubes; How to Connect Phonograph Pick-ups; Improving the Tone Quality of Old Sets; Connecting Additional Loud Speakers; all fully illustrated with diagrams.

Other articles: Modernizing Old Radio Sets: How to Convert Battery to Power Sets: Selection of Tubes; Push-Pull Amplifiers; Replacing Audio Transformers; Phono Attachments; How to Choose Power Transformers; Voltage Dividers; Wattage of Power Transformers; Selecting and Installing Replacement Parts in Radio Sets; Filter Condensers; Repairing Eliminators.

WRITE TODAY. Enclose 2 cents for postage. Treatise sent by return mail.

NEW! NEW!!

Superheterodyne S-W Converter



At last a short-wave converter that converts any broadcast set into a superheterodyne short-wave receiver. Employs three 227 tubes and covers from 20 to 115 meters. No plug-in coils! Coil switch is used to cover all wavelengths. Single dial control, no body capacity, no squeals. This converter has built-in filament transformer to heat the three 227's. All you need to obtain from your receiver is a positive B voltage anywhere from 45 to 180 volts. Voltage is not critical; no molestation of the receiver. So simple a child can operate it. Size 7 x 10 x 5 inches. Shipping weight, 8 lbs. **List Price $25.00.**

No. 1614—Super Converter (less tubes). YOUR PRICE......... $14.69

World-Wide Short-Wave Set

NOT A CONVERTER

NEW

A perfect radio short-wave receiver for use between 17 and 84 meters. **To** put into operation, connect antenna, ground, 45-volt "B," and 6-volt "A" batteries, and headphones to the posts provided, plug in a type '01A tube, and tune in! An ingenious circuit makes possible a 4-coil single-winding plug-in design. This little instrument has the same **sensitivity** as many big, shielded short-wave receivers costing ten times as much. A power amplifier may be added for any degree of volume. Complete with 4 plug-in coils. Has fine vernier dial for precision tuning. **Never has a first class short-wave set sold for so little money.** This short-wave set measures 5½x7x4 in. high, over all. Ship. weight, 3 lbs. List price, $12.50.

No. 1666—World-Wide S.-W. Set. Your price.................. $6.25

6 MONTHS GUARANTEED NEONTRON TUBES

Sold on a **6 MONTHS FREE REPLACEMENT GUARANTEE BASIS, PROVIDING TUBE LIGHTS!** All tubes are carefully meter-tested before shipment, and carefully packed. Do not confuse these HIGH QUALITY tubes with any other "low priced" tubes—our low prices are possible because we do a VOLUME business!

NEW

Choice	Choice of	Choice	Choice	Choice	Choice
226	112A	245	222	230	235
227	200A-199X	280	210	231	247
171A	199UV-120	171	250	232	
201A	224		281		
63c ea.	69c ea.	79c ea.	1.58 ea.	1.08 ea.	1.50 ea.

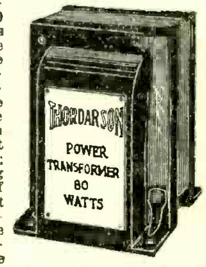
R.C.A. LICENSED TRIAD AND PERRYMAN TUBES

These nationally advertised tubes are guaranteed UNCONDITIONALLY for six months. The prices are slightly higher than our NEONTRONS because these tubes are of much better quality. See listing above for tube numbers.

Choice Price	Choice Price	Choice Price	Choice Price	Choice Price	Choice Price
76c	96c	86c	$1.76	$1.46	$2.09

THORDARSON "245" Power Transformer

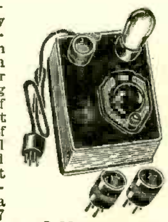
A Miniature Power Plant — Supplies All ABC Voltages — 80 Watts



In addition to supplying a full 250 volts to the plates and 50 volts to the grids of two type '45 tubes in push-pull, this transformer may be used to light the filaments of seven or eight 2.5-volt filament tubes; and by connecting in series two of the three 2.5-volt filament secondaries it is possible to light 5-volt filaments too. Five secondaries: S1—5 V., 2 Amp.; S2—340 V. Cent. T.; S3—2½ V., 3 Amp. Cent. T.; S4—2½ V., 10½ Amp.; S5—2½ V., 3 Amp. Cent. T. **Just the power transformer for building up a high-grade public address amplifier to use a screen-grid A.F. amplifier to boost the output of a microphone or phonograph pick-up;** following this with two stages of push-pull amplification consisting of two '27's in the first stage and two '45's in the second. Bottom of transformer has bakelite panel on which are mounted all taps. **It outperforms ANY similar transformer.** Many Service Men keep this model transformer on hand for emergency replacements in hundreds of makes of radio sets. For 110-120 volts, 50-60 cycles. **Size:** 5 in. high x 4 x 3½ in. Shipping weight, 8 lbs. **List Price, $15.00.**

No. 1450—Thordarson Power Transformer. YOUR PRICE....... $3.84

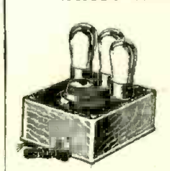
Flewelling-Dayton SW Adapter



This wonderful instrument connects to any A.C. radio set by putting into tube socket in place of the tube (which must be a type '27, or "heater" tube) the plug which is on the end of its 2-ft. cable; then put tube into tube-socket of adapter. Remove aerial from broadcast set and connect to antenna post on adapter. Special plug-in coil No. 1 covers a wavelength band of 17 to 29 meters; coil No. 2, 27-28 meters; coil No. 3, 47-84 meters. Plug-in coil inductances come with the adapter. 5½x7¼x4" high, overall. Ship. weight 4 lbs.

No. 1613 — Dayton Flewelling Short-Wave Adapter. List Price, $15.00. YOUR PRICE (without tube).... $4.93

Short-Wave Converter



Build a short wave converter at lowest price on record, but with which excellent results are obtainable nevertheless. The voltage for the three 227 tubes used may be obtained from an external filament transformer or from a secondary winding of 2½ volts in a power pack. Wavelength from 30 to 110 meters. No plug-in coils; coil switch is used to cover wave band. Single dial tuning, no grunting, no body capacity, no squeals. Leak-condenser modulation. Converter consisting of all parts (less filament transformer) including cabinet, panel, diagram and 4-page instruction sheet (less tubes).

No. 1619—YOUR PRICE $4.85

No. 1615—6-Volt Battery Model, same price.

High-Voltage Condenser Units

We guarantee these condensers unconditionally. They are ideal for general replacement purposes and can be installed in any new power-pack. All condensers are furnished with 8-inch lengths of tinned "push-back" wire.

600 VOLTS Cat. No.	Mfd. Capac.	Your Price	800 VOLTS Cat. No.	Mfd. Capac.	Your Price
1702	½	$0.25	1706	1	$0.40
1703	1	.30	1707	2	.70
1704	2	.40	1708	4	1.05
1705	4	.60			

WE ARE A WHOLESALE HOUSE AND CANNOT ACCEPT ORDERS FOR LESS THAN $3.00.

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