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Eleventh Year 565th Issue

JAN. 21
1933

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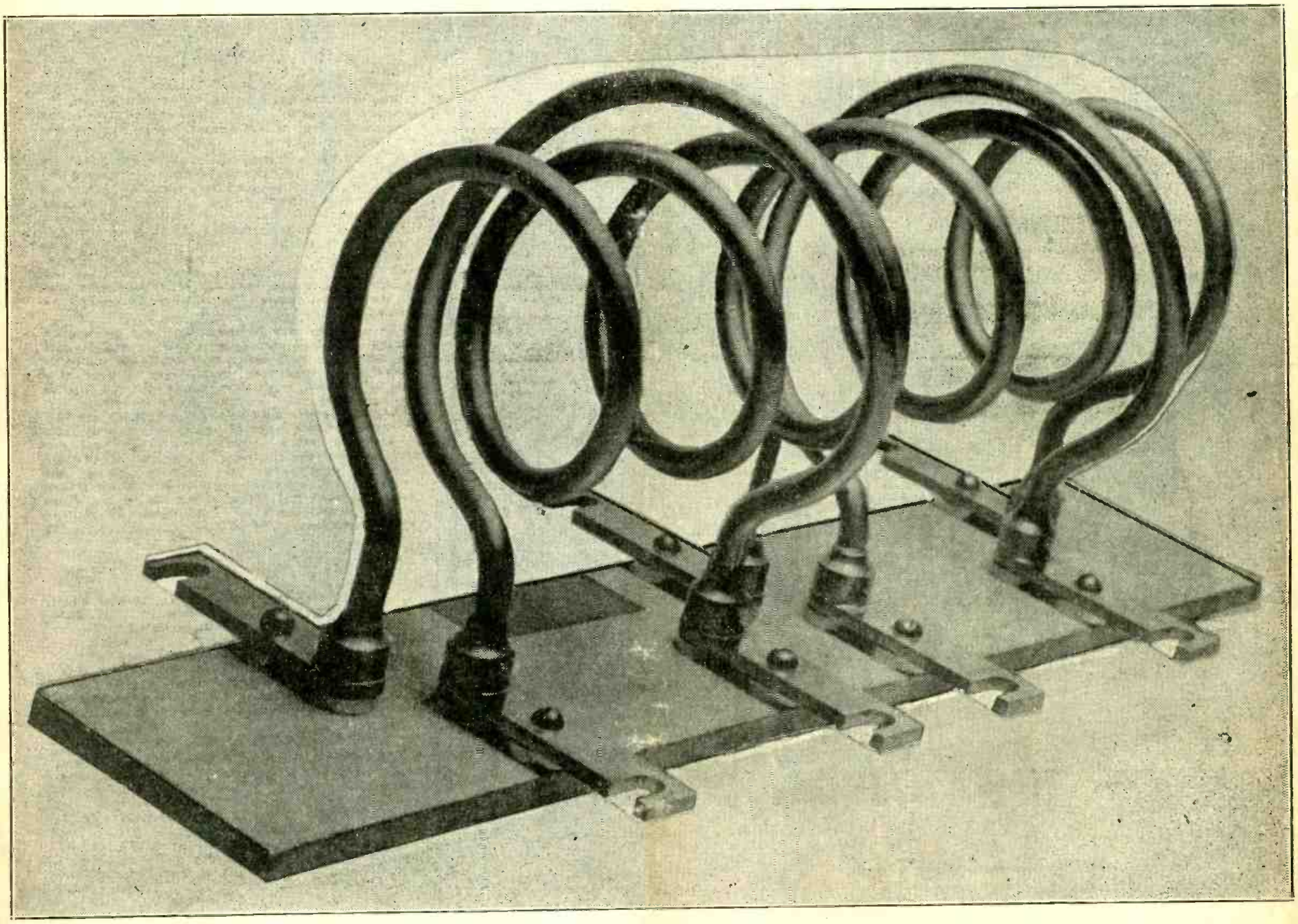
GIANT SHORT-WAVE RADIATOR



Topical Photos
The antenna coil system of the new short-wave British Empire twin transmitters at Daventry. See page 8.

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FULL-SCALE PICTURE DIAGRAM OF TWO-TUBE 15-200-METER BATTERY RECEIVER—Printed in Radio World dated April 2, 1932. This is the diagram asked for by so many readers who were interested in the short-wave receiver described in issue of Feb. 27, 1932. Both copies mailed for 30c. RADIO WORLD, 145 W. 45th St., New York City.

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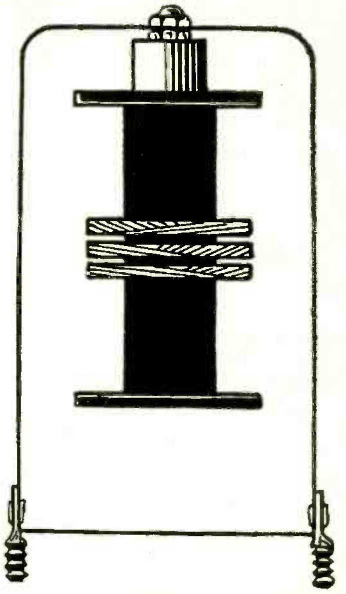

Special semi-tuned coupler, for a variety of uses. It consists of three inductively related windings in an aluminum shield, 1¾ inches diameter, 3 inches high overall, broadly resonant at the lower frequency extreme of the broadcast band. Secondary is center-tapped.

The semi-tuned transformer may be used as a so-called untuned stage of r-f feeding the detector, to make the amplification more nearly even throughout the band of radio frequencies by increasing the gain at the low frequency end. For general use the effected center tap on the secondary may be ignored.

If the duplex diode-triode is to be used in t-r-f sets, this transformer may be connected for full-wave detection with primary in preceding plate circuit, extremes of secondaries (green and green with white tracer) to anodes of the diode (55, 85), center (see below) to cathode through a resistor of 0.5 meg. This is one of the most practical ways of applying the diode to t-r-f sets, with or without automatic volume control, as the problem of a grounded rotor of a condenser and a return that cannot be directly grounded is avoided.

The coil also may be used for a-v-c pickup, by putting one choke winding in the plate circuit of the detector, with no condenser from plate to ground, but condenser from other end of this coil to ground, and thus using the pickup of the secondary to feed the a-v-c circuit.

The transformer may be used as antenna coupler.

The windings consist of special honeycomb coils of low distributed capacity, with wire not too fine for this the intended purposes. The color code: red and yellow are primary; green and blacks are one secondary; green with black tracer and black with red traced other secondary. Connect black and black with red tracer for center-tapped secondary. Cat. STC @..................75c

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J. MURRAY BARRON
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A NEW CIRCUIT OF STARTLING PROMISE!

Anderson-Bernard Invention Introduces 1,000 kc Bandspread and "Step Tuning"

By Herman Bernard

[*Never before have we published a circuit embodying entirely new ideas that offered such promise as the Anderson-Bernard circuit which is outlined as to theory and principle in the following article. To all interested in easy tuning of short waves, with broadcast band and lower frequency coverage as well, this circuit commends itself. It is theoretically sound, as well as of great importance. It is not the type of circuit that can be slapped together with any success, but requires careful workmanship. It is hoped that within two months constructional plans along lines of the authenticated circuit as constructed by the inventors will be printed in these columns. Meanwhile we offer the theory virtually complete in the present article, and promise that from week to week, prior to the constructional series, there will be further enlightening information about this amazingly novel, original and outstanding circuit that introduces* 1,000 *kc bandspread for all the ranges from* 500 *kc up.*—EDITOR.]

ON January 3d, 1933, shortly before noon, J. E. Anderson and I devised a method of band-spread tuning that introduces a new feature in receiver design. The principal idea worked out is to tune the intermediate frequency when the receiver is used as a superheterodyne and for lower frequencies use the otherwise intermediate channel as a tuned radio frequency set. Thus the receiver in the form shown in the diagram would be a combination of both, although by different frequency selections could be a superheterodyne in its entirety.

Since the new idea applies to the radio frequency levels—signal, oscillator and intermediate—the circuit will be discussed in respect to them.

T-R-F for Low Frequencies

Let us progress from lower to higher signal frequencies. We may switch the antenna to the input to the first intermediate tube, and then use the intermediate amplifier to tune in from 450 to 150 kc directly, and by switching to tune in from 500 to 1,500 kc directly. The particular switching method used is one that puts a condenser of 0.1 mfd. across a honeycomb coil of 2 millihenries inductance, to serve as filter circuits when one is tuning in the broadcast band, whereas when the bypass condensers are switched out of circuit the inductances of the chokes and the broadcast windings add up, to afford the lowest frequency band.

Thus we account for 150 to 450 kc and 500 to 1500 kc in the t-r-f manner, the low frequency band being particularly useful for the purposes of Europeans, who, by the way, do not require response from 450 to 500 kc, so this missout is all right.

Super for Higher Frequencies

Now we come to the first short-wave band. The switch at the intermediate level is set for 500 to 1,500 kc, so we shall tune the intermediate through a frequency spread of 1,000 kc. This will be true at all times hereafter.

The switching arrangement in the mixer coil system, with which the modulator and oscillator (left upper and lower tubes in diagram) are associated, picks up the antenna to feed the modulator input, the coils for the modulator and oscillator as well as the small capacity tuning condensers (0.00014 mfd.).

Now we must remember that the intermediate frequency will not be the same at all times. Also we must bear in mind that the modulator input is orthodox, without benefit of band spread. Let us therefore determine the frequencies of the circuits.

We desire to start at 1,500 kc, and this concerns only the modulator. The condenser tuning will give us a frequency ratio of 2.2-to-1, therefore with proper coil selected for the modulator we would tune from 1,500 to 3,300 kc. This would be true despite oscillator or intermediate frequencies, as the modulator tuning is on the basis of the carrier frequency alone.

Frequency Selection

We have to select some intermediate frequency, and are limited in our choice to 500 to 1,500 kc. As the intermediate frequency is lowered the difference between oscillator and signal frequencies becomes less, so we must start at or near the highest frequency setting of the intermediate, in order that when we tune the intermediate it will result in response to higher frequencies. So we select 1,500 kc as the intermediate frequency of the moment.

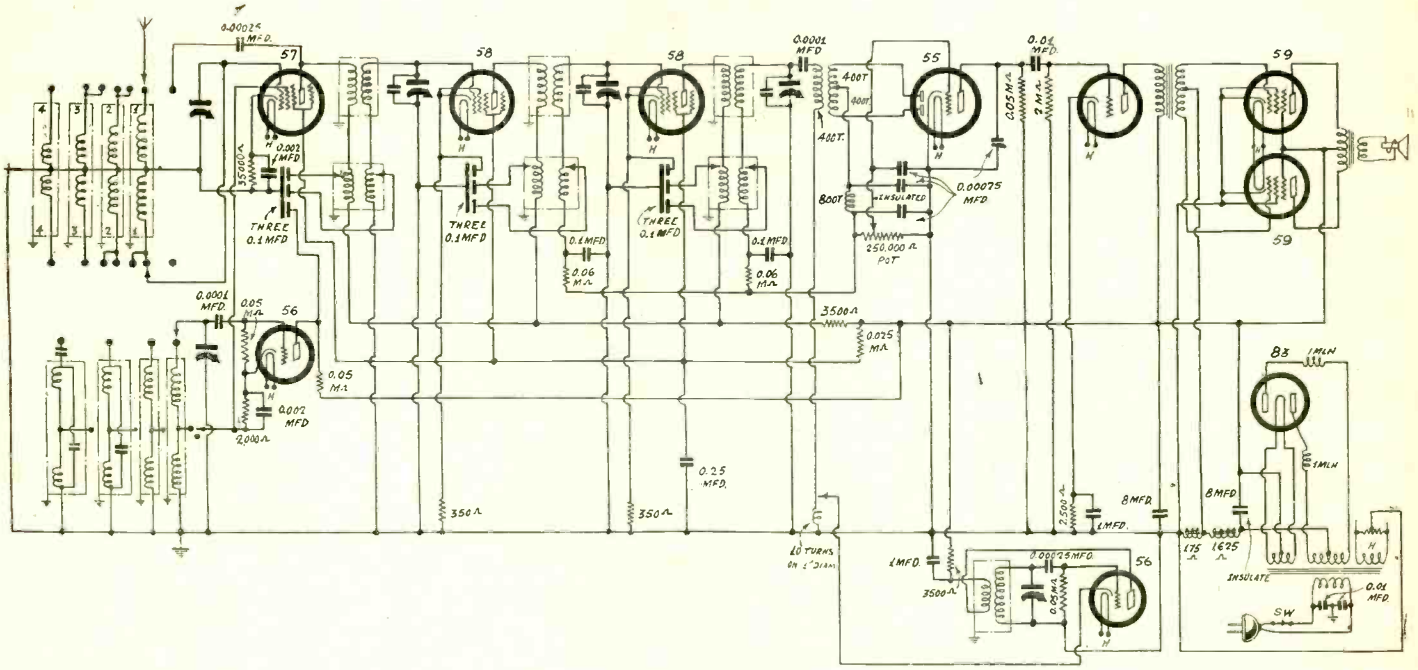
Our next step is to select the oscillator frequency necessary to produce this intermediate frequency when the signal and oscillator frequencies are mixed. The beat should be 1,500 kc. We shall select the higher frequency for the oscillator. Then the desired oscillator frequency will be the sum of the two, or 1,500 plus 1,500 kc.

So we design an oscillator coil that with 0.00014 mfd. will tune to 3,000 kc as the lowest frequency.

Now, to keep pace with the different signal frequencies to be tuned in we have to adjust the modulator tuning condenser in the usual fashion, no band-spreading being used, but none is actually needed, as this circuit is a rough tuner for all strong signals, and is not even critical on weak signals, except at the very high-

(*Continued on next page*)

Step Tuning Introduced As Bandspread Adjunct



(Continued from preceding page)

est frequency band. So we do not need to worry about this circuit, particularly as at minimum capacity of its tuning condenser we could always hear strong signals well, without benefit of tuning. We include tuning in this circuit to improve the selectivity when such improvement is needed and also to get rid of image interference, that is, prevent two stations from being heard at a given setting of the oscillator for any single intermediate frequency.

Tuning Operation

Now we have set the oscillator at 3,000 kc. The signal frequency we start with is 1,500 kc, and by tuning the intermediate through its band, and keeping pace with the modulator tuning, we cover a span of 1,000 kc. It is always 1,000 kc, remember, or the difference between the extremes of the intermediate amplifier.

So the tuning operation would be like this: (1) the modulator is set to each of the signal frequencies desired to be received, from 1,500 to 2,500 kc; (2) the oscillator is set at 3,000 kc and left there; (3) the intermediate channel is tuned through 1,000 kc, which is to the same effect as would be tuning the oscillator continuously to frequencies 1,000 kc higher, if the i-f remained at 1,500 kc.

Thus have we finished completely with a band of 1,000 kc, and have had the dual benefit of fixed oscillator frequency for this purpose, and variable frequencies only for modulator and intermediate.

1,000 kc Steps for Oscillator

The next step requires that the oscillator be set at 4,000 kc, since the intermediate frequency has caused the effect of all our tuning to be in 1,000-kc bandspreads. Or, to put it differently, since we shall start again with 1,500 kc intermediate, and the signal frequency will be 2,500 kc, the oscillator frequency will have to be the sum of the two, which is 4,000 kc.

Therefore, the oscillator is set at 4,000 kc, the r-f tuning is done from 2,500 to 3,500 kc, and the intermediate is tuned from 1,500 to 500 kc.

Due to the frequency range of the intermediate we have to proceed with the oscillator in steps of 1,000 kc. As we know the oscillator's tuning range to be from 3,000 to 6,600 kc, we know that with a given coil, unchanged in the oscillator, we can account for oscillator frequency steps of 3,000, 4,000, 5,000 and 6,000 kc. Hence there are four steps in the first short-wave band (lowest frequency).

The oscillator extremes actually used are 3000 and 6,000 kc, so the excess of 600 kc may be devoted to overlap. The r-f level (modulator) must be lower by the amount of the intermediate frequency. Since the oscillator frequencies are higher, the tuning range (carrier frequencies) will be exhausted before the oscillator's range is expended. Thus, the oscillator, on its first coil, will tune from 3,000 to 6,600 kc, while the highest frequency for the r-f level will be 6,000 minus 500, or 5,500 kc, requiring use of the second r-f coil before the second oscillator coil is used.

Oscillator and Modulator Tabulation

We found that the first r-f coil would tune from 1,500 to 3,300 kc, so the second r-f coil will tune, on the same frequency ratio basis, from 3,200 to 7,040 kc. Thus the second r-f coil is used from 3,200 to 5,500 kc for the rest of the step tuning on the oscillator's first coil. As the frequencies increase, however, this disparity will become less and less.

Taking the coils, therefore, to account for the first range of the oscillator, and the equivalent r-f frequency kilocycles, we have:

R-F Level (Modulator Input)	*Coil No.*	*Oscillator Step and kc.*		*Coil No.*
1,500-2,500	1	(1)	3,000	1
2,500-3,500	1 & 2	(2)	4,000	1
3,500-4,500	2	(3)	5,000	1
4,500-5,500	2	(4)	6,000	1

Now, for the next range of the oscillator, with modulator counterpart:

5,500- 6,500	2	(1)	7,000	2
6,500- 7,500	2 & 3	(2)	8,000	2
7,500- 8,500	3	(3)	9,000	2
8,500- 9,500	3	(4)	10,000	2
9,500-10,500	3	(5)	11,000	2
10,500-11,500	3	(6)	12,000	2
11,500-12,500	3	(7)	13,000	2
12,500-13,500	3	(8)	14,000	2

Good Distribution

From the foregoing it is apparent that the number of steps on the oscillator in-

Coil Data for the Anderson-Bernard Step-Tuned Circuit

Four coils are needed for each of the two circuits in the mixer, that is, a total of eight coils for modulator and oscillator.

The following tabulation gives the inductance, winding data on 1 inch diameter, and frequency ranges of the tuning for all the coils. It should be noted that the oscillator is padded for the two smallest coils, in one instance in parallel fashion, in the other in series-parallel fashion. See the diagram. The tuning condenser originally is 0.00014 mfd. in each instance.

MODULATOR COILS:

Coil No.	*Micro-henries*	*Frequencies*	*Winding Data, 1 in. Diam.*
1	80	1,500- 3,300	66 turns No. 28 enam.
2	18	3,200- 7,040	24 turns No. 28 enam.
3	4	7,000-15,400	13 turns No. 18 enam.
4	0.8	15,000-33,000	4.6 turns No. 18 enam.

OSCILLATOR COILS

1	20	3,000- 6,600	26 turns No. 28 enam.
2	4+	6,600-14,500	14 turns No. 18 enam.
3	0.9	14,500-25,000	5 turns No. 18 enam.
4	0.3	25,000-36,000	2.4 turns No. 18 enam.

The foregoing data do not account for modulator primary or for oscillator tap location, but the primary may be one-quarter the number of secondary turns, and the tap at one-quarter the number of turns from the ground end for the first two oscillator coils and at center for the higher frequency coils.

The Intermediate Frequency Varied in New Circuit

creases with frequency. There are four steps in the first instance, twice as many in the second. While we have used the full ratio as afforded by the tuning condenser in both instances (modulator and oscillator) and shall continue to use the full ratio for the r-f level to the end, for the oscillator we shall cut down the ratio by padding, so that the number of steps henceforth will be fewer than otherwise. This aids in finding the right "steps." The total number of steps would be 34. apportioned as follows: first coil, 4; second coil, 8; third coil, 11; fourth coil, 11. Considering the frequency differences, this is a fairly even distribution.

The tabulation for the remaining pair of coils for the modulator and oscillator need not be given, as the same principle applies. and it can be seen from the diagram that the third stage padding is parallel and the fourth stage series-parallel.

Double Superheterodyne

The circuit is shown merely to illustrate the system. Of course, the practical application may be somewhat different, but the fundamental principle would be retained. It has been stated that the variably tuned intermediate level. which constitutes the r-f system totally for broadcasts, is really a t-r-f set in itself, but there is no reason why the t-r-f section should not itself be the front end of a superheterodyne. Then there would be a constant intermediate frequency, of low value, as well as the variable intermediate frequency in the broadcast range corresponding to the t-r-f part of the integral superheterodyne.

How this system would work out as a super "inside" is not known, but from experience one is led to believe that there might be some trouble due to feedback, and also due to that particular form of coupling which results in one oscillator beating with another. There would be a high frequency oscillator, a broadcast frequency oscillator (using the term broadcast in its approximate sense) and an auxiliary beat oscillator at the low intermediate level. From known troubles with superheterodynes where there was only one oscillator, it can be surmised that, while not impossible, it is still an engineering feat to develop a three-oscillator superheterodyne that is relatively free from trouble. It is the kind of a job that only an inspired, resourceful and persistent soul would enjoy tackling.

Principally Anderson's Idea

On the next page will be found an article by Mr. Anderson in which he states the general theory of the circuit in his own way. and all interested in the new circuit should read what he has to say, because he is the principal contributor to the idea (by far) and also is an outstanding authority on the superheterodyne.

He states that the dials may be calibrated so that, with the signal level calibration standard, the responsive frequency of the superhetrodyne portion of the circuit may be obtained by substracting the intermediate frequency from the oscillator frequency. Of course, there would be three dials, each calibrated, but it has been pointed out that separate manual control of the circuits is essential.

There are various uses for the general system beyond those that have been discussed so far in the present article or those included in Mr. Anderson's brief summary. For instance, suppose one desired to build a television receiver to bring in a single station. The circuit could be so arranged that the frequency span of the variably tuned intermediate amplifier would be 200 or 250 kc or any other span in about that desired region. Thus when a curve is run one would determine how wide a channel is being passed. Virtually the one station should be tuned in over the total span of the dial, an example Mr. Anderson illustrates too, in another connection.

As a Bandspread Broadcast Set

Also the system is applicable strictly to broadcast frequencies, whereupon the spreadout will be much greater. Suppose that it is desired to divide the broadcast band into four parts. Assume 500 to 1500 kc. Then there would be 250 kc for each full spread of the dial, and as wide a separation obtained physically on the dial as any one could desire. If, besides, a large dial were used, there would be no mechanical tuning difficulty even between 1,450 and 1,500 kc, where there is crowding on all receivers, no matter what type of condenser or dial is used.

What benefit the extreme case of a straight frequency line condenser bestows on the high frequency end is taken away (although justifiably) from the low frequency end. So, persons who complain about too much crowding of stations at the high frequency end are the same ones who object to the closeness together of the stations at the low frequency end when the straight frequency line type of condenser is used, and moreover allege that the set is less selective at the high frequency end now (due to greater separation between stations on the set as to dial positions, which has nothing to do with the ratio of the reactance to the radio frequency resistance of the circuit which is the sole selectivity determinant).

No doubt many experimenters feel perfectly competent to try out a system based on the present revelations, and they are encouraged to do so because of the certain practicability of the system on the basis of the diagram, although no doubt there will be "bugs" to iron out. Not much constructional information can be given at present.

However, there is one element of information that every one who desires to try out the system would welcome, and that has to do with winding the coils for the mixer. Since the intermediate channel is at broadcast frequencies, and since the low frequency spectrum is of no particular interest in the United States, an existing t-r-f set may be used for the intermediate, audio and power portion, and the mixer built to suit this condition.

Therefore the coil data are given, and readers are encouraged to try this circuit, for they will find it does perform. Those interested in how the designers and inventors of the circuit built it up will have to follow RADIO WORLD week by week until the series of articles dealing with the subject constructionally is printed. There will have to be considerable waiting, due to the production of calibrated dials.

Step Tuning Now Introduced for First Time Ever

The Anderson-Bernard circuit discussed herewith is of extreme importance and value, and may some day prove to be the ruling circuit for short waves. particularly for ultra frequencies, as it introduces a most sensible method of bandspread tuning.

Certain precautions are necessary. One of them is that the intermediate amplifier must not pick up broadcast stations directly, when the circuit is used as a superheterodyne. This means the circuit must be fully shielded, and that in some instances, to avoid pickup by leads, these leads must consist of shielded wire of which the shield sheath is grounded. Moreover, adequate filtration of the broadcast frequencies must be maintained to preserve the independent functioning of tube circuits and prevent feedback that produces oscillation.

Extremely novel indeed is the step tuning of the oscillator. As outlined by Mr. Bernard, this consists of setting the oscillator at given points, instead of tuning it continuously, since the tuning of the intermediate channel is the equivalent of variably tuning an oscillator that works in conjunction with a fixed intermediate level. So far as known, step tuning has never before been introduced. And, of course, it is a feature associated with the band spread method as devised by these two engineers.

It is impossible to gang the short-wave condensers, so each of them is separate, although the intermediate tuning condensers are ganged in the usual manner of broadcast t-r-f sets.

The oscillator at lower part of the diagram is for c-w reception, and for general purposes will not be needed. If it is independently controlled, and oscillates at 150 to 50 kc, so it may be used for both the broadcast and low frequency (150-450) t-r-f purposes, in the first instance on the tenth harmonics and in the second on the third harmonics.—EDITOR.

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234	2.80	864	2.10
235	1.65	865	15.00
236	2.80	866	6.75
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OSCILLATORS

Fully Discussed and Compared in Next Week's Issue. The Latest Improvements Explained

Only recently has the profession got seriously to work to study oscillators and solve the special problems associated with them, including frequency stability, oscillation at peak wave crest and constant plate impedance. In next week's issue, January 28th, J. E. Anderson will review the subject with his usual thoroughness.

THE NEW SPANNER

Unique Calibration Plan Outlined

By J. E. Anderson

SHORT-WAVE receivers and converters often fail to bring in many stations because of the difficulty of accurately tuning the circuits. The frequency of resonance changes so rapidly with changes in the capacity of the condenser that it is next to impossible to stop on the peak of a carrier. This is especially true of the tuners that cover the higher frequency ranges. Many stations that are relatively weak are passed over without any suspicion of their presence although they would be strong enough could the tuning be done accurately.

Amateurs have met with this difficulty and have solved it with the so-called band-spanning tuner. In this a fixed condenser is put in parallel with a small variable, and the variable is so related to the fixed that the particular amateur band covered by the tuner is spread out over the entire dial of the small variable condenser. By this method it is possible to separate stations as close as 1,000 cycles apart in the 7,500 kc band.

The band-spanning effect can be obtained for all bands by a relatively simple device—simple in theory, though it may be somewhat complicated in practice—when the receiver is of the superheterodyne type, and that includes the converter. Suppose the intermediate tuner is adjustable continuously like the tuner of a broadcast set. If the oscillator in the superheterodyne remains at a fixed frequency and if the intermediate and radio frequency tuners be varied, a certain range of frequencies will be receivable, this range being determined by the range of the intermediate frequency tuner. Even if the radio frequency tuner is not adjusted. the band can be tuned in after a fashion by adjusting the intermediate frequency tuner only, provided that the radio frequency tuner is not too selective.

How It Works

Let us assume that the intermediate frequency tuner covers the band from 500 to 1,500 kc, which is nearly the same as the broadcast band. Let the high frequency oscillator be set at 3,000 kc. When the intermediate tuner is set at 1,500 kc, a signal frequency of 1,500 kc will be brought in, and when the intermediate tuner is set at 500 kc, a signal frequency of 2,500 kc will be brought in. Signal frequencies between 1,500 and 2,500 kc will be brought in at other settings of the intermediate tuner, that is, at settings between 500 and 1,500 kc. The band between 1,500 and 2,500 kc will be spread out over the entire dial of the intermediate tuner. There will be no more crowding of signals in this band than there would be in the broadcast band.

Now suppose we raise the oscillator frequency to 4,000 kc. Then when the intermediate tuner is set at 1,500 kc, a signal frequency of 2,500 kc will be brought in, and when the intermediate tuner is set at 500 kc, a signal frequency of 3,500 kc will be brought in. Thus the band between 2,500 and 3,500 kc will be brought in over the entire scale of the intermediate tuner.

Changing Oscillator Frequency

The same idea may be carried on to as high frequencies as we wish, and no matter how high we go the band 1,000 cycles wide will be spread out over the entire scale of the intermediate frequency tuner. Thus we have a band-spanning device that applies to all signal frequencies.

The oscillator frequency may be changed in steps either by changing the inductance or by changing the capacity, or both. The inductance may be changed by means of a switch and the capacity by moving the condenser dial in definite and predetermined steps. Or, if it is not desired to change the oscillator frequency by the full 1,000 kc, it may be changed by any smaller or greater amount.

Of course, if we wish to have a greater spread we can narrow the range of the intermediate frequency tuner, employing in effect the same scheme as that used by the amateurs. Thus we could, if necessary, make the intermediate tuner cover only 100 kc from one end of the dial to the other. Then we would have to have ten times as many steps on the higher frequency oscillator to cover the entire short-wave band continuously. Such spreading is hardly necessary for a general receiver. The 1,000 kc band should be sufficient.

The reason for using a 1,000 kc band is one of convenience. The oscillator frequency is stepped up 1,000 kc at a time, and the radio frequency band is also stepped up by the same amount for each change of frequency.

It is possible to calibrate the receiver quite simply by this means. Suppose we mark off the dial of the oscillator in integral multiples of one megacycle, starting with 3,000 kc, and also that we calibrate the intermediate frequency dial in kilocycles. Then if we set the oscillator dial on any division and set the intermediate tuner on any given value, the radio frequency signal to which the circuit is tuned is the difference between the oscillator setting and the setting of the intermediate. For example, let us set the oscillator on a division indicating 5,000 kc and the intermediate on a division pointing to 750 kc. The circuit is then tuned to 4,250 kc. This applies only to the oscillator and the intermediate, of course. If we have a radio frequency tuner. that too may be calibrated, and it should be set on 4,250 kc.

Accuracy Required

The setting of the oscillator on the even megacycles and the intermediate tuner on the kilocycles accurately enough to give the frequency to which the circuit is to be tuned will offer little difficulty for the lower radio frequencies, say below 10,000 kc. But for higher frequencies extreme accuracy will be required or the calibration will only give approximate results. Suppose, for example, that we can set the high frequency oscillator to an accuracy of one per cent. at 30,000 kc. This means that we can set it within 300 kc. But the intermediate covers only 1,000 kc. Hence the settings on the intermediate dial will not mean a great deal. being, perhaps, 33 per cent. off. If the high frequency oscillator is not of very high stability it may not be possible to set it within 5 per cent., which would throw the signal off the intermediate dial. However, if we make an oscillator of high frequency stability and if we use a large carefully divided dial for it, we may be able to set it to within 0.1 of one per cent. That, naturally, would enable us to set the circuit much more accurately. If the calibration of the circuit is to be more than a rough guide. a 0.1 per cent. accuracy would be necessary, at least on frequencies higher than 10,000 kc.

Lack of possible accuracy in the setting of the oscillator does not vitiate the band-spanning effect of the intermediate tuner. It merely vitiates the value of the calibration.

The calibration of the oscillator in steps of one megacycle is comparatively simple. The government is sending out a highly accurate frequency of 5 megacycles that can be received, with a suitably sensitive receiver, in any part of the country. If a 1,000 kc oscillator is set up and adjusted to zero beat with this standard, the harmonics of this oscillator will give all the integral megacycles needed.

Overlap of Ranges

If we tune the oscillator steps to integral megacycles and the intermediate tuner covers just 1,000 cycles, there will be no overlap of adjacent ranges; and if the setting of the oscillator is not just right, the tuner will not quite cover all the stations without resetting the high frequency oscillator. The simplest way to overcome this difficulty is to make the intermediate tuner cover a little more than 1,000 kc.

It will be noticed that the higher frequencies in each oscillator step will be tuned in on the lower frequency settings of the intermediate tuner. This is an advantage in that it spreads out the higher frequency stations more than the lower.

The mathematical expression of the relations among the frequencies involved in this scheme is simple. Let F be the signal frequency desired, Fo the oscillator frequency, and f the intermediate frequency. Then $F = Fo - f$ is the simple relation. In any oscillator step f is varied, and since Fo is fixed, F is also varied. The range of variation of f may be, as suggested, from 500 to 1,500 kc. F then varies from Fo — 500 to Fo — 1,500. To tune in radio frequencies in ascending magnitude we start the intermediate tuner at 1,500 and go toward 500 kc. As soon as we have reached 500 we increase Fo by 1,000 kc and again start tuning the intermediate amplifier from 1,500 to 500 kc. Fo is again increased by 1,000 kc and the process repeated.

If the oscillator steps are exact multiples of 1,000 kc the equation may be written $F = 1{,}000n - f$, in which n is any integer from 3 up.

For C-W Reception

When continuous wave code signals are to be received an additional oscillator is necessary in the intermediate frequency level. Since this frequency is variable the oscillato rfrequency must also be variable, for its frequency should always be about 1,000 cycles higher or lower than the intermediate frequency used at any time. It would be quite feasible to gang the condenser of this oscillator with the condensers in the i-f tuner. Lack of perfect tracking would not be serious for a detuning of 1,000 cycles or less is of little importance.

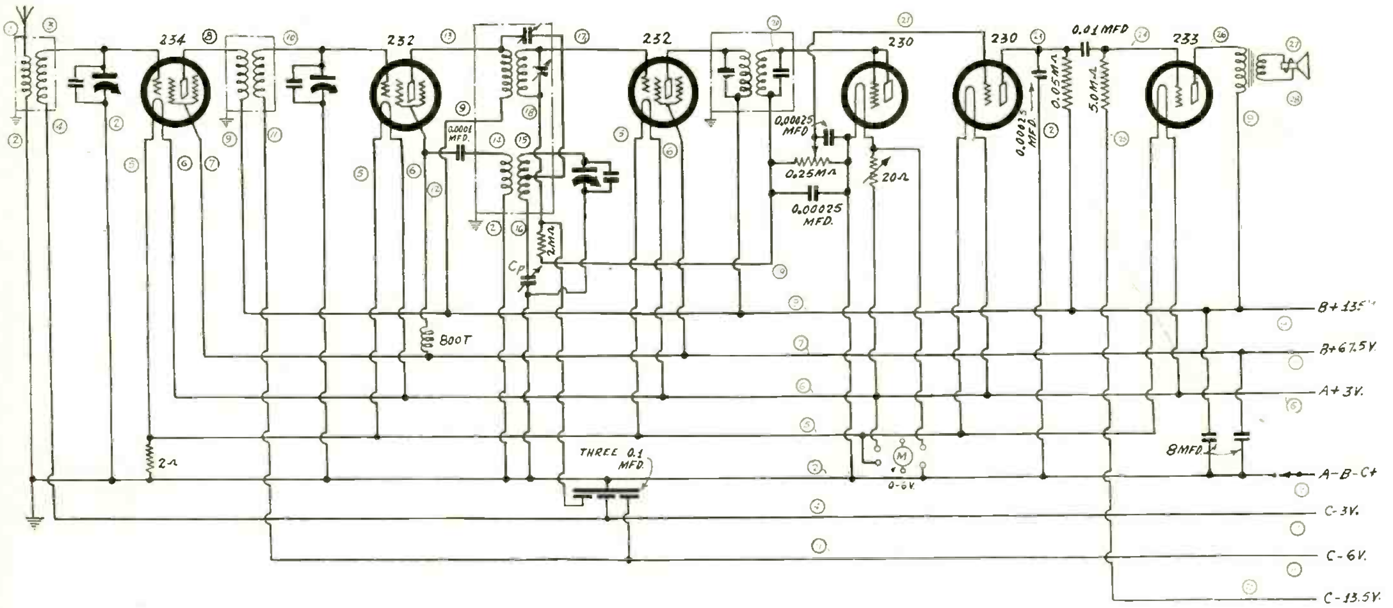
If the band-spreading idea is applied to a broadcast superheterodyne the auxiliary oscillator could be in the low fixed i-f level, and tuning it would be unnecessary.

COSMIC IMPORTS INCREASE

Cosmic Products Corporation, through its New York offices, 135-137 Liberty Street, reports great increase in the export business. It recently shipped to Australia one of the largest complete shipments of condensers ever sent there. The corporation has local offices in most of the larger cities of the Far East and invite correspondence from those interested in cartridge, by-pass and filter condensers.

SUPER DIAMOND in Battery-Operated Form

By Adam Rawley



NOT MANY battery-operated receivers are being described these days, mainly because by far the greatest market for sets is in districts where alternating current is available. Yet there are large areas in this country and in Canada where no electric power is available. Those who live in such districts are entitled to radio service, for they, too, help to pay the radio bill.

Most of those in non-electrified districts are so far removed from any broadcasting stations that they must depend on long-distance reception. Hence they need sensitive receivers. They live in places where battery replacements are not easy. Hence they need receivers economical in operation. The distances to the nearest broadcasting stations may be such that they live in the fading zone. Hence they need receivers provided with automatic volume control.

The most economical sets are those built with the two-volt tubes. Hence the receivers should be of this kind. The most sensitive receivers are the superheterodynes, and most sets for non-electrified districts should be of this type. The latest radio wrinkles should be incorporated in the receivers, in so far as they are applicable to battery-operated sets. One of these is diode detection. Yes, diode detection is feasible in battery-operated sets even though we have no duplex diode-triode tubes of this kind.

Tubes Used

In Fig. 1 is a six-tube battery-operated receiver of the superheterodyne type employing the two-volt tubes. It is the equivalent of the a-c Super Diamond changed to battery operation. At first we have a 234 super-control radio frequency amplifier. Then we have a 232 combined detector and oscillator. This is followed by another 234 used as intermediate frequency amplifier. Then we come to a 230 used as a diode detector, the plate and the grid being tied together to form the anode. Another 230 is used as an audio frequency amplifier in a resistance coupled circuit. Finally there is a 233 power pentode.

The radio and intermediate frequency tuners are typical of the corresponding parts of a-c midget sets. There are two radio frequency tuners, an oscillator tuner, and there are two doubly-tuned intermediate frequency circuits.

The diode detector is also typical. The filament is used for cathode, since there is no other in a filamentary tube, and the plate and the grid are tied together and used for anode, just as the two anodes in a 55, for example, are tied together when half-wave rectification is used. The load resistance, which is a 250,000 ohm potentiometer, is connected between the low side of the tuned circuit and the negative end of the filament, which is also the ground. The usual bypass condensers are used, a small condenser of 250 mmfd. across the entire load resistance and another of the same value from the slider to ground.

Since there is no triode amplifier in the 230 it becomes necessary to use the second 230 tube to amplify the detected signals before they are applied to the power tube. This 230 amplifier is diode biased. Due to this fact there is a definite limitation in the strength of the signals that can be applied, for as the signal increases in strength the bias increases and the cut-off point is approached. A somewhat similar limitation would exist if the tube had a fixed bias. The limitation, however, does not mean that strong signals cannot be received clearly, for the gain in the 233 power tube is so great that that tube would become overloaded before the 230 amplifier.

Automatic Volume Control

The entire voltage developed in the load resistance of the diode is utilized for automatic volume control. However, it is applied only to the intermediate frequency amplifier. If desired, it could also be applied to the radio frequency amplifier, the first tube in the circuit. As the drawing now is, the grid return of that tube goes to a fixed bias of three volts. All that is necessary is to put a 0.25 megohm resistor in the lead now going to the three-volt tap on the grid battery and connect free end of the resistor to the grid return of the intermediate tube. This would help to prevent overloading of the first tube and also the first detector on very strong signals. Of course, in most cases where this receiver will be used there will not be many strong signals.

The detector-oscillator is somewhat unusual, necessarily so because the tube does not have an independent cathode. There is a choke in the screen lead and the winding that would ordinarily be connected in the cathode lead is connected to the screen through a fixed condenser.

The two-volt tubes are rather critical with respect to filament voltage. Regardless of what the supply voltage may be the circuit should always be adjusted so that the voltage across the filaments is 2 volts. There is a special rheostat for the diode tube, one of 20 ohms, for adjusting the voltage across the filament of that tube. The other tubes are placed on a separate rheostat of two ohms or more.

As a help in making the adjustments a 0-6 voltmeter is provided. Terminals are also arranged so that any of the filament voltages may be measured and also so that the supply voltage may be obtained.

The Speaker

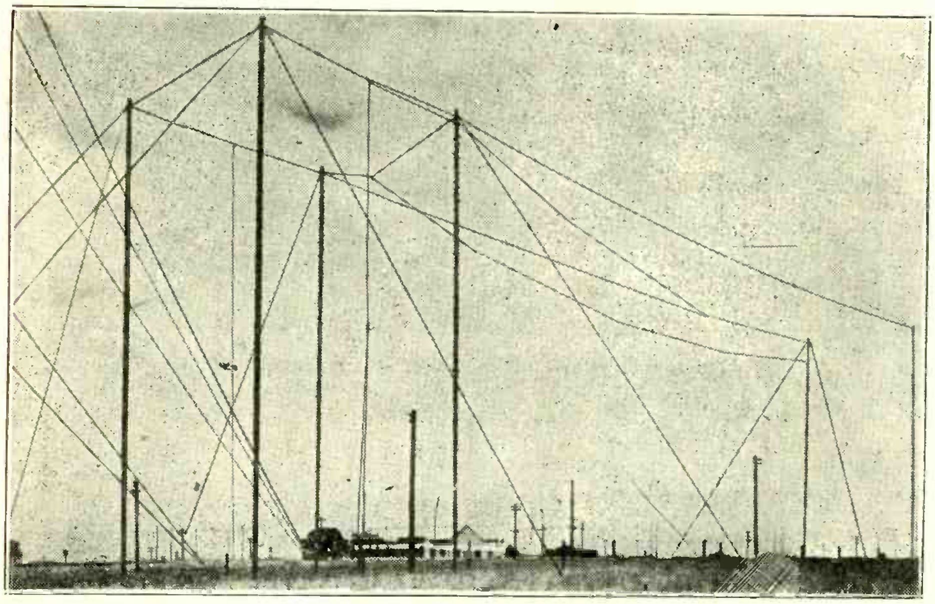
What speaker to use on a battery-operated set has always been a problem, especially since magnetic speakers went out of general circulation. However, it is no longer a problem, for now we have permanent field dynamic speakers especially designed for the 233 tube. Naturally, such a speaker should be selected.

The circuit requires a plate battery of 135 volts, a filament battery of 3 volts, and a grid battery of 13.5 volts. The plate battery can be made up of three 45-volt units of the medium or large sizes. The filament battery may be made up of No. 6 dry cells connected in series-parallel. Two such cells must always be in series, giving 3 volts. The number connected in parallel depends somewhat on the use of the set. If it is only used occasionally it is best not to use more than two in parallel, or at most three, for if more were used most of the energy stored in them would be wasted "on the shelf." However, if the set is to be used continuously for hours every day it would be economical to use more of them, say four or five in parallel.

DIRECTIONAL AERIALS

Used at British Empire Transmitter

By Edgar Thuring Wellesley



Topical Press

The new Empire transmitter at Daventry, England, designed to reach the entire British Empire by short waves, uses directional antennas. The West African aerial array is shown. The transmission plant is in background.

DIRECTIONAL antennas are of many different types. The simplest, and perhaps the first to be recognized as having directional properties, is the inverted L antenna. Its directional proportions are not very pronounced, but it receives better from, or transmits better in, the direction opposite that in which the horizontal part points.

The next direction antenna is the loop. Its plane of greatest effectiveness is that of the loop itself, and its plane of least, or zero, effectiveness is the plane at right angles to the plane of the loop.

Another directional antenna is that composed of a loop and a vertical wire. The plane of greatest as well as least effectiveness is the plane of the loop. It is least in one direction and maximum in the opposite. If the effective pickups of the loop and the vertical wire are made equal, the maximum effectiveness is equal to twice the effect of either and the least is equal to the difference, which in this special case is zero. This type of antenna has been used for receiving a distant station in the very shadow of a strong broadcast station antenna, the blind spot being pointed to that antenna and the opposite "pole" toward the station to be received.

Recent Forms

The above three directional antennas are about as old as radio itself, for they were used in the very earliest day of the art.

Comparatively recently other forms of directional antennas have been developed. One is the beam antenna. In the simplest form this takes the form of a parabolic cylinder. That is, vertical wires are erected in the form of a parabola and the actual transmitting antenna is placed at the focus, and this antenna is also vertical, of course.

When the waves transmitted or received are very short, the antenna takes the form of a paraboloid, exemplified by the automobile headlight or by the searchlight. Of course, the dimensions involved are vastly different, for the antenna dimensions must be comparable with the wavelength transmitted or received.

The New "Arrays"

The latest directional antennas are the so-called antenna arrays, and these are of various degrees of complexity and design. Ordinarily they cover a great deal of ground and they may be linear as far as their projection on the ground is concerned. The general idea is to prevent the transmission in one direction, or reception from that direction, by reflecting the waves in the direction they are to go when they try to go in some other direction, but this reflection must be done in the proper phase. The problem of getting the sharpest beam in a given direction with the greatest possible efficiency is a complex one, but that it has been solved is attested by the success achieved with the directional antenna arrays erected in many parts of the world. It is evident that even before any of the arrays had been tried commercially to any extent the authorities had great faith in the solutions or the complex and the expensive structures would not have been built.

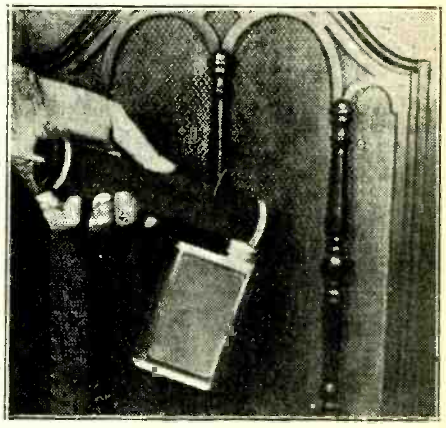
The new British Empire twin stations at Daventry, England, for sending entertainment to the vast domain of the Empire, uses directional aerials. As can be seen from the photograph, just one directional system is extensive. As transmissions are in eight different directions, the South African antenna plot is only one-fifth the total. The twin stations send short waves, replacing 5GSW.

A THOUGHT FOR THE WEEK

"So-o-o-ooo-ooo-U. S. N. A." was the address on the envelope that had been dropped in a letter box. Uncle Sam knew, and—as you have already suspected—it was delivered to none other than Ed Wynn.

O Radio, thou fame builder!

TIGHTENS CLOTH



Put water instead of you-know-what into the sprayer and thus dampen a distended and folding grille cloth. When dry, presto! 'Tis tight again. Reason: shrinkage.

TRADIOGRAMS

By J. Murray Barron

Harvey's Radio Store, 103 West Forty-third Street, New York City, is exceptionally well located for the mid-town shoppers and is now specializing on the bargain counters for the repair man, set builder and set owner. Here are to be found radio parts and accessories of large variety. Harvey Sampson, sole proprietor, extends a cordial invitation to all to drop in and look the place over.

* * *

R. C. A. Institutes, 75 Varick Street, New York City, will send without obligation full information on the new general course in Radio, which is given at the New York resident school only. There is also an illustrated catalog about specialized resident school courses in radio and allied science, and a catalog about extension courses for study at home.

* * *

Radio experimenters and those who intend to enter the radio industry in any capacity should equip themselves with a thorough knowledge of the subject. There are many who can not attend schools in person, at least not now. To these an extension course should make a strong appeal, for the technical knowledge may be acquired as they do their experimenting or during their work, if they be employed in the radio industry. To others who have an eye for the future and wish to equip themselves for the many positions that are sure to come about when business adjusts itself, no time could be more fitting than now when there is so much leisure and readjustments in the costs of worthy educational courses. Those who can attend a resident school will find the R. C. A. Institute on Varick Street well fitted to give proper instruction and turn out fully qualified men.

THREE NEW TUBES

25-Z-5 a Voltage-Doubling Rectifier; 43 for d-c, 42 for cars, both power valves

A NEW tube is about to be announced, embodying the established principle of voltage-doubling, although this will be the first tube to be offered for broadcast use that makes use of this principle. The tube will be a rectifier and is expected to carry the designation 25-Z-5. It will be in an envelope like that enclosing the 55, except without a grip cap. The base will be of the six-pin type.

This will be "no-transformer" type of rectifier, in that no transformer will be needed to supply the plate voltage. However, there will be two independent cathodes of the indirectly heated class, and these will require 25 volts a-c.

While no official information has yet been given about this most interesting prospective tube, the data herewith supplied are close to what the final characteristics will be, and the suggestions for use are consistent with what will be the official recommendation.

Half- or Full-Wave

The tube may be used either as a full-wave or a half-wave rectifier, for supplying d-c power from an a-c source to a broadcast receiver, power amplifier or other similar circuit.

As a full-wave rectifier it will require that the line voltage be applied between cathode and plate of one unit of the tube and between other cathode and other plate of the second unit of the tube. When used as a full-wave rectifier it is equivalent to the use of two separate single-wave rectifiers, with the special voltage-doubling feature.

The voltage doubling arises from the fact that during the half-cycle or alternation when one tube is conducting the other tube's condenser will be discharging.

In rectifiers current flows between cathode and plate only when the plate is positive. Such a circuit for single wave rectifies a-c only on alternative half cycles. The pulses are smoothed out by a filter. If two plates are employed, each rectifies half the time, but the output voltage is approximately half that obtaining under the single-wave rectification method, affording, however, twice the output current capacity.

Voltages in Series

If there are two diodes, as in the new tube, and one is reversed in respect to the other, and there is adequate filter capacity next to the rectifier, provision is thus made for rectification and filtration of each half cycle. During the period that one unit of the rectifier is discharging, the condenser of the other unit is charging, so that the d-c output voltage of the conducting tube and discharge voltage of the condenser add up. This arrangement, like conventional full-wave, gives a ripple voltage of twice the frequency of the supply voltage, and thus filtration is made easier, although large capacity is necessary to afford good regulation when the current drain is substantial. With the new tube the drain may be substantial, since the rating will be around 100 milliamperes at 220 volts output (assuming 110 volts input).

The voltage rating of the filter condenser is not to be based on the d-c voltage but on the peak value of the a-c supply.

The tube may be used as a half-wave rectifier and therefore is applicable to the so-called "universal" sets that have become vastly popular in the last few months. These sets are small ones indeed, much smaller than the usual midget, are in a moulded decorative cabinet, and work on a-c or d-c.

The tube permits the construction of a receiver having little heat dissipation in the series resistor.

Characteristics will call for 25 volts heater supply, at 0.3 ampere, with 125 volts a-c as the maximum per plate, and a maximum d-c load current of 100 ma.

The 43 With 25-volt Heater

Another 25-volt 0.3 ampere tube is expected to be announced soon. This will be the 43, a pentode power tube. The characteristics are reported to be as follows:

Heater voltage, 25 volts.
Heater current, 0.3 ampere.
Plate voltage (maximum), 135 volts.
Screen voltage (maximum), 135 volts.
Grid bias voltage, minus 20 volts.
Plate current, 34 milliamperes.
Screen current, 7 milliamperes.
Plate resistance, 35,000 ohms.
Amplification factor, 80.
Mutual conductance, 2,300 micromhos.
Load resistance, 4,000 ohms.
Power output, 2 watts (9 per cent. total harmonic distortion).

The tube may be used at 95 volts on plate and screen, grid bias voltage minus 15 volts, plate current, 20 milliamperes, screen current, 4 milliamperes, plate resistance, 45,000 ohms, amplificator factor, 90, mutual conductance, 2,000 micromhos, power output, 0.9 watt (total harmonic distortion, 11 per cent.).

The 43 will have a six-pin base and will be particularly suitable for d-c sets operated from the house line and "universal" sets.

42 To Be Announced

Besides, to the 6.3-volt or automotive series the 42 will be added by the large manufacturers. Some of the smaller ones have had such a tube. The intended characteristics follow:

Heater voltage, 6.3 volts.
Heater current, 0.7 ampere.
Plate voltage, 250 volts.
Screen voltage, 250 volts.
Grid voltage, minus 16.5 volts.
Plate current, 34 milliamperes.
Screen current, 6.5 milliamperes.
Plate resistance, 100,000 ohms.
Amplification factor, 220 (approximately).
Mutual conductance, 2,200 micromhos.
Load resistance, 7,000 ohms.
Output, 3 watts at 7 per cent. total harmonic distortion.

The tube will be particularly suitable for automobile and for 110 and 220-volt line d-c use. It will produce exceedingly large volume of sound even at small signal input, and so far will rank first among power tubes, as to sensitivity.

High Rectified Output Voltage Is Explained

WHY is it that the rectified voltage from a B supply or a grid battery eliminator sometimes is higher than the applied voltage despite the fact that there is a voltage drop in the rectifier tube?—S. W. A., Pittsburgh, Pa.

The maximum rectified voltage possible is equal to the peak of the input voltage. The peak is 41 per cent. greater than the effective voltage and therefore the rectified voltage may be 41 per cent. higher than the input voltage. This will only occur when no current is drawn. As soon as current is drawn there will be a drop in the tube and in the supply transformer. But considerable current may be drawn before the output voltage falls below the effective a-c input voltage. It may also be that the a-c meter used for measuring the a-c voltage draws so much current that the input voltage is appreciably higher than the measured a-c voltage. The test should be made when the a-c voltmeter is across the supply transformer winding.

"Immortal" Gas Tube

A NEW TYPE radio tube using no filament was described and demonstrated by Dr. August Hund, research engineer of Wired Radio, Inc., at the January meeting of the Institute of Radio Engineers.

The new tube has been the subject of intense and secret study by Dr. Hund and his associates in Wire Radio's Newark, N. J., laboratories for the last year and a half. During that time many of the tubes, of different shapes and sizes, have been constructed and tested. None of these tubes has had a filament. It is believed that, because of their lack of a filament, the new tubes will "last indefinitely" and that they will outlast the receiver in which they are first placed. Obviously, since there is no filament, it cannot burn out, the most frequent cause of tube failure. Also, no A battery is needed to operate them, but only a B battery or B battery eliminator of the ordinary type.

A receiver using four or five of the tubes received programs from a local station with sufficient volume to be heard throughout the hall, and a one-tube receiver operated a loudspeaker with good audibility. These tests were made without any source of filament current.

Engineers who were present at the demonstration agreed that it was possible that the new tube would revolutionize the radio industry, and others saw a possible "new deal" to the industry as a result of the development of the new tube.

One of the advantages of the tube is that it is extremely easy to make and hence that it will be relatively inexpensive. Dr. Hund stated that tubes made without any precautions of cleanliness worked just as well as those made under the usual precautions of extreme cleanliness. "They seem to thrive on dirt," he said. Moreover, it is not necessary to exhaust the bulbs of all air as is essential in other tubes.

How to Determine Small Changes in Inductance, Capacity

Sometimes experimenters have occasion to estimate the frequency change in an oscillator due to a small change in capacity or in inductance, or vice versa.

There is a very simple formula obtained by differentiating the frequency formula. It is $dF = -FdC/2C$, in which dF is the change in the frequency F due to a change dC in the capacity C. By solving for dC the change in capacity can be found from the frequency change. A similar formula can be obtained for a change in inductance by replacing dL for dC and L for C. The formulas assume that the changes are very small, say, one per cent. of either L or C. Note that the sign in the second member is negative. This signifies only that the frequency changes in the opposite direction from either L or C. That is, if dL or dC is an increase, the corresponding dF is a decrease. For small changes in the turns on the inductance coil the same formula can be used except in this case the factor 2 is not used. If N is the total number of turns on the coil and dN is the change in the number of turns we have $dF = -FdN/N$. This is more useful than either of the other formulas because it can be used in adjusting inductances. Suppose, for example, that we have a coil of 127 turns and we find that the circuit tunes to 530 kc and we want it to tune to 550 kc with the same setting of the tuning condenser. How many turns should be removed? We have $dF = 20$ kc, $N = 127$, and $F = 530$ kc. Therefore $dN = -4.8$ turns. The negative sign means that we should remove this number of turns. Hence the final coil will have 122.2 turns. The first result gives only an approximation for it assumes that the inductance is proportional to the square of the number of turns. This assumption is not quite right when the coil is long compared with its diameter. The formula should be applied again for a second and closer approximation.

MEASURING RESISTANCE

If the tube in a vacuum tube voltmeter is of the screen grid type the circuit will be like that in Fig. 1. This can be used for any purpose a vacuum tube voltmeter can be used and in addition it can be used for estimating the values of resistances. Suppose the input terminals are shorted and R2 is made equal to zero. C is adjusted until the meter reads full scale. Now if R1 is left at some constant value, the current will vary as R2 is varied. By getting a relation between R2 and the current resistance may be measured. R2 would cover a medium range of resistances.

Now suppose R2 is left at some fixed value, which may be zero. Then the current will vary as R1 is varied. Therefore if we get a relation between the current and the resistance in the screen circuit we have another means of measuring resistances. This would cover a range of high resistances. The known resistances during calibration can be put in parallel with the fixed resistance R1 and thereafter the unknown should be connected in parallel.

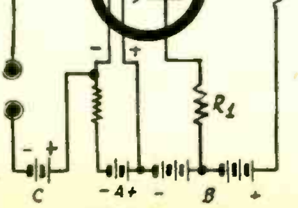


FIG. 1.

TUBE CHARACTERISTICS

230

Type of tube	Filamentary triode
Socket	Four contact
Purpose	Detector and amplifier
Grid-plate capacity	6.0 mmfd.
Grid-filament capacity	3.7 mmfd.
Plate-filament capacity	1.25 mmfd.
Overall height	4 1-4 inches
Overall diameter	1 9-16 inches
Filament voltage	2 volts, d-c
Filament current	60 milliamperes
Ballast for 3-volt supply	16.7 ohms
Ballast for 6-volt supply	66.7 ohms
Amplification factor	9.3
Plate resistance	10,300 ohms
Mutual conductance	90 micromhos
Optimum load resistance	20,000 ohms

Bias Detector

Plate voltage, maximum	180 volts
Grid bias	18 volts

Amplifier

Plate voltage	135 volts
Grid bias	9 volts
Plate current	3 milliamperes
Max. undistorted output	70 milliwatts

Amplifier

Plate voltage	180 volts
Grid bias	13.5 volts
Plate current	3.1 milliamperes
Max. undistorted output	130 milliwatts

Socket Fig. 1

231

Type of tube	Filamentary triode
Socket	Four-contact
Purpose	Power amplifier
Overall height	4 1-4 inches
Overall diameter	1 9-16 inches
Filament voltage	2 volts, d-c
Filament current	130 milliamperes
Ballast for 3-volt supply	7.7 ohms
Ballast for 6-volt supply	30.8 ohms
Amplification factor	3.8

Amplifier

Plate voltage	135 volts
Grid bias	22.5 volts
Plate current	8 millamperes
Plate resistance	4,100 ohms
Mutual conductance	925 micromhos
Max. undistorted output	185 milliwatts
Optimum load resistance	7,000 ohms

Amplifier

Plate voltage	180 volts
Grid bias	30 volts
Plate current	8 milliamperes
Plate resistance	3,600 ohms
Mutual conductance	1,050 micromhos
Max. undistorted output	375 milliwatts

Socket Fig. 1

232

Type of tube	Filamentary tetrode
Socket	Four-contact
Purpose	Detector and amplifier
Overall height	5 1-4 inches
Overall diameter	1 13-16 inches
Grid-plate capacity	0.06 mmfd. (max.)
Grid-filament capacity	6.0 mmfd.
Plate-filament capacity	11.7 mmfd.
Filament voltage	2 volts. d-c
Filament current	60 milliamperes
Ballast for 3-volt supply	16.7 ohms
Ballast for 6-volt supply	66.7 ohms
Screen voltage*	67.5 volts

Bias Detector

(0.25 megohm load.)

Plate voltage	180 volts
Grid bias	6 volts
Plate current	0.3 milliamperes or less
Screen current	About 1-3 plate current

Amplifier

Plate voltage	135 volts
Grid bias	3 volts
Plate current	1.7 milliamperes
Screen current	About 1-3 plate current
Amplification factor	610
Plate resistance	950,000 ohms
Mutual conductance	640 micromhos

Amplifier

Plate voltage	180 volts
Grid bias	3 volts
Plate current	1.7 milliampere
Screen current	About 1-3 plate current
Amplification factor	780
Plate resistance	1,200,000 ohms
Mutual conductance	650 micromhos

Socket Fig. 4

*When a high load resistance is used in an amplifier circuit the screen voltage should be much less from 7.5 to 22.5 volts.

The cap of the tube is the control grid terminal and the G-prong on the base is the screen grid terminal.

233

Type of tube	Filamentary pentode
Socket	Five-contact
Purpose	Power amplifier
Overall height	4 11-16 inches
Overall diameter	1 13-16 inches
Filament voltage	2 volts, d-c
Filament current	0.26 ampere
Ballast for 3-volt supply	3.85 ohms
Ballast for 6-volt supply	15.4 ohms
Plate resistance	50,000 ohms
Optimum load resistance	7,000 ohms

Amplifier

Plate voltage	100 volts
Screen voltage	100 volts
Grid bias	8 volts
Plate current	10.5 milliamperes
Screen current	2.5 milliamperes
Amplification factor	60
Mutual conductance	1,200 micromhos
Max. undistorted output	300 milliwatts

Amplifier

Plate voltage	135 volts
Screen voltage	135 volts
Grid bias	13.5 volts
Plate current	14.5 milliamperes
Screen current	3 milliamperes
Amplification factor	70
Mutual conductance	1,450 micromhos
Max. undistorted output	700 milliwatts

Socket Fig. 6

234

Type of tube	Filamentary pentode
Socket	Four-contact
Purpose	Super-control r-f amplifier and detector
Overall height	5 1-4 inches
Overall diameter	1 13-16 inches
Filament voltage	2 volts, d-c
Filament current	60 milliamperes
Ballast for 3-volt supply	16.7 ohms
Ballast for 6-volt supply	66.7 ohms
Grid-plate capacity	0.02 mmfd. (max.)
Grid-filament capacity	6.4 mmfd.
Plate-filament capacity	12.8 mmfd.
Screen voltage*	67.5 volts

Bias Detector

(*For detector in superheterodyne*)

Plate voltage	90 to 180 volts
Grid bias	8 volts for 180 volts on plate
Plate current	Adjust to 0.3 milliamperes or less by means of bias

Amplifier

Plate voltage	135 volts
Grid bias	3 volts
Plate current	2.8 milliamperes
Screen current	About 1-3 of plate current
Amplification factor	360
Plate resistance	600,000 ohms
Mutual conductance	600 micromhos

Amplifier

Plate voltage	180 volts
Grid bias	3 volts
Plate current	2 milliamperes
Screen current	1 milliampere
Mutual conductance	620 micromhos
Amplification factor	620
Plate resistance	One megohm

*If the tube is used in a resistance coupled circuit for amplification with a high resistance in the plate circuit the screen voltage should be much lower.

The cap is the control grid.

Socket Fig. 4A

49

Type of tube	Filamentary two-grid
Socket	Five-contact
Purpose	Class A and Class B power amplifier
Overall height	4-11/16 inches
Overall diameter	1-13/16 inches
Filament voltage	2 volts, d-c
Filament current	0.12 ampere

Class A Amplifier

Plate voltage	135 volts
Grid bias	20 volts
Plate current	6 milliamperes
Amplification factor	4.5
Plate resistance	4,000 ohms
Mutual conductance	1,125 micromhos
Max. undistorted output	170 milliwatts
Optimum load resistance	8,000 ohms

Class B Amplifier

(*Average two tubes*)

Plate voltage	180 volts
Grid bias	zero.
Plate current	4 to 28 milliamperes
Mutual conductance	3,000 micromhos
Optimum load resistance	9,000 ohms (min.)

A driver stage with a special coupling transformer is required to feed the Class B amplifier tubes. The driver may be a 49 operated as a Class A amplifier.

Socket Fig. 7

TOP VIEW OF SOCKETS

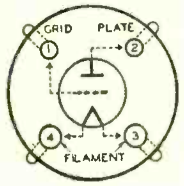


FIG. 1

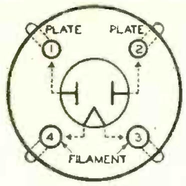


FIG. 2

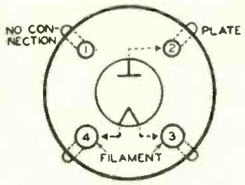


FIG. 3

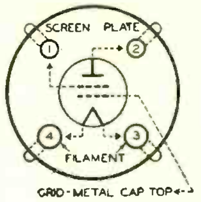


FIG. 4

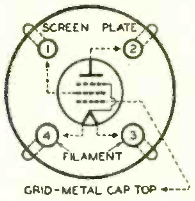


FIG. 4A

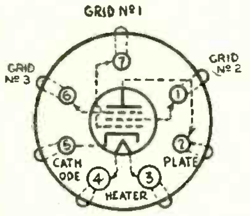


FIG. 5

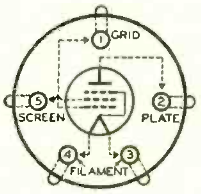


FIG. 6

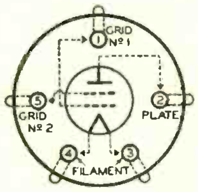


FIG. 7

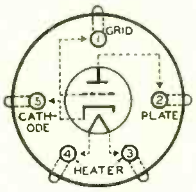


FIG. 8

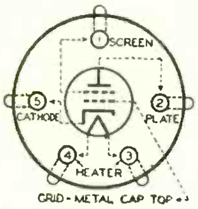


FIG. 9

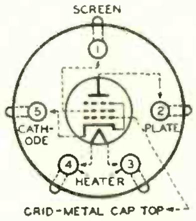


FIG. 9A

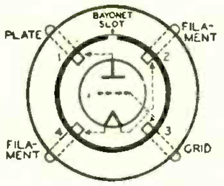


FIG. 10

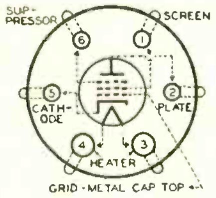


FIG. 11

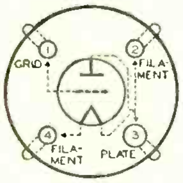


FIG. 12

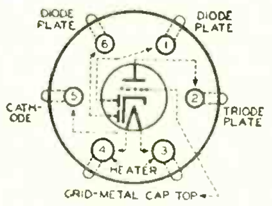


FIG. 13

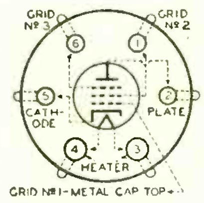


FIG. 14

Tabulated characteristics of tables will be published from week to week. The data on page 10 are the first. The above group of socket illustrations should be used for the series. Note that the diagrams also indicate the physical location of the elements.

Langmuir Greatly Increases Emission

Dr. Irving Langmuir, winner of the 1932 Nobel prize in chemistry for his contributions to the science of adsorption, has devised the most sensitive method thus far developed for detecting the presence of atoms and measuring their speed and charge. Dr. Langmuir, who developed the thoriated tungsten filament, a means of increasing the electron emission greatly, is Assistant Director of the General Electric Laboratories.

Counted in Current Terms

Adsorption has to do with two-dimensional surface chemistry, and is akin to calculus in mathematics, since calculus increases the scope by including direction as well as quantity. Adsorption is the adhesion of molecules or atoms to the surface of a substance caused by introducing an added substance. It is thus distinguished from absorption, which is the distribution of a substance through mutual occupancy.

Dr. Langmuir's newest work concerns evacuated tubes, into which various gases are introduced, enabling the fine measurements in terms of electric current to a high degree of accuracy, of atoms at as low a pressure as one billionth of an atmosphere.

Although the courts have held that Dr. Langmuir's contribution to tube science by the commercial development of the thoriated tungsten filament did not constitute invention, the value of the work he did has been recognized by fellow engineers throughout the profession generally.

It will be recalled that the metallic thorium was heated to a temperature of 3,000 degrees centigrade, forming a layer on the tungsten filament of a vacuum tube, so that the filament emitted 100,000 times as many electrons as formerly.

Now Dr. Langmuir has found out that the emission may be further increased if some caesium is introduced into the evacuated envelope in which there is a tungsten filament. From the caesium there is an escape of vapor sufficient to form a new film, representing a further advance in adsorption science.

Fast Work

The formative period of one second is sufficient to increase the electron emission from the filament 100 quintillion times (100,000,000,000,000,000,000).

The atoms flee from the filament as soon as the filament is heated, which heat may be introduced by passing through the filament an electric current. By this time, however, the erstwhile atoms are ions, that is, each atom has lost one electron. It is possible to measure the evaporation as an electric current, and in this way Dr. Langmuir has developed the most sensitive means of measuring the speed of the atom or ion, as well as counting the number of caesium atoms on the filament surface at any time. Thus the co-force exertion of atom on atom is measured as well as the electrical properties of adsorbed films.

RESISTOR

In Audio Circuits, Inc

By J. E.

HERE is a new idea on push-pull resistance-coupled amplification. A new idea on what? Resistance-coupled push-pull amplification? What does that mean? Is it possible to have push-pull amplification with resistance coupling, or any direct type of coupling?

More or less. We certainly may have a symmetrical circuit of the direct-coupled type, and since the term "push-pull" has not been applied to any other type of circuit using direct coupling we might as well let it be applied to the symmetrical direct-coupled amplifier.

If we divide a certain signal voltage equally between two tubes and in opposite phase and then follow these tubes with a push-pull output transformer, or a push-pull speaker, we have true push-pull amplification in that stage, provided, of course, that the two tubes are exactly equal. The point is, we do not have to divide the voltage by means of a push-pull input transformer. Doing it by means of a center-tapped resistor in which pure signal current is flowing is just as good as doing it with a transformer. Whatever we do we must keep the two push-pull tubes operating in a symmetrical manner, both in respect to grid bias and signal voltage.

Simple Two-stage Amplifier

Consider as Fig. 1 a two-stage circuit using transformer coupling for input and output, R1 a bias resistor between first tube's cathode and center-tap, condenser C1 across the resistors. The tubes are two 56s and two 59s. R2 and R3 are the plate loads, R4 and R5 the grid leaks, and C2 and C3 the stopping condensers. The input voltage is divided equally between the two 56s by means of a push-pull input transformer. Both tubes are also biased equally because the bias is the voltage drop in resistance R1. Due to the fact that the two sides of the circuit are equal but working in opposite phase, there is practically no variation in the mean current through the bias resistance. This should make it unnecessary to use the by-pass condenser C1. However, there is a slight variation in the current on the odd harmonics and also on the even harmonics because of the practical impossibility of making the two sides of the circuit exactly equal. Hence it is always well to use a by-pass condenser across the bias resistance in a push-pull stage. In this case the resistance R1 should be about 1,000 ohms and the condenser 2 mfd.

In the plate circuits of the two 56s we have two equal resistors, R2 and R3, each approximately 100,000 ohms. The plate voltage is supplied at the junction of these. Let us suppose that the signal voltage applied on the grid of the upper 56 is e/2 volts. Then it is —e/2 volts on the lower tubes, since the signal voltages on the two tubes are equal in magnitude but opposite in direction. Further, let the internal resistance of each tube be Rp, the amplification constant u; and the load resistance on each tube R. That is the resistance values of R2 and R3 is R. Then the output current of the upper tube is $-ue/2(Rp+R)$ and that of the lower $ue/2(Rp+R)$. Note that the phase of each current is changed with respect to the input voltage.

The output voltage of the upper tube is the drop across R, or it is $-ueR/2(Rp+R)$. The output voltage of the other tube is the same except that the sign is changed. The total output voltage of the push-pull amplifier is the potential difference between the two plates, which is the sum of the absolute values of the two output voltages obtained above. That is, the total output voltage is $ueR/(Rp+R)$, which is available for application on the next stage.

This total voltage, obviously, is applied across C2R4R5C3. If C2 equals C3 and if R4 equals R5, the drop in R4, the input voltage to the upper 59, will be exactly equal to the drop in R5, the input voltage to the lower 59, and this equality will obtain at all frequencies. However, the phase of one will be opposite to the phase of the other, for at any instant the current can flow throgh R4R5 in only one direction and it will flow away from the grid toward the cathode in one tube and toward the grid and away from the cathode in the other tube. Thus we have succeeded in amplifying the voltage impressed on the first stage and dividing it properly for another push-pull amplifier. We may call this resistance-coupled push-pull amplification.

Suppose we wish to do away with the stopping condensers and the grid leaks in the circuit in Fig. 1 and thus make it non-reactive. It becomes necessary to use the method of coupling that has become associated with names of Loftin and White. This method of coupling is particularly suitable when tubes of the heater type are used, and it applies equally well to push-pull and to single-sided amplification. No, not quite equal, for it works somewhat better with push-pull. This circuit is shown in Fig. 2.

Let us assume that the two tubes in the first stage are exactly equal and that they are put in exactly equal settings respecting to voltages and impedances. Then the voltage drop in either R2 will be the same, but again the phases of the voltages as referred to the grids of the tubes in the second stage will be opposite. We have, therefore, equal signal voltages applied to the output tubes in the proper phase for push-pull. But how are the bias voltages? Obviously, whatever the steady bias on one tube it is the same on the other. But it may not be right. The bias is measured from the cathode to the grid. Suppose the cathode connected to the junction of the two R2 resistors. Then the bias would be equal to the drop in either resistor, and this bias is equal to the value of the resistance and the plate current in the preceding tube. The current in turn depends on the bias on the preceding tubes. This interdependence makes it difficult to adjust a circuit of this type, but it is no more difficult to adjust a symmetrical circuit than a single-sided one.

Adjusting the Bias

Let us assume that we have fixed the bias on the first tube so that the steady plate current in each tube is 0.5 milliamperes. Also let us assume that each of the load resistors is 100,000 ohms. Then the drop in each resistor would be 50 volts, which is entirely too much for 59 type tubes. although it would be just right for 45 type tubes.

Now instead of connecting the cathode to the junction of the two resistors, let us connect it to the slider on potentiometer P and move this toward the left. that is, in the negative direction. Then we decrease the grid bias on the two 59 tubes, for it is equivalent to moving the cathode toward the grids and thus intercepting only a portion of the drop in the resistors. This is true only for the bias. The full signal voltage drop in R2 is still applied to the tubes. The 59 tubes require a negative bias of 18 volts when the plate voltage is 250 volts and the tubes are used in the pentode connection. We assumed that the adjustment of the first stage was such that the drop in either coupling resistor was 50 volts. Hence we have to decrease the bias by 32 volts, which is done by moving the slider toward the left on potentiometer P.

If we had a voltmeter that drew no cur-

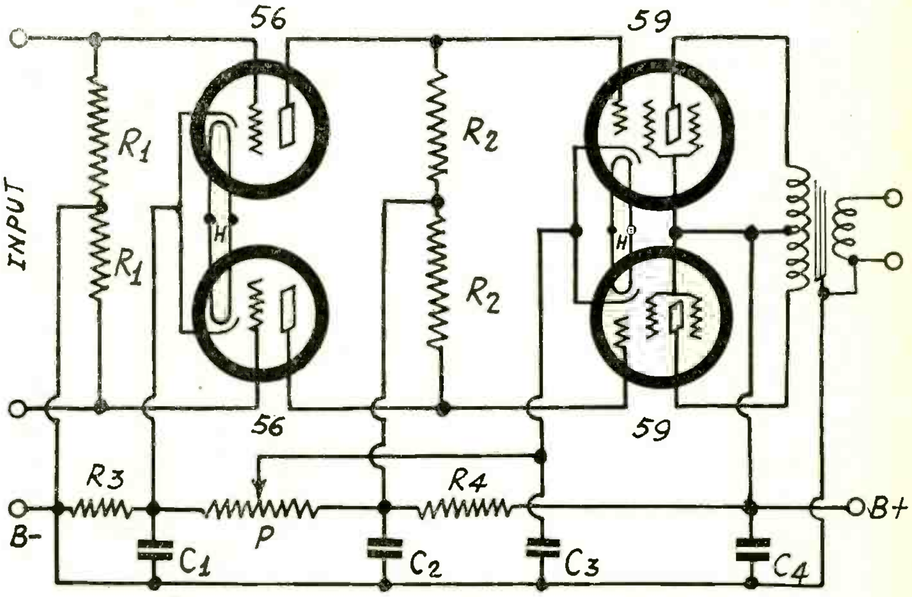


Fig. 2.
A two-stage push-pull amplifier in which the two stages are coupled two equal resistors. The circuit is of the Loftin-White type.

PUSH-PULL

luding a New Hookup

Anderson

rent we could adjust the position of the slider on the potentiometer by connecting the voltmeter between either grid of the power stage and the cathodes of that stage, and then adjusting the slider until the voltage had the right value for the tube. This does not work out when the meter draws current because there will be a large drop in the coupling resistors. The best way of making the adjustment is to put a milliammeter in the plate circuit of one of the tubes and then adjusting the potentiometer until the current has the correct value. Just what this should be might be determined by putting a known voltage of 18 volts on the grid first and noting the current.

High Supply Voltage Needed

In order to make this direct-coupled amplifier a success it is necessary to have a high supply voltage for the amplifier. First we must have a bias for the tubes in the first stage, which is the drop in R3. Then we must have a rather high voltage on the plates of the tubes in the first stage, which is the drop in the total resistance of P. Finally we must have a high voltage on the plates of the output tubes, which is the drop in R4 and the right portion of P.

Let us assume that the voltage on the power tubes is 250 and that on the first tubes 150 volts. With this voltage on the 56s we need a bias of about 8 volts. This would seem that we need a voltage of 408 volts between B plus and B minus. However, we can get along with less because we use part of the drop in P for the power tubes as well as for the 56s. To find the solution of the problem we may analyze the circuit as in Fig. 3. We first assume that the total current is 100 milliamperes. Of this 88 milliamperes will flow to the plates and the screens of the two 59 tubes. The 12 milliamperes will flow through R4. The milliampere will be diverted to the plates of the 56s, leaving 11 milliamperes in the right portion of P. At the slider the 88 milliamperes taken by the power tubes are returned to the potentiometer and consequently the current in the left portion of P will be 99 milliamperes. At the left of P the one milliampere taken from the 56s returns to the voltage divider, and therefore the current in R3 is 100 milliamperes.

Voltages

As was stated, the voltage drop in R3 is to be 8 volts. Hence R3 should be 80 ohms. The drop in the left hand portion of P should be 118 volts and the current is 99 milliamperes. Hence this part of P should have 1,191 ohms. The drop in the right hand portion should be 32 volts and the current is 11 milliamperes. Hence the right portion of P should have a resistance of 290 ohms. The total resistance of P should then be about 4,100 ohms. R4 is determined from the voltage drop 218 volts and the current 12 milliamperes. That is, R4 should be 18,150 ohms. The values must not be taken too literally because variations are permissible. We might use 20,000 ohms for R4, 75 ohms for R3, and 5,000 ohms for P. It is clear that R3 and P must be capable of carrying 100 milliamperes. Hence they should be wire-wound.

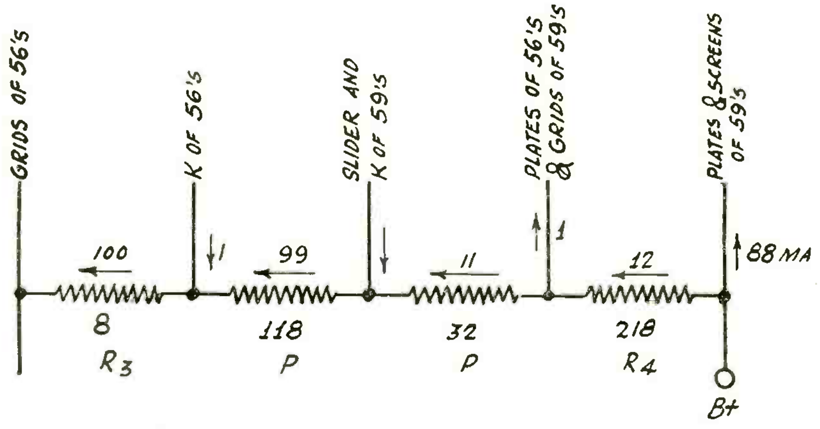


Fig. 3.
This shows the method of analyzing the voltage divider in Fig. 2 to obtain the correct distribution of voltage and the correct resistors.

The total voltage required on the basis of the precise values in Fig. 3 is 376 volts. Any voltage between 350 and 400 volts would be all right. The main adjustment is that of the position of the slider on the potentiometer, which must be done experimentally for correct effective bias on the power tubes. Large variations in the plate voltage on the 56s are permissible and it is for that reason that the actual resistances used are not critical.

The input signal voltage to the two 56s is divided by means of two equal resistances R1, each of which may be half megohm. If this method of division is used neither grid must be grounded, either directly or through any condenser. Of course, it is all right if the secondary of an audio coupling transformer is connected across the two terminals. Unless we can devise some method for coupling a detector to a push-pull stage correctly we must use a transformer, for ordinary direct methods of coupling will not work.

The condensers C1, C2, C3, and C4 in Fig. 2 are all functioning at audio frequencies and should be suitably large. Neither should be smaller than 2 mfd. There is no objection to using condensers ten times as large, or even larger.

The New Idea

In the first paragraph we promised a new idea in push-pull resistance-coupled amplification. So far there has been nothing essentially new. But we are leading up to it. Before we explain it let us review another old idea, one that is correct in conception but little used.

Consider the circuit in Fig. 4. Here we have an ordinary diode rectifier utilizing a 56 tube. The grid is used as anode and the cathode and the plate as cathode. R is the load resistance. If a modulated signal is impressed on the circuit there will be an audio voltage developed across R. This voltage may be divided between the two tubes in a push-pull amplifier provided we do not ground any part of the diode circuit, except, possibly, the center point of R. Due to rectification of the carrier there will be a d-c component in the voltage across R. The current through R will be in the direction of the arrow, and therefore the upper end of R will be positive with respect to the lower end.

Now if we should connect the grid of the upper tube to the upper end of R and the grid of the lower tube to the lower end of R and the cathode returns of the two power tubes to ground, or to the mid-point of R, the upper tube would be positively biased by half the voltage drop in R and the lower tube would be negatively biased by the same amount. Of course, this will not do. Hence we must use two equal stopping condensers C1, say of 0.02 mfd. or more, and we must also use two equal grid leaks R2. Now the upper grid can be connected to the top of the upper R2 and the grid of the lower tube to the bottom of the lower R2. If the junction of the two R2 resistors be grounded and connected to the cathode returns the signal voltage will be properly divided between the two 59 tubes, both as to phase and as to magnitude. Only the one point indicated must be grounded.

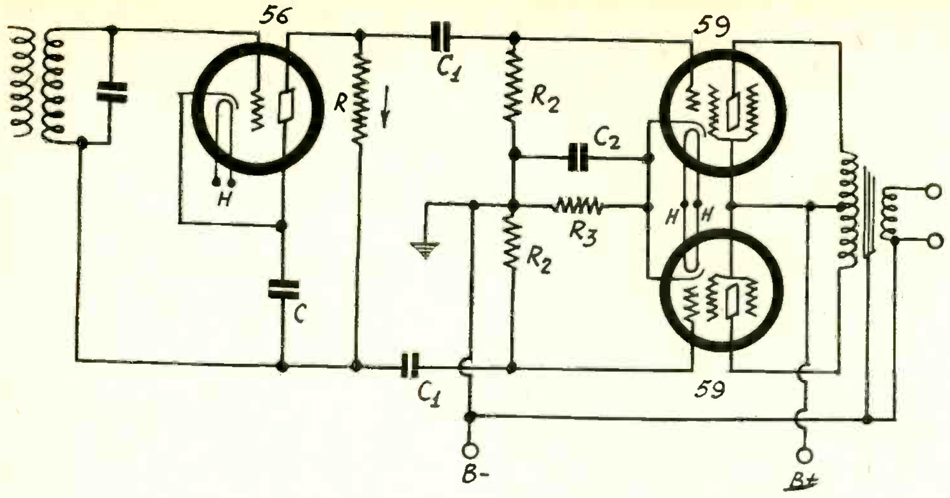
Removing Stopping Condensers

In order to have a more nearly non-reactive amplifier it is desirable to remove the stopping condensers from the circuit in Fig. 4. This can be done if we find some means of maintaining a correct negative bias on both tubes in the push-pull stage. In the solution of that problem lies the new idea that we promised.

Refer to Fig. 5. Here we have a full-wave rectifier utilizing the 55 tube. The load resistance on this rectifier is the sum of the resistances R1 and R2, which are supposed to be exactly equal. Suppose we connect the grid of the upper 59 to the upper end of R1 by moving the slider of P to the lower end. We then have a practically non-reactive coupler of the desired type. However, the upper tube is positively biased.

On the radio-frequency transformer LL2 let us put a third winding L1. Connect one side of this to the grid of the 55 and the other to a filter that returns to the cathode. The grid-cathode circuit will then act as a rectifier of the half-wave type. P is the load resistance on this rectifier. Now if the d-c voltage drop in P is equal to the voltage drop in R1 and R2, the d-c bias on the upper 59 will be equal to the bias on the lower 59 when the grid is connected to the upper end of P. When the slider is half-way up the bias on the upper tube is zero for then the drop in half of P has just neutralized the drop in R1. If the slider is moved all the way up the negative bias on the two tubes is equal.

(Continued on next page)



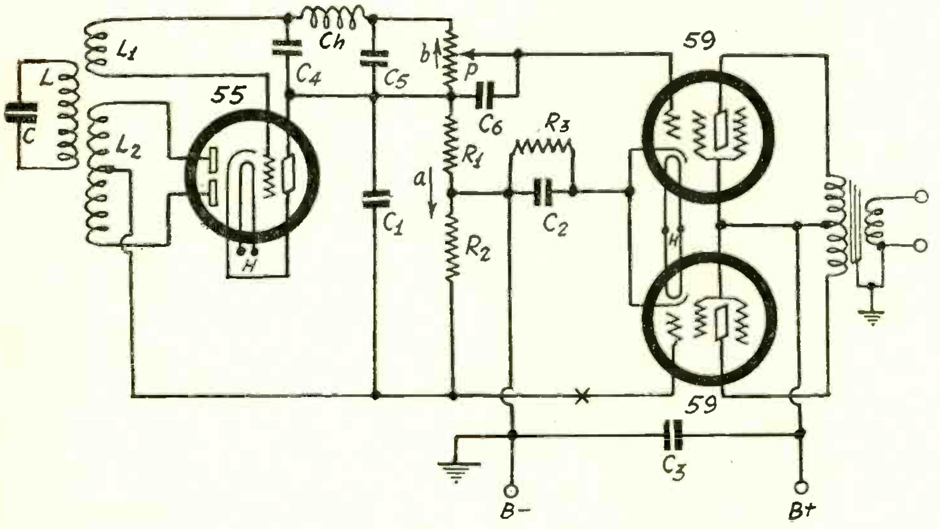


FIG. 4 (top)
A method of coupling a diode rectifier to a push-pull amplifier without the use of an input coupling transformer.

FIG. 5
A new method of coupling a diode rectifier detector to a push-pull amplifier that is nearly non-reactive. An auxiliary rectifier is used to equal negative bias on the two push-pull tubes.

(Continued from preceding page)

In order to separate the signal and the bias properly we must filter the output of the detector for the carrier only and the supplementary rectifier for audio as well. That is, C1 should only remove the carrier from the voltage across R1 and R2 and the filter consisting of C4, Ch, and C5 should remove carrier and audio fluctuations so that there is only d-c voltage across P.

Lack of Symmetry

A potentiometer is used as load resistance on the supplementary rectifier as a convenience in adjusting the bias on the upper output tube to equality with the bias on the lower tube. It would be difficult to select a winding L1, degree of coupling between this winding and the primary L, and the load resistance P so that the drop in this resistance is the same as the drop in R1 and R2 without having a single variable for doing it. If the voltage across P is greater than the sum of the voltages across R1 and R2 then the proper adjustment can be effected simply by moving the slider on P. To effect the adjustment the current in the plate circuit of the lower tube should first be measured and then the milliammeter should be put in the plate circuit of the upper tube and the slider on P moved until the current in that tube is exactly equal to that in the lower tube.

The circuit is not quite symmetrical due to the presence of the supplementary rectifier on the upper side. There will be a greater capacity to ground on the upper side than on the lower, for the grid of the 55, L1, the filter, P, and C6 all will have capacity to ground and there is nothing on the lower side to compensate for this. Even the plate and the cathode will have a higher capacity to ground than the L2 winding and the two anodes of the detector rectifier. Any lack of symmetry due to these stray capacities can be eliminated by putting a capacity of suitable value across R2.

Another cause of dissymmetry is the presence of a portion of P in the grid lead of the upper tube. However, this is effectively counteracted by C6, if this condenser is large enough. If need be, a resistor equal to the lower portion of P could be inserted in a corresponding position in the lower tube and this could be shunted with a condenser equal to C6. Of course, this suggested condenser and C6 will make the circuit somewhat reactive, but even so the circuit will be more nearly non-reactive than if a stopping condenser and a grid leak were used.

The lead in which the extra resistance and the extra condenser should be placed is indicated by X. It should not be placed so that the extra resistor would change the load resistance on the detector rectifier, for that would upset the signal balance.

The arrows *a* and *b* indicate in which direction the rectified current flows and show why the bias on the upper tube is made more negative, or less positive, the farther up the slider is on P.

C1 need not be larger than 250 mmfd. if each of R1 and R2 is of the order of 0.5 megohm, and it may even be smaller when it is important that the high audio frequencies be reproduced. C4 and C5 should at least be 0.1 mfd. each, and Ch may be 10 millihenries. C6 may also be 0.1 mfd., although a smaller value can be used if P has a resistance of the order of 0.5 megohm and if most of this is below the slider.

Precautions

Since it is important that the capacity to ground of the filter be as low as practical condensers C4, C5, and C6 should not be encased in a grounded metal shield and they should not be close to any grounded metal. Likewise Ch should be kept away from any grounded metal. If the choke is shielded, the shield should be large compared with the largest dimension of the coil.

If the stray capacity on one side of the circuit is to be balanced by means of a condenser across R2, this may be done experimentally. It might be done as follows: Connect the condenser of an oscillator between the grid of the upper tube and ground. By means of the variable condenser in the oscillator adjust the frequency to zero beat with some other frequency, say that of a broadcast station. Now switch the high potential side of the condenser from the upper grid of push-pull circuit to the lower grid. Now connect a variable condenser across R2 and adjust it until the oscillator zero-beats with the same frequency. The capacities to ground of the grids of the two 59s are then exactly equal. Just what capacity is needed across R2 depends on the value of the stray capacity on the other side of the circuit. It ought not to be greater than 100 mmfd. so that a small trimmer condenser of this capacity could be used. This adjustment may be made before the power is turned on the push-pull amplifier for the capacity will not change materially when the power is turned on.

This method of coupling a rectifying type detector to a push-pull amplifier is new and has not heretofore been published.

Note that the power tubes are diode biased in addition to the fixed bias obtained through R3. Note also that the relative diode bias of the two tubes remains the same on the two tubes for when the voltage rises in R1 and R2 due to an increase in the carrier strength the voltage drop in P rises in the same proportion.

If the signal were strong enough it would not be necessary to use R3. However, if it were not used the bias on the power tubes would be zero when there is no carrier impressed on the detector. This would cause the current to rise excessively in the power tubes. Therefore the use of R3 is advisable. Perhaps the drop in R3 need not be quite so high as if there were no diode bias applied with the signal. Ordinarily the bias resistance R3 for 59 tubes would be about 200 ohms. In this case 100 ohms might be sufficient.

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STATION SPARKS

By Alice Remsen

When You're Not Here!

For "Pages of Romance"; WJZ

Each Sunday at 5:30 p.m.

Impatient, dear, am I when you're not here.
I cannot bear the touch of other hands,
The sound of other voices hurt,
And alien lips are poison girt—
When you're not here, my dear!

My eyes can see no other face but yours;
The very wind that blows across the waste,
With soft caresses breathes your name,
And fans my love to deeper flame—
When you're not here, my dear!

But when, with outstretched hands, you come to me
I am content; my whole heart sings with joy,
And throbs with loving, tender stress;
I'm mad with love's wild carelessness—
When you are here, my dear!

—A. R.

* * *

AND ROMANCE AND LOVE WILL COME TO YOU if you listen in to the dramatization of "Pages of Romance," and to the sweet voice of Ralph Kirberry. This program is sponsored by the Centaur Company.

* * *

The Radio Rialto

Gene and Glenn are just finishing their program for Sohio over WLW; they are singing what I consider one of the prettiest songs of the season, "Spring Is in My Heart Again"; these boys are wonderful; I never miss them if I can help it; they have a million friends, and "Jake and Lena" actually seem like real people. . . . There's a new commercial program on WLW, Tuesdays and Thursdays at 7:45 p. m., sponsored by the Merrell Company, makers of Detoxal Toothpaste. Program is known as the "Merrell Melodiers," with an orchestra directed by Lloyd Shaffer, a mixed vocal sextet, and Billie Dauscha. . . . Jan Garber was forced to leave the Netherland Plaza Hotel because of previous contracts, but rumor has it that Jan will be back again soon; he is very popular in Cincinnati. Seymour Simon opened in Jan's place. Seymour has a fine band and a great reputation as a smart conductor, clever song writer and an all-round good fellow. . . . Louis Aiken, star basso of WLW, and a member of the Varsity Four, received severe scalp wounds in an automobile accident early on Christmas morning; he's all right now, and working just as usual. . . . The Threesome, a harmony trio, consisting of Grace Brandt, Eddie Albert and Herb Nelson, have returned to the microphone of WLW, after an absence of several months spent on theatrical tours through the West; a very versatile trio, singing good harmony of both popular and classical selections. . . . As I predicted last week, the Flying Dutchmen are no more for the time being; in their place comes "Midnight Reflections," conducted by William C. Stoess, with your girl friend as soloist, together with Eddie Alberts and Marie Neuman, over WJZ and a network of thirty-three stations, at midnight on Sundays, Eastern Standard Time.

Well, now I think I should turn to NBC for a little news. . . . Just imagine we're in New York; taxis nosing like beetles on a strip of light to the door of "711." . . . Smart crowds window gazing in the one of the world's best-known shopping centers. . . . A bass viol player extricates himself and his giant fiddle from an elevator doorway. . . . A blast of melody spills from Studio B into the foyer. . . . Paul Whiteman, grown remarkably lean, chats earnestly in a corner with the dignified, white-haired Walter Damrosch. Milton J. Cross, veteran announcer, in dinner clothes, talks with Pat Kelley. Virginia Rea is laughing with the Revelers. Howard Petrie paces the floor as he reads his script. Phillips Lord rehearsing in shirt sleeves for his "Country Doctor" program. Kelvin Keech hurries past. Lowell Thomas arrives hatless for a late program—and we hear bits of gossip; Maxwell House Showboat is presenting guest artists on its program now, and Muriel Wilson is the soprano you hear warbling with Lanny Ross. . . . The Monarch Mystery Tenor, and Charles J. Gilchrist, have had their network extended to embrace both coasts. . . . Leonard Joy, bless his heart, conducts the Marx Brothers orchestra, Mondays, 7:30 p. m., WJZ and network. . . . Mary McCoy plays the part of Eugenia Skidmore in the Cuckoo program. . . .

And now we'll pop over to WABC. . . . Let's see, what have we here! . . . Norman Brokenshire talks grandiloquently to the pretty hostess, stoops and kisses her hand with a courtly gesture. . . . Evan Evans gets out of the elevator and his dark eyes light up, as he smiles at us. . . . There are the Humming Birds, sweet girls, just as nice as they sound. . . . Plenty of news reaches our ears. . . . Aunt Jemima has been re-signed by Jad Salts. . . . The Barbasol Company has tied up Singin' Sam again . . . The Jo-Cur Company is continuing its program, "Sunday Matinee of the Air." . . . Lennie Hayton, who conducts the new Chesterfield program, is only twenty-four years old and began his career as pianist with Paul Whiteman. . . . Kate Smith's time on the air has been changed to 8:30 p. m., Tuesdays, Wednesdays and Thursdays. . . . Ruth Etting, Mondays and Thursdays at 9:00 p. m. . . . Smith Brothers, 8:00 p. m., Wednesdays and Fridays. . . . Abe Lyman's Orchestra, 8:45 p m., Tuesdays, Wednesdays and Thursdays. . . . Guy Lombardo and Burns and Allen, 9:30 p. m., Wednesdays. . . . Jack Benny and Ted Weems, 8:00 p. m. Thursdays, and Stoopnagle and Budd, 9:30 p. m. Thursdays.

Betty Barthell, who sings on the Chesterfield programs, comes from the South —Nashville, Tennessee—to be exact. . . . When Feodor Chaliapin, the great Russian basso, faces the microphone, he undoes his polka-dot bow tie and rips open his collar; he is a giant of a man, with a shock of blond hair and piercing blue eyes, looking more like a Northern sea captain than an opera singer. . . . Georgie Price has embarked on a pretentious vaudeville schedule; he is now playing the Paramount, Warner Brothers and Loew theatres around New York. . . . Fred Allen writes his own gags. . . . Bruno Walter, the outstanding German conductor of the present day, who is now being heard over WABC and a coast-to-coast network, as guest conductor of the New York Philharmonic-Symphony Orchestra, every Sunday from three to five p. m., is a native of Berlin and studied at the Stern Conservatory under Ehrlich, Bussler and Radecke: he started his professional career at the age of seventeen.

Now I've made myself homesick for my dear old Rialto, for Fifth Avenue, Madison Avenue, the song publishers, the N. V. A. Club, and the dear old RADIO WORLD office. . . . Oh, well, I'm still in Cincinnati, and I like it; I'm going to pop over to Fountain Square, hop on a Northside bus and out to the studio. So long until next week.

* * *

BiographicalBrevities

About Seymour Simons

WJZ-WLW, Mondays, 12:30 a.m.

That versatile band leader, Seymour Simons, was born in Detroit; graduated from the University of Michigan in 1917 as a Bachelor of Science and mechanical engineer. Was always musical. While at college wrote several of the Michigan Union operas. After graduation he went with Packard Motor Company as assistant research engineer. Enlisted in air service in October, 1917; commissioned second lieutenant. After the war went to New York with a bunch of songs; met the late Nora Bayes; that was the turning point in the young man's career; Nora encouraged the young song writer. He wrote his first big song hit for her—"Just Like a Gypsy"—and then wrote two complete shows for the famous songstress and one for Elsie Janis. Later went abroad, wrote a show for London and several hits for Parisian revues.

Returning to the States, Seymour organized his own orchestra, playing picture houses. After that a three-year contract at the Florentine Room of the Hotel Addison in Detroit. During this time he met and fell in love with Ruth Oppenheim; after a whirlwind courtship they were married, on July 8th, 1924. Three beautiful children blessed their union, but Seymour lost his beloved wife and since then his music and his children have been his life. He is the son of David W. Simons, an earnest and public-spirited citizen of Detroit; he has a very distinguished brother in the person of Federal Judge Charles C. Simons.

In appearance Seymour is slightly built, not so tall, with a large, humorous mouth and a pleasant twinkle in his eyes. He sings, very creditably. Is kindhearted, easy to get along with. Very much of a philosopher. Has a very witty way of recounting experiences. Makes a good host. Is a devoted father and son. Has written many songs, some of them very big hits, including: "Honey," "All of Me," "Just Like a Gypsy," "Sweetheart of My Student Days," "Tie a Little String Around Your Finger," "The One I Love Just Can't Be Bothered With Me," "Breezing Along With the Breeze," and "Night." He has several new numbers coming out in the near future. He and his band are now under the management of the Music Corporation of America.

Literature Wanted

Readers desiring radio literature from manufacturers and jobbers should send a request for publication of their name and address. Address Literature Editor,* RADIO WORLD, *145 West 45th Street, New York, N. Y.

Walter H. Smith, 2202 Addington Ave., Montreal, P. Q., Canada.
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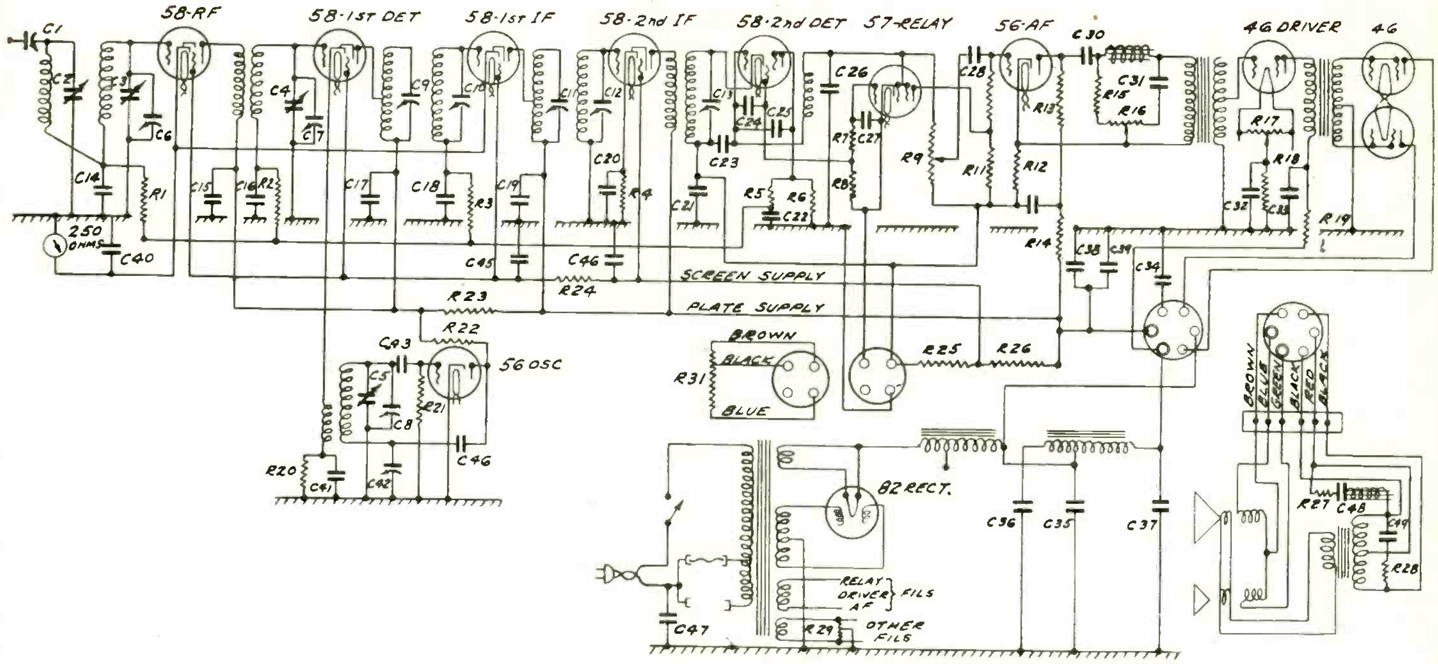
UNITED AMERICAN BOSCH CORPORATION

SERVICE INSTRUCTIONS - MODELS 312 and 313



SCHEMATIC WIRING DIAGRAM OF MODEL 312 RECEIVER

R1 - 100,000 ohms
R2 - 100,000 ohms
R3 - 100,000 ohms
R4 - 500 ohms
R5 - 500,000 ohms
R6 - 1 megohm
R7 - 1 megohm
R8 - 2 megohm
R9 - 500,000 ohms
R10 - 1 megohm
R11 - 1 megohm
R12 - 1000 ohms
R13 - 10,000 ohms
R14 - 10,000 ohms
R15 - 10,000 ohms
R16 - 100,000 ohms
R17 - Center Tap
R18 - 1500 ohms
R19 - 5000 ohms
R20 - 5000 ohms

R21 - 100,000 ohms
R22 - 30,000 ohms
R23 - 1000 ohms
R24 - 1000 ohms
R25 - 2800) ohms
R26 - 2400)
R27 - 3000 ohms
R28 - 10,000 ohms
R29 - Mid Tap
R30 - 2100 ohms

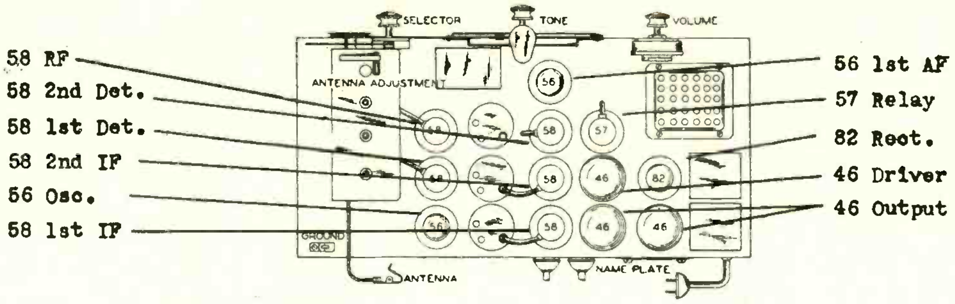
C1 - Trimmer
C2 - Tuning
C3 - Tuning
C4 - Tuning
C5 - Tuning
C6 - Alignment
C7 - Alignment
C8 - Alignment
C9 - Alignment

C10 - Alignment
C11 - Alignment
C12 - Alignment
C13 - Alignment
C14 - .05 mfd.
C15 - .05 mfd.
C16 - .05 mfd.
C17 - .05 mfd.
C18 - .05 mfd.
C19 - .05 mfd.
C20 - .05 mfd.
C21 - .05 mfd.
C22 - .05 mfd.
C23 - 100 mmf.
C24 - .05 mfd.
C25 - .05 mfd.
C26 - 100 mmf.
C27 - .1 mfd.
C28 - .05 mfd.
C29 - .5 mfd.

C30 - .1 mfd.
C31 - .05 mfd.
C32 - 8. mfd.
C33 - 4.)
C34 - 4.) mfd.
C35 - 8.)
C36 - 4.)
C37 - 8.) mfd.
C38 - 4.)
C39 - 4.)
C40 - .05 mfd.
C41 - .05 mfd.
C42 - Alignment
C43 - 100 mmf.
C44 - .05 mfd.
C45 - .05 mfd.
C46 - .05 mfd.
C47 - .01 mfd.
C48 - 2. mfd.
C49 - .01 mfd.

Stage	Tube	Fil.	Plate	Screen	Cathode	Grid
1st R.F.	58	2.4	180	85	3-6	0
1st Det.	58	2.4	180	90	4.5-10	0
1st I.F.	58	2.4	195	90	3.5-6	0
2nd I.F.	58	2.4	195	90	3.5-6	0
2nd Det.	58	2.4	0	2	40	0
Relay	57	2.4	2	25	0-45	0
1st A.F.	56	2.4	120	1	45	0
Driver	46	2.4	290	290	-	30
Output	46	2.4	430	0	-	0
Output	46	2.4	430	0	-	0
Osc.	56	2.4	75	-	-	-
Rect.	82	2.4	-	-	-	-

Note: These values are readings of a high resistance voltmeter from each socket terminal to ground. The filament voltages are, of course, an exception. Cathode readings are given for those tubes having the grid at ground. The values are only approximate and will vary with the line voltage and the type of meter employed.



TEMPORARY CONDENSED PARTS LIST FOR MODEL 312 RADIO RECEIVERS

MAIN ASSEMBLIES

103563	Chassis with tubes
103854	Speakers (2) with baffle (C)
103802	Speakers (2) with baffle (G)
103805	Speaker only (small)
103806	Speaker only (large)
103885	Cabinet (Model C)
103886	Cabinet (Model G)

COILS

103675	Field coil (either speaker)
103525	R.F. transformer (single)
103526	R.F. transformer (double)
103519	Oscillator coil
103586	1st and 3rd I. F. transformer
103587	2nd. I. F. transformer
103588	Coil only for 1st. I. F.
102841	Coil only for 2nd. I. F.
103736	Inductance coil
104116	Choke filter (2 leads)
103554	Choke filter (3 leads)
103746	Rectifier R. F. choke
103584	Choke coil (small)

CONDENSERS

103740	Housed filter (5 leads)
103595	Housed filter (6 leads)
101301	.0001 mfd. (offset terminals)
101143	.0001 mfd.
103695	.01 mfd. - 4 ply
102500	.01 mfd. - 3 ply
102493	.05 mfd. - 2 ply
102492	.05 mfd. - 3 ply
102494	.1 mfd. - 3 ply
102498	.5 mfd. - 3 ply
103828	2. mfd. - 2 ply
103037	8. mfd.
104060	Antenna trimmer

FUSE

101723	Fuse (2 amp.)

KNOBS

100798	Dial knob
102272	Antenna trimmer knob
101445	Potentiometer knob

MISC. PARTS

103560	Dial scale only
102282	Diaphragm (small)
102283	Diaphragm (large)
98713	Lamp for dial

METER

103296	Tuning meter

RESISTORS

103549	Volume control
103548	Tone control
99583	(500 ohms)
100729	(1000 ohms)
99581	(1500 ohms)
103836	(3000 ohms)
100824	(5000 ohms)
98366	(5000 ohms)
100825	(10000 ohms)
101722	(30000 ohms)
100727	(100000 ohms)
100194	(1/2 megohm)
100815	(1 megohm)
100196	(2 megohm)
103741	Mid tap variable
99412	Mid tap resistor
103742	Tapped resistor
103701	Potentiometer

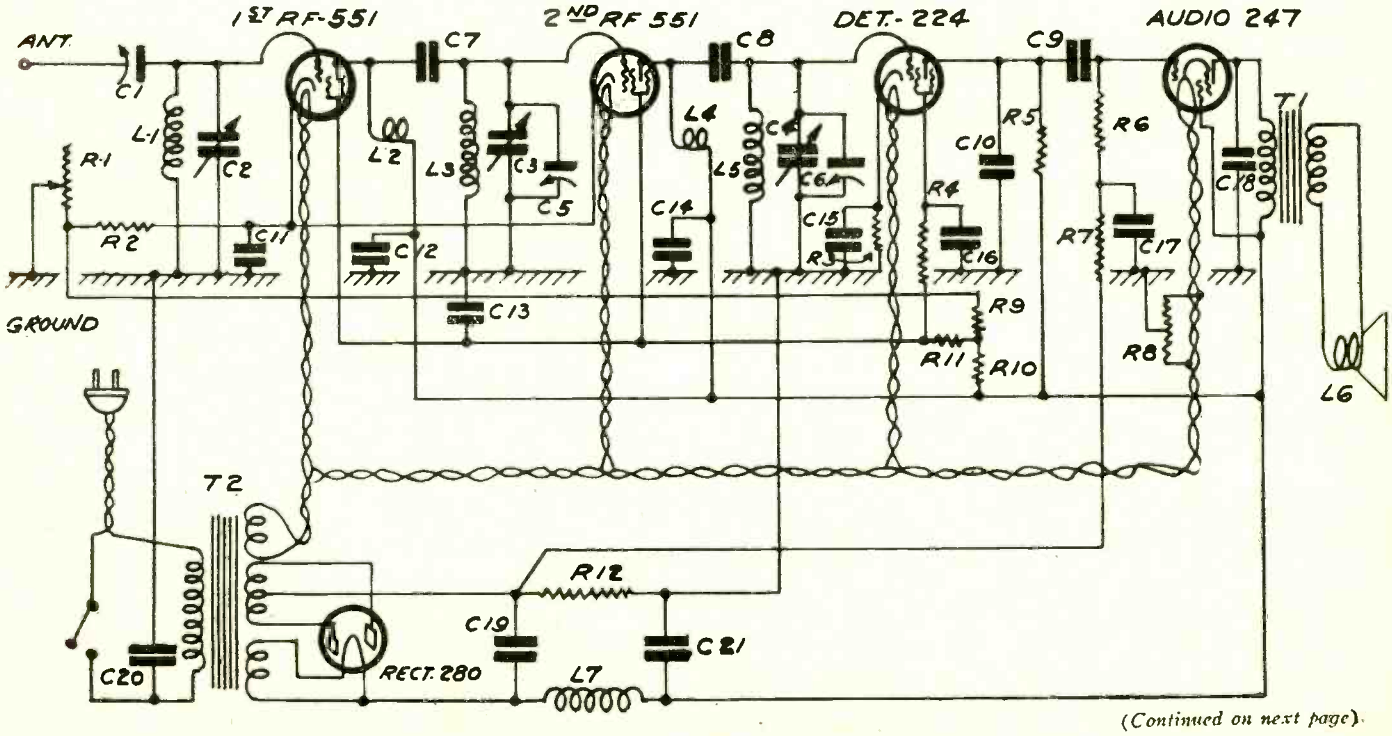
SOCKETS

103686	Socket (4 prong)
103514	Socket (5 prong)
103513	Socket (6 prong)

TRANSFORMERS

103738	Power transformer
103815	Output transformer
103765	Input transformer
103737	Driver output trans

SERVICE INSTRUCTIONS - MODELS 205 and 206



Model 205 Receiver

(Continued on next page)

(Continued from preceding page)

ELECTRICAL VALUES

R1 - 10,000 ohms	R11 - 10,000 ohms	C9 - .006 mfd.	C19 - 8. mfd.
R2 - 200 ohms	R12 - 400 ohms	C10 - .0001 mfd.	C20 - .01 mfd.
R3 - 50,000 ohms	C1 - Trimmer	C11 - .05 mfd.	C21 - 4 mfd.
R4 - 2 megohms	C2 - Tuning	C12 - .05 mfd.	L1 - Ant. Coil
R5 - 1 megohm	C3 - Tuning	C13 - .25 mfd.	L2 - Primary
R6 - 500,000 ohms	C4 - Tuning	C14 - .01 mfd.	L3 - Secondary
R7 - 100,000 ohms	C5 - Alignment	C15 - 1. mfd.	L4 - Primary
R8 - Center Tap	C6 - Alignment	C16 - .25 mfd.	L5 - Secondary
R9 - 20,000 ohms	C7 - Coupling	C17 - .05 mfd.	L6 - Voice Coil
R10 - 15,000 ohms	C8 - Coupling	C18 - .01 mfd.	L7 - Field Coil

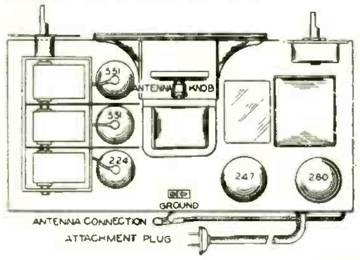
Note: Electrolytic filter condensers C19 and C21 are a single assembly. Condensers C11 to C18 inclusive are also a single assembly contained in the square can underneath the base plate.

SOCKET VOLTAGES

STAGE	TUBE	FIL.	PLATE	SCREEN	CATHODE	GRID	PLATE MA.
1st RF	551	2.3	250	90	2.5	3.0	4.5
2nd RF	551	2.3	250	90	2.5	3.0	4.5
Det.	224	2.3	*150	*20	3.0	1.5	.5
Audio	247	2.3	250	250	--	*16	*32
Rect.	280	4.8		Plate current of each plate			20

The readings were made with the volume control in the full "on" position.

*These voltages are the correct values. The average test kit will give much lower readings, (as low as 1/10 of these values) due to the low resistance of the meters compared to the high resistance included in the detector plate and screen circuits and the audio grid circuit.



IMPORTANT

Antenna Adjustment: The small knob located on the loud speaker must be adjusted at the time of installation to obtain the best reception. Make this adjustment on a weak station which is received at some point near 30 on the dial and then re-check the adjustment at several other points to make sure that it has been accurately done.

Chassis: The chassis may be removed by pulling off the knobs and unscrewing the felt feet.

RESISTOR COLOR CODE

200 ohms ------- Red ---- Black -- Brown
400 ohms ------- Yellow - Black -- Brown
10,000 ohms ---- Brown -- Black -- Orange
15,000 ohms ---- Brown -- Green -- Orange
20,000 ohms ---- Red ---- Black -- Orange
50,000 ohms ---- Green -- Black -- Orange
100,000 ohms ---- Brown -- Black -- Yellow
500,000 ohms ---- Green -- Black -- Yellow
1 megohm -------- Brown -- Black -- Green
2 megohms ------- Red ---- Black -- Green

TEMPORARY CONDENSED SERVICE PARTS LIST FOR TYPE R.S. 205 RADIO RECEIVER

MAIN ASSEMBLIES
- 103655 Chassis (with tubes)
- 102280 Speaker
- 103878 Cabinet with plates

COILS
- 101858 Field coil (speaker)
- 102438 R. F. coil complete
- 102243 R. F. primary coil
- 102439 Antenna coil

CONDENSERS
- 102178 By-pass assembly
- 102022 Antenna trimmer
- 101143 Fixed (.0001 mfd.)
- 101881 Large filter cond.
- 103695 Cond. (.01 mfd-4ply)
- 100705 Cond. (.006 mfd.)

KNOBS
- 102445 Volume and tuning knobs
- 100929 Trimmer cond. knob

MISCELLANEOUS PARTS
- 101895 Dial with scale
- 102282 Diaphragm for speaker
- 98713 Lamp for dial

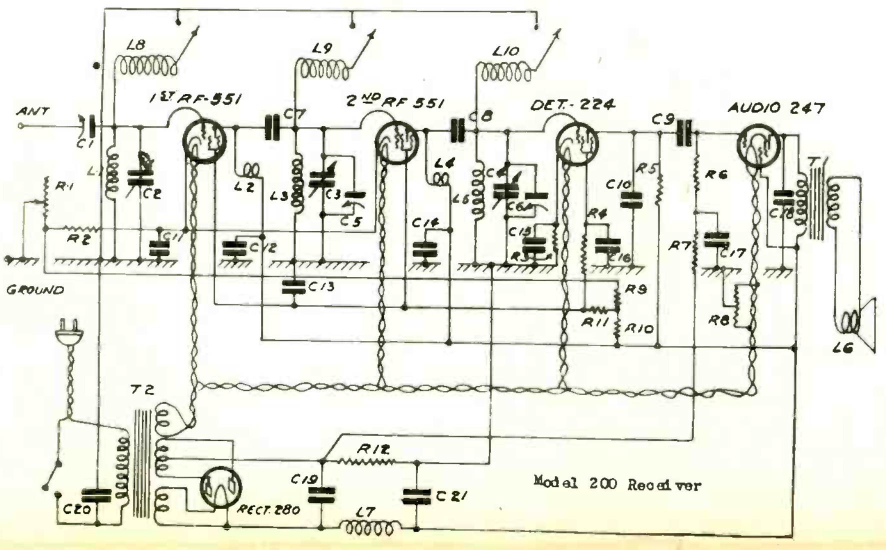
RESISTORS
- 102342 Volume control & switch
- 102437 Volume control only
- 102314 Resistor (200 ohms)
- 102177 Resistor (400 ohms)
- 100825 Resistor (10,000 ohms)
- 101404 Resistor (15,000 ohms)
- 100813 Resistor (20,000 ohms)
- 100512 Resistor (50,000 ohms)
- 100727 Resistor (100,000 ohms)
- 100194 Resistor (1/2 megohm)
- 100815 Resistor (1 megohm)
- 100196 Resistor (2 megohms)
- 99412 Mid tap resistance

SOCKETS
- 101890 Dial light socket
- 102447 Tube socket for '24 tube
- 102449 Tube socket for '80 tube
- 102446 Tube socket for '47 tube
- 102448 Tube socket for '51 tube

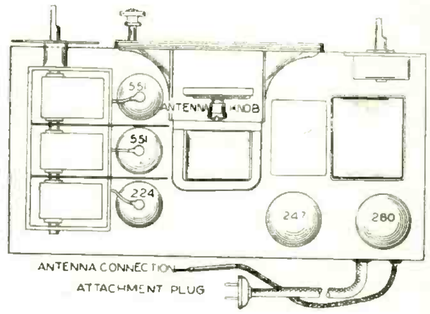
SWITCH
- 101930 Switch with (2) nuts

TRANSFORMER
- 102551 Output transformer
- 101939 Power transformer

SERVICE INSTRUCTIONS - MODELS 200-201

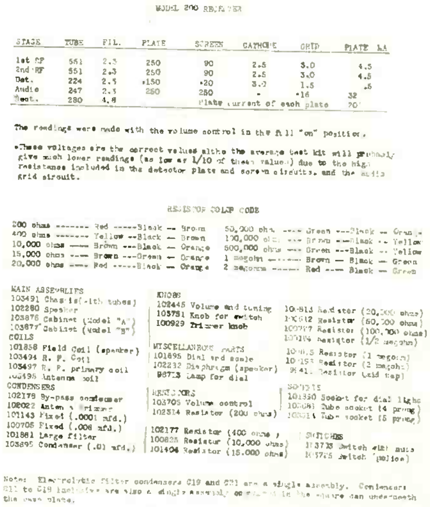


Bosch Model 200; Top of Chassis, Code and Values



ELECTRICAL VALUES

R1 - 10,000 ohms	R11 - 10,000 ohms
R2 - 200 ohms	R12 - 400 ohms
R3 - 50,000 ohms	C1 - Trimmer
R4 - 2 megohms	C2 - Tuning
R5 - 1 megohm	C3 - Tuning
R6 - 500,000 ohms	C4 - Tuning
R7 - 100,000 ohms	C5 - Alignment
R8 - Center Tap	C6 - Alignment
R9 - 20,000 ohms	C7 - Coupling
R10 - 15,000 ohms	C8 - Coupling
C9 - .006 mfd.	C19 - 8. mfd.
C10 - .0001 mfd.	C20 - .01 mfd.
C11 - .05 mfd.	C21 - 4 mfd.
C12 - .05 mfd.	L1 - Ant. Coil
C13 - .25 mfd.	L2 - Primary
C14 - .01 mfd.	L3 - Secondary
C15 - 1. mfd.	L4 - Primary
C16 - .25 mfd.	L5 - Secondary
C17 - .05 mfd.	L6 - Voice Coil
C18 - .01 mfd.	L7 - Field Coil



STAGE	TUBE	FIL.	PLATE	SCREEN	CATHODE	GRID	PLATE MA
1st RF	551	2.3	250	90	2.5	3.0	4.5
2nd RF	551	2.3	250	90	2.5	3.0	4.5
Det.	224	2.5	*150	*20	3.0	1.5	.5
Audio	247	2.5	250	250	-	*16	32
Rect.	280	4.8		Plate current of each plate			20

The readings were made with the volume control in the full "on" position.

The above data apply to the circuit diagram in first two columns (bottom).

COMMERCIAL RECEIVER DIAGRAMS

A regular feature of RADIO WORLD is the publication of the circuit diagrams of the latest commercial receivers, with full technical data. Such publication is usually several months in advance of the printing of the diagrams in general circuit manuals and keeps one abreast of the very latest developments as reduced to practice. Therefore read RADIO WORLD every week.

PHILCO
REG. U.S. PAT. OFF

Service Bulletin—No. 146

Models 89 and 19

The Philco Radio of the 89 and 19 Series is a 6 tube superheterodyne, employing the high efficiency 6.3 volt filament tubes, automatic volume control and pentode output. The intermediate frequency used in adjusting the superheterodyne circuit is 260 kilocycles. The power consumption of the models 89 and 19 is 60 watts.

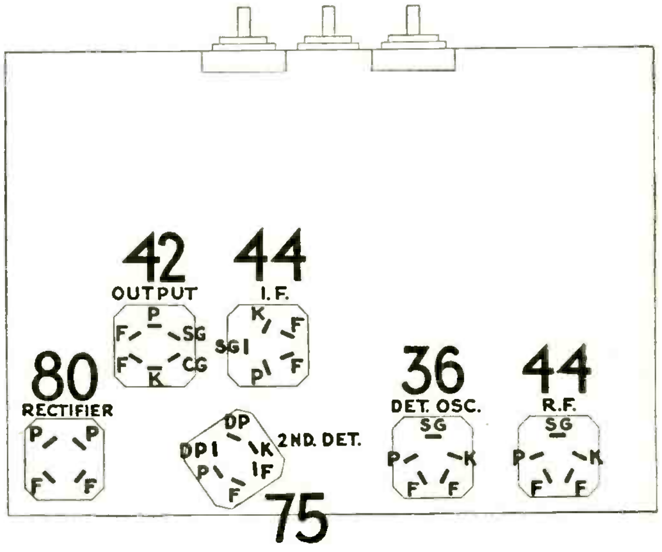
Table 1—Tube Socket Data*—A. C. Line Voltage 115 Volts

Circuit	RF	Det. Osc.	IF	2nd Det.	Output	Rectifier
Type Tube	**44**	**36**	**44**	**75**	**42**	**80**
Filament Volts—F to F	6.3	6.3	6.3	6.3	6.3	5.0
Plate Volts—P to K	235	230	240	175	235	350/Plate
Screen Grid Volts—SG to K	90	90	90	....	245	....
Control Grid Volts—CG to K	.3	7.5	.3	.3	.15	....
Cathode Volts—K to F	3.5	7.8	3.5	....	14	....
Diode Plate Volts—K to DP				.2	....	....

*All of the readings above in Table 1 were taken from the under side of chassis, using test prods and leads with a suitable A. C. voltmeter for filament voltages and a high resistance, multi-range D. C. voltmeter for all other readings. Volume control at maximum and switch and station selector set for 550 KC. Readings taken with a radio set tester and plug-in adapter will not be satisfactory.

Table 2—Power Transformer Data

Terminal	A. C. Volts	Circuit	Color
1–2	105–125	Primary	White
3–4	6.3	Filaments	Black
6–7	5.0	Filament of 80	Blue
9–10	670	Plates of 80	Yellow
5	. .	Center Tap of 3–4	Black-Yellow Tracer
8	....	Center Tap of 9–10	Yellow-Green Tracer



F	Filament	SG	Screen Grid	K	Cathode
P	Plate	CG	Control Grid	DP	Diode Plate

Figure 1—Tube Socket, Under Side of Chassis

Caution: Never connect the chassis to the power supply unless the speaker is connected and all tubes are in place.

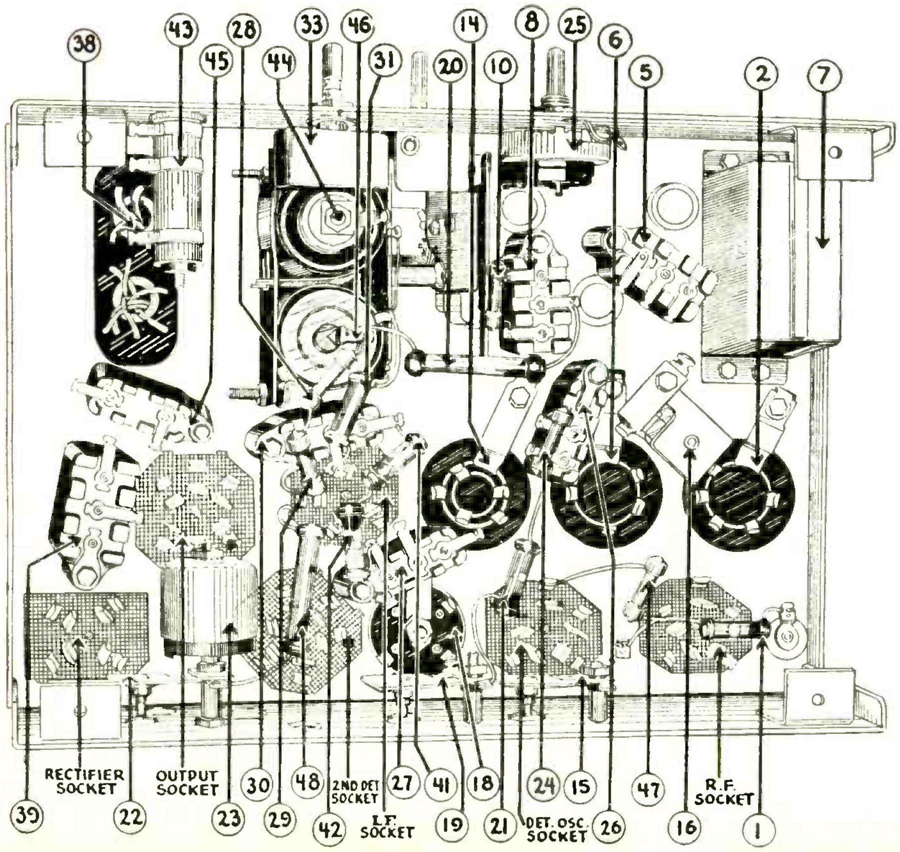


Figure 2—Bottom View of Chassis, Showing Parts

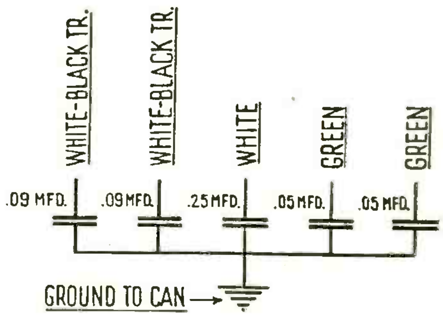


Figure 3—Internal Connections Filter Condenser.

(Continued on next page)

(Continued from preceding page)

Adjustment of Models 89 and 19

These receivers are accurately adjusted at the factory prior to shipment. Under normal conditions it will never be necessary to readjust the compensating condensers. If for any reason such adjustment should be required, it should not be attempted without first receiving the proper instruction and equipment from your Distributor. The Philco Oscillator equipment has been designed for use in this work and will be found the most inexpensive and most reliable for the purpose.

Models 89 and 19

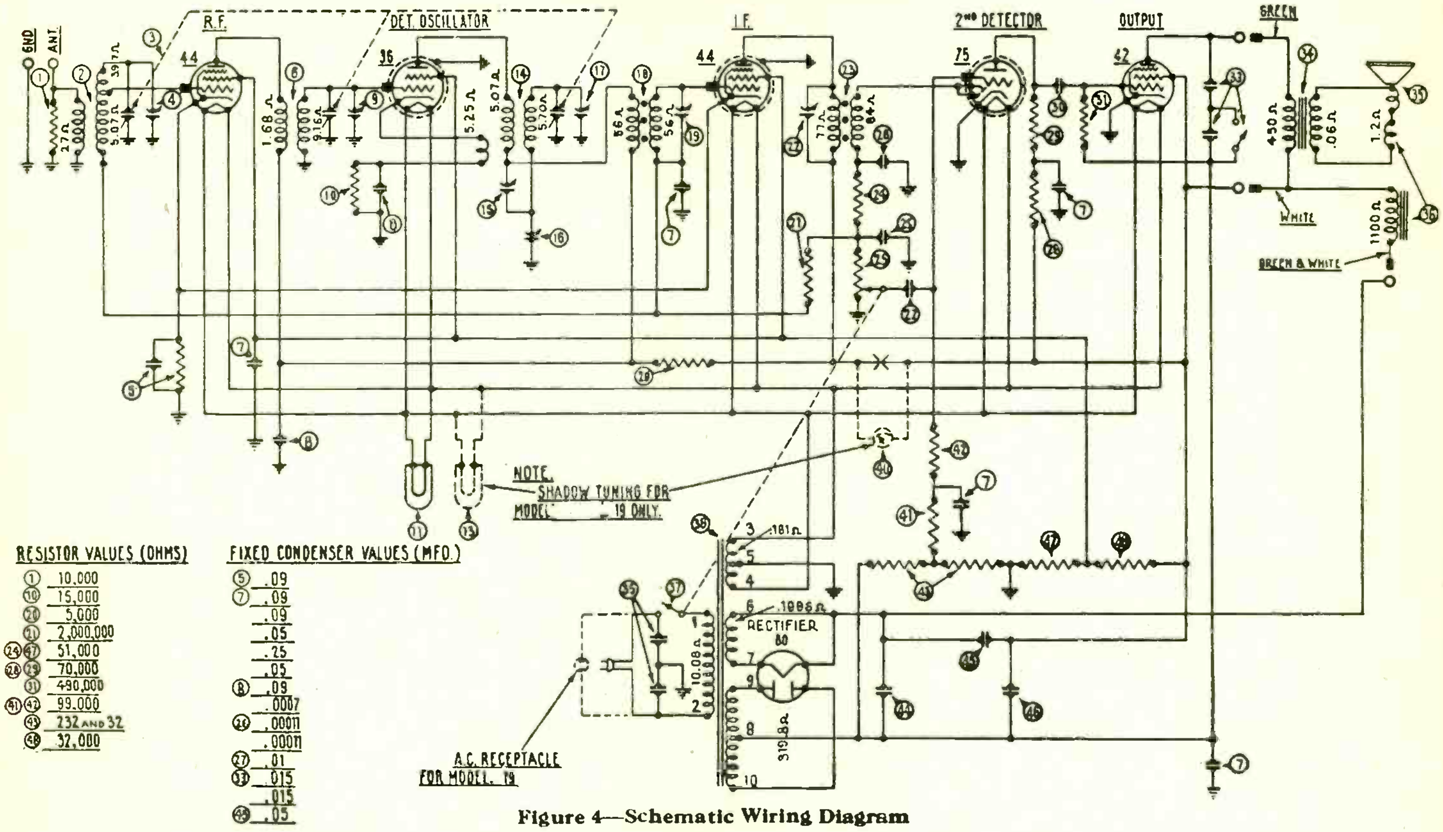


Figure 4—Schematic Wiring Diagram

Replacement Parts for Models 89 and 19

①	Resistor (10,000 Ohms) Brown—Black—Orange	4412
②	Antenna Transformer	06619
③	Tuning Condenser Assembly	06577
④	Compensating Condenser—(R.F. Part of Tuning Condenser Assembly)	
⑤	Condenser and Resistor—(.09 Mfd. and 200Ω)	4989-W
⑥	Interstage Transformer	06662
⑦	Filter Cond. Bank (.09—.09—.05—.05—.25)	06624
⑧	Condenser (Double—.09 and .0007 Mfd.)	8174-B
⑨	Compensating Condenser—(R.F. Part of Tuning Condenser Assembly)	
⑩	Resistor (15,000 Ohms) Brown—Green—Orange	6208
⑪	Pilot Lamp	6608
⑫	Dial Scale	7882
⑬	Pilot Lamp—(Shadow Tuning)	6608
⑭	Oscillator Transformer	06620
⑮	Compensating Condenser — (1st I.F. Primary)	04000-M
⑯	Compensating Condenser — (Low Frequency	04000-S
⑰	Compensating Condenser—(R.F. Part of Tuning Condenser Assembly)	
⑱	First I.F. Transformer	06621
⑲	Compensating Condenser (1st I.F. Secondary)	04000-M
⑳	Resistor (5,000 Ohms) Green—Black—Red	3526
㉑	Resistor (2,000,000 Ohms) Red—Black—Green	5872
㉒	Compensating Cond. (2nd I.F. Primary)	04000-A
㉓	Second I.F. Transformer	06622
㉔	Resistor (51,000 Ohms) Green—Brown—Orange	6098
㉕	Volume Control and A.C. Switch	8003
㉖	Condenser (Double—.00011 & .00011 Mfd.)	8035-C
㉗	Condenser (.01 Mfd.)	3903-AB
㉘	Resistor (70,000 Ohms) Violet—Black—Orange	5385
㉙	Resistor (70,000 Ohms) Violet—Black—Orange	5385
㉚	Condenser (.01 Mfd.)	3903-T
㉛	Resistor (490,000 Ohms) Yellow—White—Yellow	4517
㉜	Bezel	8055
㉝	Tone Control	06764
㉞	Output Transformer	2580
㉟	Voice Coil and Cone Assembly	02823
㊱	Speaker Field and Bucking Coil Assembled with Pot (K-7)	02761
㊲	Switch (A.C.) Part of Vol. Control Assembly	
㊳	Power Transformer (50-60 Cycles, 115 Volts)	8046
	Power Transformer (25-40 Cycles—115 Volts)	8047
	Power Transformer (50-60 Cycles—230 Volts)	8048
㊴	Condenser (Double—.015 and .015 Mfd.)	3793-E
㊵	Shadow Tuning	6497-G
㊶	Resistor (99,000 Ohms) White—White—Orange	4411
㊷	Resistor (1,000,000 Ohms) Brown—Black Green	4409
㊸	B.C. Resistor (235 Ohms and 32 Ohms—Wire Wound)	7998
㊹	Electrolytic Condenser—6 Mfd.	8165
㊺	Condenser (.05 Mfd.)	3615-E
㊻	Electrolytic Condenser—6 Mfd.	8166
㊼	Resistor (51,000 Ohms) Green—Brown—Orange	4518
㊽	Resistor (32,000 Ohms) Orange—Red—Orange	3525
	Tube Shield	8005
	Knob (Large)	03063
	Knob (Small)	03064
	Knob Spring	5262
	Grid Clip	4897
	Four Prong Socket	7544
	Five Prong Socket	7546
	Six Prong Socket	7547
	Pilot Lamp Shield	5760

Radio University

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RADIO WORLD, 145 WEST 45th STREET, NEW YORK, N. Y.

Voice on Television

IT IS my understanding that the voice accompaniment of certain television signals is carried on the same carrier, the voice being carried by a sub-carrier of 45 kc. Can you suggest a method by which the voice can be received?—W. H. C., New York, N. Y.

If the voice is carried by a sub-carrier of 45 kc which itself is a modulation on the television carrier, it is necessary to detect twice. The television receiver contains one detector, the one that brings out the modulation. Among the television signals is the 45 kc sub-carrier. If you put in a tuned circuit in the plate circuit of the detector or in the plate circuit of the audio amplifier and then adjust it to 45 kc you can impress it on a second detector to make the voice audible. If the tuned circuit is put in the plate circuit of the audio amplifier the voice carrier may be so strong that it will not be necessary to amplify the signals after detection. This, however, depends on how good an amplifier the audio circuit is at 45 kc. Few audio amplifiers are any good at that frequency but they should be for good television reception.

* * *

C Supply Volume Control

IF A C battery eliminator is put into a receiver for biasing all the tubes, could this also be used as a manual volume control successfully?—R. W. T., Harrisburg, Pa.

Surely, it can be used. If the volume can be controlled by controlling the bias on the high frequency tubes, and that is the way it is done in most instances, the voltage from the C battery eliminator can be used. Return the grids of the tubes to be controlled to a slider on the output potentiometer of the C supply and slide it to control the volume. The only condition is that the voltage across the potentiometer is high enough to stop the amplification in the controlled tubes. The slider need not interfere with any fixed bias voltages that may be taken from the C supply, for a voltage divider may be connected in shunt with the potentiometer.

* * *

Speaker Field Power

WHAT power should be dissipated in the speaker field of a dynamic and how does the sensitivity of the speaker depend on the power? If a speaker designed for six volts is put on 100 volts, what happens? If one designed for 100 volts is put on six volts, what happens?—W. C. N., Wilmington, Del.

As long as the speaker field core is not saturated the sensitivity increases with the power supplied the field. The amount of power that should be supplied depends on the size of the speaker and the power it is supposed to handle. If you put 100 volts on a field designed for six volts you will have a virtual short-circuit. In most cases the results will be disastrous. If you put six volts on a speaker designed for 100 volts, nothing will happen. You will only have a dead speaker. In respect to power, a speaker designed for automobile use has a field resistance of four ohms and it is to operate on six volts. It will take a current of 1.5 amperes and therefore the field power is nine watts. A speaker designed for 100 volts, approximately, has a resistance of 1,800 ohms. Usually, the current through this field is 60 milliamperes. Therefore the power expended in the field is nearly 6.5 watts. This field is often given 75 milliamperes, when the power expended in the field is a little over ten watts.

* * *

Resistance Meter

MY milliammeter has a range from 0 to 100 milliamperes. I wish to use this meter in making resistance measurements. I plan to use a No. 6 dry cell in series with the circuit. What should be the limiting resistance? How low resistance should I be able to measure with this meter?—T. H. Y., Atlanta, Ga.

You will need 15 ohms. You ought to be able to measure resistance as low as 0.8 of an ohm. That assumes that you can read 95 milliamperes on the meter.

* * *

Pentode Automobile Tubes

IS THERE a tube of the automobile series that corresponds with the 58? That is, is there a pentode available with the suppressor grid accessible?—S. H., Indianapolis, Ind.

Not yet. The nearest to it is the 239, which is a variable mu pentode but with the suppressor grid connected to the cathode inside the tube.

* * *

Small B Supply

IF POSSIBLE I should like to build a simple B supply with a small heater type tube and without the use of any transformers, except, perhaps, a filament transformer. What tube would you recommend for rectifier and how should the line be connected to the circuit so that it will be safe?—R. W. D., Fort Worth, Tex.

Any of the heater tubes can be used, like the 227, the 56, or the 237. The choice would depend on the tube that is available and on the filament voltage that can easily be obtained. The first two require a voltage of 2.5 volts and the third a voltage of six volts. Connect the line to the plate and grid tied together and to the filter choke. From the line-choke junction connect the first filter condenser. The other side of the condenser goes to the cathode. This amounts to putting the filter in the negative leg of the circuit. Putting the line between plate and the choke minimizes danger in case of short circuit.

* * *

Rectifiers in Parallel

ONE 280 tube is rated at 125 milliamperes. But I have occasion to build a B supply requiring about 200 milliamperes. I cannot use two 281 tubes for the current rating is not high enough, but I could use two 280 tubes. The question is how to connect them. Should I connect the two plates on each tube together and thus make each tube a half wave rectifier or should I retain each tube as a full-wave rectifier, connecting the corresponding plates of the two tubes together?—H. K., New York, N. Y.

It makes little difference which way it is done. It is probably simpler to wire the tubes as half-wave rectifiers, for the two plates, being very close together, can be joined with a short piece of wire.

* * *

Measuring A-C Voltage

IS IT possible to measure the voltage across a tuned circuit by means of a thermo-milliammeter and a calibrated oscillator? If so, please explain how it may be done.—H. E. H., Brooklyn, N. Y.

It is possible if you know either the inductance or the capacity in the circuit. If you measure the current in the coil or in the condenser with the thermo-milliammeter at a known frequency, you can determine the voltage from the reactance. The voltage across the condenser is the current through the condenser multiplied by the reactance and the voltage across the coil is the current through the coil multiplied by the reactance of the coil, assuming that the coil has negligible resistance. If you measure at resonance, which is the only way you can measure accurately, the voltage across the coil should be the same as that across the condenser. In making the computations use henries for inductance, farads for capacity, amperes for current, cycles per second for frequency.

* * *

Connecting Phono Pick-up

WHY would it not be all right to connect the phonograph pick-up unit permanently in series with the grid leak of an audio amplifier tube? Whatever voltage is developed in the pick-up unit will be in the grid circuit and it will be applied in full regardless of the grid leak.—G. W. L., New Rochelle, N. Y.

If no current could flow in the grid leak it would be all right. But current will flow and as soon as it does the drop in the grid leak will be about 95 per cent of the voltage generated in the pick-up unit. This current is not necessarily grid current. If there is a grid leak in the circuit there is also likely to be a stopping condenser, a plate resistance, and an active plate in front of the grid leak. Current can flow through these. The resistance between the grid end of the leak and the grounded side of the circuit is likely to be small in comparison with the resistance of the leak, and under those conditions most of the voltage generated in the pick-up unit will be dropped in the grid leak and very little will get to the grid itself. It would be better to short circuit the grid leak when the pick-up unit is to be used. By means of a switch the leak could be shorted when the pick-up unit is to supply the signal and the pick-up unit when the detector is to supply the signal. A single pole double throw switch would do. If the grid leak is a potentiometer with the slider connected to the grid, the pick-up unit can be connected in series with the leak on the ground side for then the potentiometer slider can be used to cut out the resistance when the pick-up unit is to be used.

* * *

Reversing a Tuning Condenser

MY TUNING condenser is such that the capacity increases when turned clockwise. My dial requires the opposite. Is there any way of reversing the condenser?—F. X. F., Boston, Mass.

Only if the shaft is removable so that shaft to which the dial is attached can be brought out at the other end of the condenser. Another way is to use gears, one attached to the dial and the other to shaft of the condenser. The best way is to get a new dial or a new condenser.

* * *

Short-Wave Converter

WILL YOU kindly publish the circuit of a short-wave converter having three tubes, a mixer, an oscillator, and a B supply.—B. W. R., Buffalo, N. Y.

You will find the circuit herewith. All the design data are given on the diagram with the exception of the tuning coils. In

(*Continued on next page*)

(*Continued from preceding page*)

this case tapped coils are used, but plug-in coils, or individual coils picked up by the switches, would be preferable. The tubes in the circuit are of the automobile series. The filaments are connected in series and presumes that the voltage of the secondary of the transformer is 20 volts. If you have a six-volt winding, or if you want to use a storage battery, connect the filaments in parallel.

* * *

Loss of High Frequencies

IN AN AMPLIFIER designed for television the detector is coupled to the audio amplifier by means of a 100,000-ohm resistor, a 0.1 mfd. condenser, and a 0.5-megohm grid leak. There is a 100 mmfd. condenser across the plate resistance. What is the relative amplification at 45 kc as compared with that at very low audio frequencies?—F. G. A., Troy, N. Y.

The ratio of the voltage across the coupling resistance at 45 kc to that at a very low audio frequency is about 1/3. Hence the relative loss is about 67 per cent.

* * *

Diode-Biasing Class B

INSTEAD OF USING 46 tubes with zero bias in a Class B amplifier would it not be all right to bias the tubes with the voltage developed in the diode detector load resistance, that is, using the voltage that is ordinarily used for a. v. c.?—T. R. M., New York, N. Y.

This would not work out so well because on weak and on no signals the power tubes would not be biased at all and the plate current would be very high. If attempted the filtering of the voltage developed across the load resistance would have to be so thorough that it would not fluctuate with the modulation, even on the lowest audio frequencies. If any bias at all is used on the power tubes it should be steady.

* * *

Frequency Rating

RECENTLY I read an article in which the frequency of the line voltage was referred to as 42 semiperiods. Does that mean that the frequency is 42 cycles per second, or what does it mean?—W. H. J., Denver, Colo.

It means that the frequency is 21 cycles per second. There are two semiperiods in every cycle, that is, in every complete period. This is a very low frequency and is not used much. The lowest commercial frequency in this country is 25 cycles per second. Instead of saving semiperiods it is more customary to speak of alternations. There are as many alternations as semiperiods.

* * *

Energy Storage in Choke

THE condensers in a B supply store up electric charge. Does a choke coil also store up electricity in the same manner? If not, how does it aid in leveling the output?—R. G. B., St. Louis, Mo.

The choke stores up energy in the form of magnetic field. It is not electricity but magnetism. When the magnetizing current decreases the field collapses, and in doing so keeps current flowing in the circuit. The effect is about the same as if the coil did store electricity.

* * *

About Vibrating Rectifiers

WHAT can be done to remove the sparking interference in an automobile B battery eliminator operating with a vibrator? The interference is now so strong that it is impossible to use the eliminator with the receiver.—F. W. E., Sandusky, Ohio.

Most of the interference occurs at the break-points of the vibrator and it is due to the sparking there. It can be removed almost entirely by suppressing the sparks. This is done by means of a condenser and a resistance, in series, connected across the gaps. The proper values of the condenser and the resistor depend on the rapidity of the vibrator. The spark suppressor must be tuned, so to speak, to the frequency of the vibrator. This is not an ordinary case of tuning for there is no coil involved but it is a matter of adjusting the time constant of the shunt circuit, that is, of the condenser and the resistance. You might start with a condenser of one microfarad and then adjust the resistance until the sparking is minimum. A resistance of the order of 100 ohms might be required. A radio-frequency choke in series with the battery might also be helpful. This is used, as you know, in mercury vapor rectifier circuits to suppress high frequency noise resulting from a cause much similar to the present. The resistor and the condenser combination is a standard spark suppressor used frequently with vibrators and relays. The object of using the spark suppressor is not so much to suppress interference as to lengthen the life of the break-points. Incidentally, break-down of vibrating type B battery eliminators is usually due to failure of the points to break clean after a short time. Hence there are two major reasons why the suppressor should be used.

* * *

Crackling in Receiver

MY SET worked well for some time but suddenly it started to develop noises. At times it crackles like pistol shots. I have had all the tubes tested and they are all right. I have also had a service man go over the set and he cannot find anything wrong with it. What do you think may be the trouble?—H. E. H., Newark, N. J.

Find out from your neighbors whether or not they are experiencing the same trouble. If they are, the trouble must be in the house or in the neighborhood. It is probable that there is a defect in the electrical wiring. Particularly find out whether the voltage drops when additional load is put on the line, such as electrical refrigerators, vacuum cleaners, and so forth. If the lights go dim when additional appliances are turned on, there is trouble in the line. The power company should be able to determine the cause and to remedy it. If the line is all right investigate any electrolytic condensers that may be in the set.

* * *

Narrow Tuning Range

MY TUNER does not go higher than 1,350 kc when it should go at least to 1,550 kc. The long wave stations come in about where they should, WMCA coming in at 96 on the dial. The tuning condensers are supposed to be 350 mmfd. What do you think is the trouble? —B. R., New York, N. Y.

The trouble is high distributed capacity in the circuits. This may be due to too little space between the primaries and the secondaries or it may be due to too much capacity in the trimmer condensers. First open up the trimmer condensers as much as possible. If this does not help it may be necessary to remove the primaries and put a thicker insulator between. Of course, if the primaries are not wound over the secondaries, the trouble cannot be there. Then you have to look elsewhere for distributed capacity. Possibly the grid leads are too long and placed too close to the grounded chassis.

* * *

Battery-Operated Receiver

WHAT tubes would you recommend for a battery-operated seven tube superheterodyne? I want a set as sensitive as possible but it must be economical as to filament current.—W. G. H., Birmingham, Ala.

The first should be a 234, the mixer should be a 232, the oscillator a 230, the i-f amplifier a 234, the second detector a 232, the first audio a 230, and the power tube a 233. These tubes will require a filament current of 0.62 ampere.

* * *

Connection of Pick-Up Unit

MY RECEIVER employs a 55 diode as detector and it is followed by a 47 power tube. I wish to put in a phonograph pick-up so that it may be left in the circuit all the time. Can you suggest a method of doing it?—F. R. A., Council Bluffs, Iowa.

A good way is shown on page 6, Dec. 31, 1932, issue of RADIO WORLD. The 55 is diode biased. The load resistor consists of one 250,000-ohm resistor in series with a 50,000-ohm resistor. The larger resistor is a potentiometer with the slider connected to the grid. The 50-000-ohm resistor is placed on the cathode side of the potentiometer, and the pick-up unit is connected across this resistor. It does not interfere appreciably with the operation of the detector and the detector need not interfere at all with the pick-up because the potentiometer slider can be set so that the radio signals are entirely excluded. If binding posts are provided for the pick-up unit it can be connected or removed quickly if desired, or it may be left permanently.

* * *

Grounding the Cathodes

IF A C battery eliminator is used on power tubes is it permissible to ground the cathodes or the center of the filaments? It is assumed that the positive end of the voltage divider of the C supply is also grounded.—T. Y. A., Topeka, Kansas.

It is not only permissible but necessary. At least the cathodes should be connected to the same point as the positive end of the voltage divider on the C supply.

* * *

Padding a Tracking Condenser

IF A tracking condenser has been designed for 175 kc intermediate is it possible to use that condenser for another intermediate frequency if the tracking section is padded suitably?—G. L. M., Chicago, Ill.

It is possible to use it with a higher intermediate frequency than 175 kc provided it is padded. But the theory for obtaining the proper inductance and series capacity used when all the condensers are equal does not apply. It is necessary to find the capacity in the oscillator section corresponding to each setting of the r-f condensers. When the capacity is known at three r-f frequencies the padding constants can be worked out. If no means for measuring the capacity is available a close approximation may be obtained by comparing it with the capacity in the r-f circuits. Supply a radio frequency of 1,450 kc and tune the r-f circuit to this frequency. Without moving the condenser switch the coil to the oscillator section and find what the resonance frequency is. We know two frequencies and the r-f inductance. Hence we can find the capacity in the oscillator condenser. Repeat this at 1,000 and 600 kc. From the three capacities thus obtained, the r-f inductance, the intermediate frequency desired, and the three tie-down frequencies, the inductance, minimum capacity, and the series condenser capacity in the oscillator circuit can be computed.

* * *

Effective Amplification

IS THE amplification of a tube ever equal to the amplification constant? If not, what proportion of the amplification factor is the actual amplification?—T. F. V., Knoxville, Tenn.

The actual amplification is always less than the amplification factor. Just what proportion it is depends on the relative value of the load impedance to the total impedance in the plate circuit. The actual voltage gain is $uZ/(Z+R)$, in which u is the amplification factor, Z the load impedance and R the internal resistance of the tube the actual amplification is only one half of the amplification factor. To make the gain higher the load impedance must be made higher. In a power pentode the load impedance is much smaller than the resistance of the tube and therefore the actual voltage gain is a small fraction of the amplification factor. In some cases it is only 1/10.

8 MFD. CONDENSER

Four for Only $1.47

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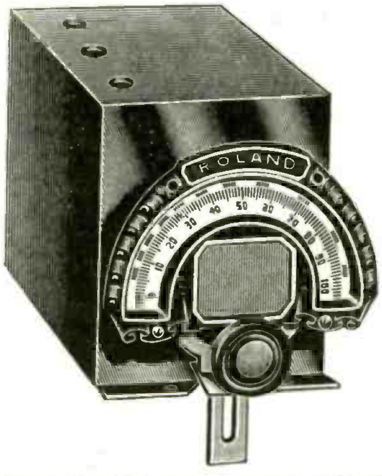
BACK ISSUES OF RADIO WORLD WANTED: Jan. 8, 1930; Mar. 1, 1930; Mar. 22, 1930. Holders please write Dr. J. M. B. Hard, 49 Wall St., New York City.



0.0005 mfd. Scovill tuning condenser, brass plates, shaft at both ends so condenser takes 0-100 or 100-0 dials and two can be used with drum dial; sectional shields built in, trimmers affixed; total enclosed in additional shield as illustrated. Access to trimmers with screwdriver. Side holes for bringing out leads to caps of screen grid tubes. Cat. SCSHC @....$1.95

Same as above, with ghost type dial (travelling light). Cat. SCSHC-DL @......................$2.85

DIRECT RADIO CO., 143 W. 45 St., New York City

DIAMOND PARTS

FIVE-TUBE MODEL

A-C operated circuit, 50-60 cycles, 105-120 volts, using two 58 t-r-f stages, 57 power detector and 47 output, with '80 rectifier. Three gang shielded condenser and shielded coils in a sensitive, selective and pure-tone circuit. Dynamic speaker field coil used as B supply choke. Complete kit of parts, including 8" Rola speaker and all else (except tubes and cabinet). Cat. D5CK @............$15.69
Wired model, Cat. D5CW (less cabinet) @.... 17.19

Kit of five Eveready-Raytheon tubes for this circuit. Cat. D5T 4.97

FOUNDATION UNIT, consisting of drilled metal subpanel, 13¾ x 8⅝ x 2¼"; three-gang Scovill 0.00035 mfd., brass plates, trimmers, full shield; shields for the 58 and 57 tubes; six sockets (one for speaker plug); two 8 mfd. electrolytic condensers; set of three coils. Cat. D5FU....... 6.19

Super Diamond parts in stock.

FOUR-TUBE MODEL

The four-tube model is similar, except that there is one stage of t-r-f, and a two-gang condenser is used. Tubes required, one 58, one 57, one 47 and one '80. Complete kit, including 8" Rola dynamic speaker (less tubes, less cabinet). Cat. D4CK $13.58

Kit of four Eveready-Raytheon tubes for this circuit. Cat 4D.TK 3.88

FOUNDATION UNIT, consisting of drilled metal plated subpanel 13¼ x 2½ x 7"; two-gang 0.00035 mfd. SFL condenser; full shield; two shields for 58-57; center-tapped 200-turn honeycomb coil; five sockets (one for speaker plug); two 8 mfd. electrolytics; set of two shielded coils; 20-100 mmfd. Hammarlund equalizer for antenna series condenser. Cat. D4FU $5.48

INDIVIDUAL PARTS

Travelling light vernier dial, full-vision, 6-to-1 vernier, projected indication prevents parallax; takes ¼" or ⅜" shaft; dial, bracket, lamp, escutcheon.

0-100 for 5-tube Diamond, Cat. CRD-0, @ $0.91.

100-0 for 4-tube Diamond, Cat. CRD-100, @ $0.91.

[If dial is desired for other circuits state whether condenser closes to the left or to the right.]

8 mfd. Polymet electrolytic, insulating washers, extra lug. Cat. POLY-8 @	$0.49
Three 0.1 mfd. in one shield case, 250 volt d-c rating. Cat. S-31 @	.29
Rola 8" dynamic for 47, with 1800 ohm field coil tapped @ 300 ohms. Cat. FP @	3.83
2 coils for 4-tube. Cat. DP @	.90
3 coils for 5-tube. Cat. DT @	1.35

DIRECT RADIO CO.

143 WEST 45th STREET
NEW YORK, N. Y.

WAFER SOCKETS

6/32 mounting holes, 1-11/16 inches apart; central socket hole recommended, 1⅛ inches, although 1¼ inches may be used.

UX, with insulator	10c
UY, with insulator	10c
Six-pin, with insulator	11c
Seven-pin, with insulator	12c

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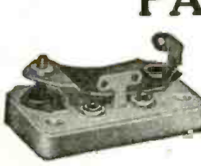
PADDING CONDENSERS



Either capacity, 50c

A HIGH-CLASS padding condenser is required for a superheterodyne's oscillator, one that will hold its capacity setting and will not introduce losses in the circuit, for losses create frequency instability. The Hammarlund padding condensers are of single-condenser construction on Isolantite base, with set-screw easily accessible. and non-stripping thread. For 175 kc. intermediate frequency use the 750-1250 mmfd. model. For i.-f. from 460 to 365 kc., use the 350-450 mmfd.

0.0005 HAMMARLUND S. F. L. at 98c.

A sturdy, precision straight frequency line condenser, no end stops. The removable shaft protrudes front and rear and permits ganging with coupling device, also use of clockwise or anti-clockwise dials, or two either side of drum dial. Front panel and chassis-top mounting facilities. True straight line. This rugged condenser has Hammarlund's high quality workmanship and is suitable for precision work. It is a most excellent condenser for calibrated radio frequency test oscillators, any frequency region, 100 to 60,000 kc., short-wave converters and adapters and TRF or Superheterodyne broadcast receivers. Lowest loss construction, rigidity; Hammarlund's perfection throughout.

Order Cat. HOS @..98c net

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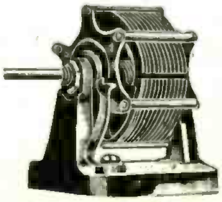
360-Degree Condenser



20 to 375 mmfd. capacity variation, effected over full 360 degrees, affords wide spreadout, better dial legibility. Great for test oscillators and all-wave tuning.

Price, $3.00 net.

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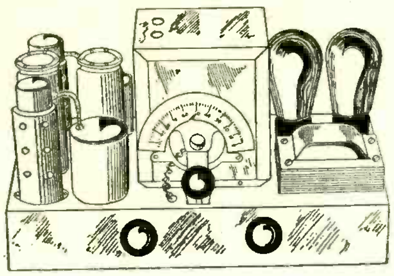
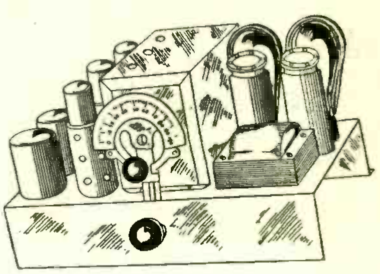


BLUEPRINTS, COILS and CHASSIS FOR THE DIAMOND OF THE AIR



FOUR-TUBE DIAMOND

Extremely fine performance, including fetching tone quality, marks the Four-Tube A-C 1933 Diamond of the Air, blueprint of which is now available (half-scale). Many have been surprised that so much can be accomplished on a t-r-f set that costs so little to build. The circuit uses a two-gang 0.00035 mfd. condenser. Special coils are required. The chassis is metal, 13.75 x 6.75 x 2.5 inches.

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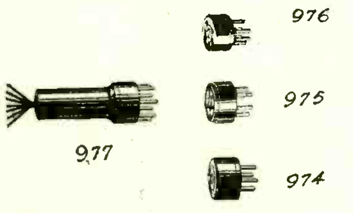
Analyzer Plug and Adapters



For constructing a set analyzer, an analyzer plug, to go into a receiver socket, is necessary. We offer the exclusive seven-pin analyzer plug, plain long handle as illustrated, and three adapters that enable putting the plug connections into UX, UY and six-pin receiver sockets. The plug has 5-foot 7-lead cable. All four parts sent free on receipt of $6.00 for one-year's subscription (52 issues). Order Cat. PRE-ANPLAD.

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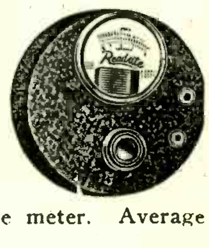

A 0-10,000-ohm ohmmeter and continuity tester. A rheostat is built in for correct zero resistance adjustment. The unit contains a three-cell flashlight battery. Supplied with two 5-foot-long wire leads with tip plugs. Case is 4-inch diameter baked enamel. Sent you for an order for one year's subscription for Radio World (52 weeks) at the regular rate of $6. Order Cat. PRE-500.

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RIDER'S MANUAL

The standby of the service man is John F. Rider's "Perpetual Trouble Shooter's Manual," of which Vols. 1 and 2 have been published.

Vol. 1 consists of 2,000 diagrams of commercial receivers, power amplifiers, converters, etc. Total pages, 1200.

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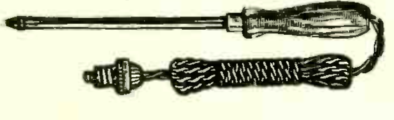
A-C, D-C SOLDERING IRON



A serviceable iron that works on a-c (any frequency) and d-c, 105-120 volts. Sent free on receipt of $1.50 for three-months subscription (13 issues). Order Cat. PRE-SOLIN.

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