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491st Consecutive Issue—TENTH YEAR

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AUGUST 22, 1931

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(See pages 3, 4 and 5 and Table Below)

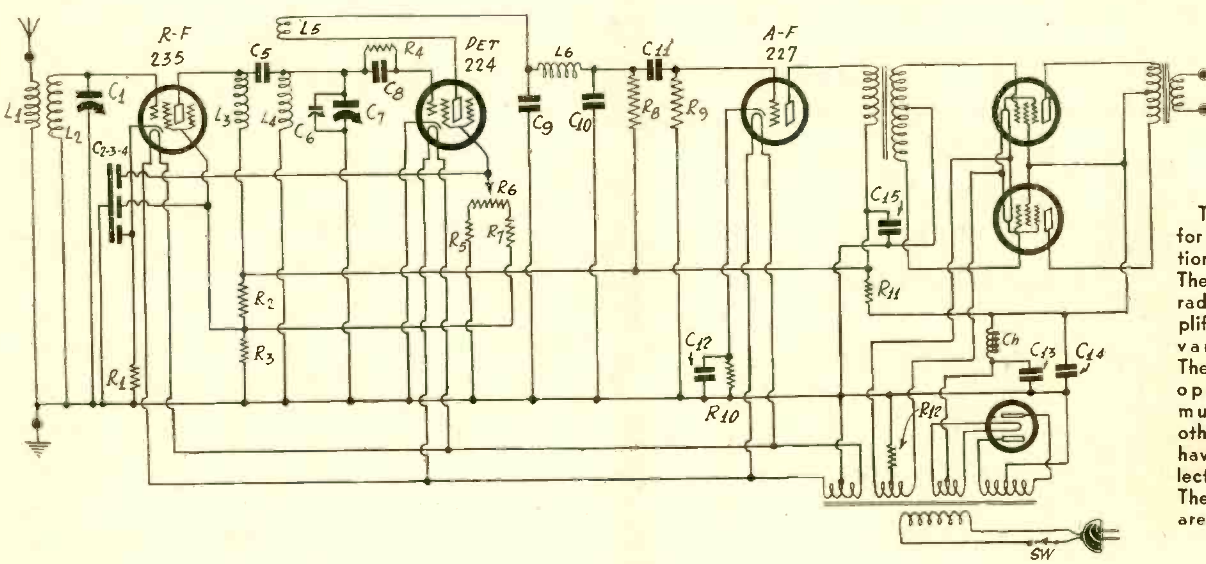

FIG. 19

The A-C circuit for speaker operation on short waves. The first tube, or radio frequency amplifier, is of the variable mu type. There is no battery operated variable mu tube, so the other circuits cannot have this extra selectivity advantage. The output tubes are 247 pentodes.

Magnet Wire Table for Radio and Audio Frequency Coils

B. & S. Gauge	cc. Ohms per 1,000 Feet	TURNS PER LINEAR MEASURE: Single Silk	Double Silk	Single Cotton	Double Cotton	Enameled	Enameled SS	Enameled DS	Enameled SC	Enamaled DC
14	2.525			15.6	13.6	15.2			14.1	13.3
15	3.184	16.9	16.3	16.1	15.1	17.0			15.6	14.8
16	4.016	18.9	18.2	17.9	16.7	19.1	18.4	17.7	17.4	16.3
17	5.064	21.2	20.3	19.9	18.2	21.5	20.5	19.7	19.3	17.9
18	6.385	23.6	22.6	22.1	20.2	23.9	22.8	21.8	21.4	19.7
19	8.051	26.3	25.1	24.4	22.2	26.8	25.4	24.2	23.6	21.5
20	10.15	29.4	27.8	27.0	24.3	30.1	28.4	26.9	26.1	23.6
21	12.80	32.7	30.8	29.8	26.7	33.7	31.6	29.8	28.9	25.9
22	16.14	36.6	34.2	33.0	29.2	37.7	35.0	32.8	31.7	28.1
23	20.36	40.6	37.7	36.2	31.6	42.3	39.0	36.4	34.9	30.6
24	25.67	45.2	41.6	39.8	34.4	47.1	43.1	39.8	38.1	33.1
25	32.37	50.2	45.8	43.6	37.2	52.9	47.8	43.8	42.8	35.8
26	40.81	55.8	50.5	47.8	40.1	59.1	52.9	48.0	45.7	38.6
27	51.47	61.7	65.5	52.0	43.1	66.2	58.4	52.9	49.7	41.4
28	64.90	68.4	60.9	56.8	46.2	74.1	64.5	57.8	54.0	44.4
29	81.83	75.1	67.1	61.3	49.2	83.3	71.4	64.1	58.8	47.6
30	103.20	83.1	79.2	66.5	52.5	92.2	77.8	69.2	63.0	50.3
31	130.10	91.5	79.3	71.9	55.8	103.4	85.6	75.3	68.1	53.5
32	164.10	100.5	86.5	77.2	58.9	115.6	93.8	81.6	73.2	56.6
33	206.90	110.1	93.6	82.8	62.1	129.3	102.7	88.2	78.5	59.7
34	260.90	120.4	101.0	88.4	65.3	144.9	112.3	95.2	84.0	62.8
35	329.00	131.4	108.5	94.3	68.4	162.3	122.5	102.4	89.6	65.9
36	418.80	142.8	116.2	100.0	71.4	181.8	133.3	109.8	95.2	68.9
37	523.10	155.0	124.2	105.8	74.3	202.4	144.1	117.1	100.6	71.7
38	659.60	167.7	132.2	111.6	77.1	227.7	156.4	125.1	106.4	74.6
39	831.80	180.5	140.2	117.2	79.8	252.5	167.7	132.2	111.6	77.1
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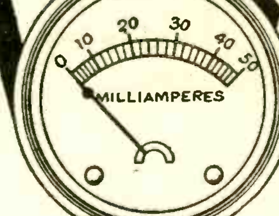

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Design of R-F Coils

Shape Factor and Wire Data Important Factors

By J. E. Anderson

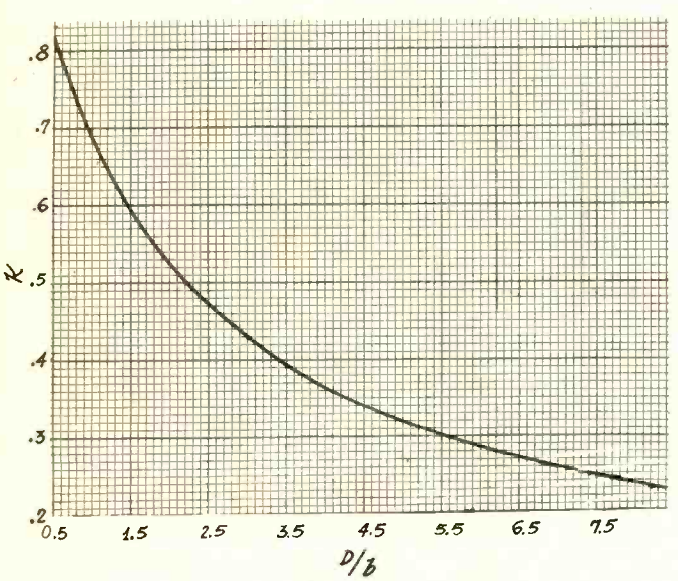

Fig. 1

This curve gives the value of K, the shape factor of a single layer solenoid, in terms of D/b, the ratio of the diameter to the axial length of the winding.

THE determination of the number of turns to give a given inductance is a problem that arises continually in radio. For this reason every radio experimenter and ambitious service man should familiarize himself with the method of computation. It is not difficult although in most instances it is a matter of cut and try which may be tedious.

Most radio frequency coils are of the single layer solenoid type because these coils are rated as the best electrically and the simplest to make.

Since the inductance of a coil depends on the ratio of its diameter to its axial length, the inductance also depends on the spacing of the turns, since the length depends on the spacing. If the turns are wound as close together as the diameter of the wire permits, the inductance depends on the diameter of the wire, or on the number of turns per inch, which in this case is the reciprocal of the diameter.

Formula for Inductance

The simplest formula for the inductance of a single layer solenoid $L=0.02505D^2n^2K/b$, in which L is given in microhenries, D is the diameter of the coil in inches, n is the number of turns, K a factor depending on the ratio of diameter to length and is given in Fig. 1, and b is the axial length of the coil. If we use N, the number of turns per inch, we have $b=n/N$, and the formula becomes $L=0.02505D^2nNK$, which is a convenient form for computation.

As an illustration of the use of the second formula let us suppose that we have a form 2 inches in diameter and wind 50 turns of No. 22 double cotton covered wire. Thus D equals 2 and n equals 50. N we find from the accompanying wire data table to be 29.2 (Front cover). Thus the formula becomes $L=0.02505 \times 2 \times 2 \times 50 \times 29.2K$, or 146.3K. If we now find the value of K we can complete the computation of the inductance of this coil.

To find the value of K we have to consult the curve in Fig. 1. K is a function of D/b or of DN/n. This ratio is 2x29.2/50, or 0.584. We find from the curve that when D/b is 0.584 the value of K is 0.793. Therefore the inductance of the coil is 116 microhenries.

Let us compute the inductance for the same coil when it is wound with 50 turns of No. 28 enameled wire. In this case the value of N is 74.1. Hence we have $L=0.02505 \times 2 \times 2 \times 50 \times 74.1K$ (2x74.1/50), or $L=371.24K$ (2.964). When D/d is 2.964 the value of K is 0.432. Hence the inductance is 160.3 microhenries. This makes it clear how the inductance depends on the diameter of the wire. In changing the turns per inch from 29.2 to 74.1 the inductance changed from 116 to 160 microhenries.

Range of Curves

The curve runs from D/b equals 0.5 to about 8.4. Nearly all practical coils come in this range. If the ratio D/b is smaller than 0.5 the coil should be wound on a larger diameter or with finer wire and if the ratio is greater than 8 the coil may be wound on a smaller form or with heavier wire, or it may be assumed that the inductance is proportional to the square of the number of turns.

It is not possible to read the curve very accurately but it is possible to read to two significant figures and to estimate the third. This is accurate enough for practical coil computations.

The ratio of D/b can also be read directly to two significant figures and the third can be estimated with sufficient accuracy.

It is not often that the inductance problem is met in the form explained above. We are not required, as a rule, to find how much the inductance of a given coil is but rather to find the number of turns that will give a certain inductance. That is a more difficult problem, but the curve Fig. 1 can be used in obtaining the turns.

Turns Formula

Suppose we wish to wind a coil that will have an inductance L microhenries on a form of D inches in diameter, using wire that winds N turns to the inch. That is the usual problem. We can rewrite the formula for inductance in the following form $nK=39.92L/D^2N$. For design work it is sufficiently accurate to write it $nK=40L/D^2N$. Hence we shall use this simplified formula. In this equation we know all the factors to the right of the equality sign but we know neither n nor K. We are required to find n. The first thing is to make use of all the known factors, namely, the required inductance L, the diameter D of the form, and the number of turns per inch of the wire, and from these compute the value of nK. That is, we know the product of n and K although we know neither factor.

Now it is a matter of cut and try, assuming reasonable values of n. As soon as we have assumed a value of n we have a value of DN/n, or of D/b, and we look up the corresponding value of K. Then we multiply the assumed value of n by the value of K just found, and compare the product with the known value of nK. If they are not equal we assume another value of n and repeat the computation. We get another value of nK. If this is nearer the known value of nK we approached the re-

(*Continued on next page*)

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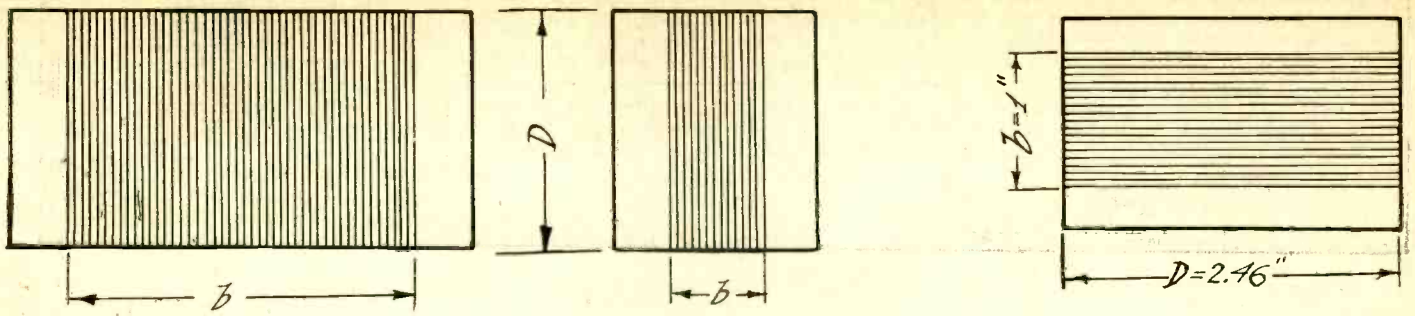

At left is a single layer solenoid having a small D/b ratio and a large value of K. In the middle is a solenoid having a large value of D/b and a small value of K. At right is a scale drawing of a solenoid having the best ratio of D/b

(Continued from preceding page)

quired turns in the right direction and we proceed with another assumption for n. This we continue until the computed value of nK is equal to the known value of it. With a little experience it will only require a few guesses until the right value is hit upon. It may be that one of the guesses will overshoot the mark. That is lucky for then we have fixed the value of n for we know that it must lie between two of the assumed values.

Illustration Cut and Try Method

Let us illustrate the method. Let it be required to wind a coil having an inductance of 160 microhenries on a form 2.5 inches in diameter, using No. 24 double cotton covered wire. The wire table gives the value 34.4 for N for No. 24 double cotton covered wire. Hence nK=40x160/2.5x2.5x34.4, or nK=29.8. We have to assume values of n, look up the corresponding value of K for each guess, multiply the assumed n by the K obtained, and continue the process until we have hit upon the n that makes nK=29.8.

The actual work will be simplified if we tabulate our guesses and the corresponding values of K, nK, and D/b, or DN/n. Since the diameter is 2.5 inches and N is 34.4, we have D/b=DN/n=86/n.

TABLE II

n	*D/b*	*K*	*nK*	*Comment*
50	1.72	.5635	28.18	
52	1.653	.5715	29.7	The second guess is very close.
53	1.622	.5763	30.55	We have overshot the mark.

In this particular case the correct value was obtained on the second guess. The third trial was only to verify the computation and to make sure that the correct value did not lie closer to 53 than 52 turns. The first guess, namely, 50 turns, gave a value of nK so close to the required 29.8 that the second guess was increased by only two turns. It might have happened that 52 turns had overshot the mark. In that case it would have been necessary to compute nK for n=51.

Another Example

Let us take another example the more thoroughly to fix the method of cut and try. Suppose it is required to wind a coil of 100 microhenries on a form 1.25 inches in diameter using No. 30 enameled wire. Now we have L=100, D=1.25, and N=92.2, obtained from wire table. Therefore nK=40x100/1.25x1.25x92.2, or nK=27.75. Also, D/b=DN/n=115.25/n.

TABLE III

n	*D/b*	*K*	*nK*	*Comment*
75	1.536	.5894	44.2	n is much too large.
60	1.94	.5329	32.0	n is now much closer.
54.9	2.100	.5137	28.2	n is still too large.
52.4	2.200	.5025	26.3	n is now too small.

An explanation is needed for the reason for assuming fractional turns in the two last lines in Table III. Fractional turns were assumed so that the ratio D/b would be simple numbers which could easily be looked up either in tables for K or the curves in Fig. 1. This method often reduces the work to one fifth that required when whole numbers of turns are used, especially when a slide rule is employed in the computation. When long multiplication is used and a curve for K is available, as the curve in Fig. 1, it may be easier to assume whole number of turns every time.

In the tabulated work in Table III. we note that the desired number of turns lies between 54.9 and 52.4. We can get the exact number quite accurately by using a simple proportion. The difference between the turns in the last two lines of the table is 2.5 turns and this difference causes a difference of 1.9 in nK. One turn therefore should cause a change in nK of 1.9/2.5, or 0.76, assuming that the variation is linear, which is quite justifiable over small changes. Now the difference between the nK for 54.9 turns and the desired value of nK, namely, 27.75, is 0.45. Now if one turn changes nK by 0.76 how many turns will cause a change of 0.45? Obviously 0.45/0.76, or 0.59 turn. Therefore the required number of turns is 54.9 less 0.59, or 54.3 turns, very nearly.

Checking the Work

After the number of turns has been determined in this manner, the inductance should be computed as a check of the accuracy of the work. In the second example we have L=0.02505 x 1.25 x 1.25 x 54.3 x 92.2K, or L=196K. But K is 0.5092 when D/b=115.25/54.3. Hence the inductance is 99.9 microhenries. The computation is therefore as accurate as could be expected.

If we compute the inductance of the coil in the first example we have L=.02505 x 2.5 x 2.5 x 52 x 34.4 x 0.5715, or exactly 160 microhenries.

Now the question arises as to what inductance should be used in different tuners. We have found a way of computing the number of turns to give a desired inductance and a way of computing the inductance when we know the turns. But what inductance shall we use?

The inductance needed is determined by the size of the tuning condenser and the frequency to which the circuit is to tune when all the capacity is used. For example, if we have a condenser the maximum capacity of which is 200 mmfd. and if we wish to tune to a frequency of 1,500 kc. when all the capacity is in the circuit, we have enough data to determine the inductance required. We do it by the well-known formula connecting frequency of resonance, inductance, and capacity. If we express the frequency in kilocycles, the inductance in microhenries, and the inductance in microfarads, this formula takes the form $F=159/(LC)^{1/2}$. Solving it for L we have $L=(159/F)^2/C$. Either of these forms of the formula should be remembered.

Applications

Let us apply this formula to illustrate its use. Suppose we wish to make a coil that resonates to 1,500 kc. when all of a 200 mmfd. condenser is across the coil. In this case F is 1,500 and C is 0.0002 mfd. Substituting in the second form of the formula we have $L=(159)^2/.0002$. Simplifying we get L=56.18 microhenries.

Again, suppose we wish to find what inductance we need when the maximum value of the tuning condenser is 0.00055 mfd. and the lowest frequency is to be 550 kc. Substituting in the second form of the formula we have $L=(159/550)^2/.00055$. Simplifying we get L=151 microhenries. In this manner we get the inductance required as soon as we have the maximum capacity of the tuning condenser and the lowest frequency to which the circuit is to tune. Or if there is only one frequency, we get the inductance as soon as we know the capacity.

Inductances for Superheterodyne Oscillators

When we are designing inductance coils for superheterodyne oscillators we have to take the intermediate frequency into account or we will very likely get a coil that is much too large. Suppose for example that in a short-wave superheterodyne we have an intermediate frequency of 1,500 kc. and we wish a coil that with a given condenser will tune to 1,500 kc. In this case we have to design the coil so that the frequency of oscillation is 3,000 kc. Obviously, if we designed it so that it would tune to 1,500 kc. like the radio frequency tuner, the coil would have an inductance several times too large. In any case we have to add the intermediate frequency to the signal frequency and then use the sum as the frequency in the equation for the inductance.

Let us take the above example and carry it through. If the tuning condenser is 200 mmfd. we found that the inductance in r-f circuit should be 56.18 microhenries. If the condenser in the oscillator is the same and if the intermediate frequency is 1,500 kc. then the inductance of the oscillator coil should be $L=(159/3,000)^2/.0002$. Simplifying we get L=14.045 microhenries, or just one fourth the value required in the r-f tuner.

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If the intermediate frequency is not quite so high the difference between the r-f and the oscillator coils is not so great. Suppose the intermediate frequency is only 450 kc. Then the oscillator frequency must be 1,950 kc. If we substitute this value in the formula for the required inductance we get 33.2 microhenries, which is 56 per cent of the r-f inductance. If the intermediate frequency is still lower the two inductances are still more nearly alike.

High Oscillation Frequency Used

The oscillator coil is smaller than the corresponding r-f coil only when the high oscillator frequency is used and when the two condensers are to tune in signals with approximately the same condenser setting. When the lower oscillator frequency is used the oscillator inductance is larger than the r-f inductance. But the lower oscillator frequency is not used very often because of inherent disadvantages. One of these is that the set is not as sensitive and another is that it is not practical to use it when the intermediate frequency is of the same order of magnitude as the signal frequency.

Shape Factors Illustrated

In Fig. 2 are illustrated three different solenoid coils. D is the diameter and b the axial length. The coil at the left has a low value of D/b but a comparatively large value of K. The coil in the middle has a large value of D/b but a small value of K. The coil at the right has been drawn to scale to show the theoretically optimum relation of the diameter to the length. For convenience the axial length of the winding has been made unity and the diameter 2.46. No denominations are given the dimensions because only the ratio matters. That is, the dimensions may be inches, centimeters, feet, or any other units of length. In case the diameter of the coil is 2 inches the axial length should be 0.813 inch to maintain the proper relation. In case the diameter of the coil is 2.5 inches the axial length of the winding should be 1.015 inches.

The optimum ratio of diameter to length is that which gives the greatest inductance for a given length of wire and therefore the ratio that makes the resistance of the coil least for a given inductance. This is true only at low frequencies. At radio frequencies the winding should be slightly longer than the length imposed by the optimum relation at low frequencies. For example, the ratio of diameter to axial length might be 2.3 instead of 2.46. When D/b is 2.46 the value of K is 0.475755 and when D/b is 2.3 the value of K is 0.491782. K has the value 0.5 when D/b is 2.223. This value of D/b is very near 20/9, for which K may be taken as 0.5. This combination is easy to remember and it is well worthy of keeping in mind since it very nearly gives a high frequency coil the best shape.

Optimum Shape Applied

Let us apply this optimum shape factor to the design of radio frequency coils. Suppose we have a form the diameter of which is 1.25 inches and we wish to wind a coil having an inductance of 56.18 microhenries. All we have to do is to determine the turns and the size of wire, or rather the turns per inch of the wire. The formula for inductance is $L=0.025D^2n^2K/b$, very nearly. We know that L is 56.18, D is 1.25, and K is 0.5. Moreover, we know that D/b is 20/9. Substituting and solving for n we have n=40.25 turns. The axial length of the winding is 1.25 divided by 20/9, or 0.5625 inches. Therefore the wire used should wind 40.25/0.5625, or 71.5 turns to the inch. The nearest size wire can be obtained from the wire table.

Again, suppose we wish to wind a coil having one-fourth the inductance, or 14.045 microhenries. On substitution we find that we need just half the number of turns, or 20.125. Hence we need wire that winds 35.7 turns to the inch, or twice as heavy wire as that used in the larger coil of four times the inductance.

A Simple Design Formula

If we retain the 20/9 shape factor and the corresponding value of K, namely, 0.5, the formula for the required number of turns is simply $n=6(L/D)^{1/2}$, in which L is the inductance desired in microhenries and D is the diameter of the form in inches. The turns per inch is found from N=20n/9D.

Suppose we have a form 1.25 inches in diameter and we wish to wind a coil having an inductance of 4 microhenries. We have $n=6(4/1.25)^{1/2}$, or n=10.73 turns. N, the number of turns per inch, equals 18.9, which is obtained by using the second formula in the preceding paragraph.

The simple formula is slightly in error but the error is less than one per cent. Closer accuracy is never required in design work because there are many factors which are not known to this accuracy.

Table of Stations' Frequency Variations

Washington

The Radio Division of the Department of Commerce has tabulated results of its measurements of broadcasting stations' deviation from assigned frequency.

The following table offers a comparison of measurements made during the past recent months beginning with December.

	Number measured	Under 50	Under 100	Under 220	Over 200
Dec.	339	....	35 (13.5%)	66 (16.5%)	238 (70%)
Jan.	363	....	54 (16%)	102 (27%)	207 (58%)
Feb.	367	....	99 (27%)	55 (15%)	213 (58%3
Mar.	337	65 (19.3%)	63 (18.8%)	77 (22.8%)	132 (39.1%)
Apr.	314	72 (22.9%)	54 (17.2%)	92 (29.3%)	96 (30.6%)
May.	326	78 (23.9%)	89 (27.3%)	68 (20.9%)	91 (27.9%)

The Federal Radio Commission has adopted a rule, effective June 22, 1932, that all broadcasting stations "shall maintain the assigned frequency between the limits of 50 cycles above to 50 cycles below the assigned frequency."

BEST COILS FOR BROADCASTS

The single layer solenoid and the loose basket weave coils are the best for broadcast tuners. These coils are very nearly alike in their physical as well as electrical characteristics. If these coils are wound with Litz they are better than when they are wound with solid wire of equivalent cross-section.

EGERT MOVES, REORGANIZES

Wireless Egert Engineering, Inc., has moved to 179 Varick Street, New York City, and is specializing on radio and audio engineering for manufacturers and institutions. It is working on a heartbeat amplifier and also a dynatron oscillator. William Egert is head of the organization, his son, Samuel, is sales manager, and Joseph Heller is chief engineer.

COMMENT

That's the Spirit!

I HAVE noticed that some of your readers complain that diagrams published in RADIO WORLD are not complete. Rarely have I seen one that was incomplete when it was meant to be. There have been many incomplete diagrams, to be sure, but they have always been included to illustrate definate points.

If a complete circuit diagram had been published in each of these cases, the point illustrated would have been hidden among a maze of non-pertinent matter. When a diagram is included in an article to illustrate a fact, everything which is not pertinent to the explanation should be left out if the illustration is to be clear. It amuses me to read letters from fellows who say that they like a particular circuit very well and should like to build it if they only had the complete data, when that particular circuit is not a receiver at all but merely a sketch illustrating, say, how to connect a switch to achieve a definite objective.

There have been omissions of certain values at times from complete receivers, but such omissions do not make the diagram incomplete, but rather the list of parts. It seems to me that those who continually complain of incompleteness expect a full and detailed treatise on radio with every circuit diagram that appears. I for one am glad when some of the details are left out, for I have learned by reading and studying these illustrative and so-called incomplete circuit diagrams to supply the details myself. I admit, however, that there was a time when I was annoyed when I saw these incomplete diagrams, but that was before it had occurred to me what they were for. Now I welcome them.

A. W. MORLEY.
San Francisco, Calif.

* * *

Value Killed

I HAVE been reading your magazine for the past year and find it to be a good radio magazine with the exceptions that are noted in the letter of August 8, from Edward Bayard. In the last issue you showed an amplifier that I wished very much to build, but no values were shown, therefore, its value for me was killed. Not being a subscriber, there is no way for me to build the circuit.

L. W. GRANT,
456 4th St. West,
Birmingham, Ala.

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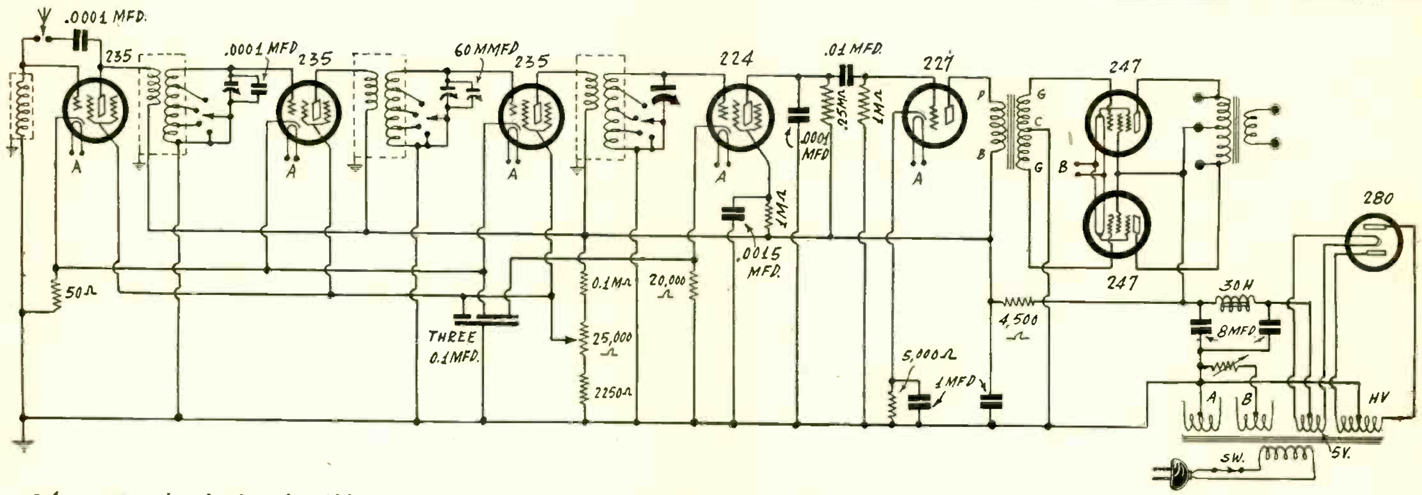
What Parts Have You?

Build a Good A-C Circuit

By Hap

HERE you have all-wave coverage for a straight tuned radio frequency receiver, where tapped coils are used. While the losses build up at high frequencies, as they always do, in this particular circuit they result in prevention of the set from producing the squeals otherwise expected on high frequencies. The choke input at the antenna for broadcasts is satisfactory, since a variable mu tube is the first radio frequency amplifier.



[*A constructional plan for this circuit will be published in an early issue.*—EDITOR.]

EVERYONE who has been experimenting with radio for any time, even only a few months, accumulates parts that have been used in trying out hookups, and often he may wish for some means of putting them to use. About the best purpose to which to devote them is the construction of a receiver, so that even though there is a set in the home already, another one may be worked in another part of the house, and may have features that the family receiver lacks.

Particularly as the newest developments in radio reception surround the variable mu and pentode tubes, and all-wave coverage, these desirable attributes may be made a part of the salvaged set.

So. Fig. 1 gives the diagram of such a receiver. There are eight tubes, including the rectifier, and the output is push-pull 247's. The type of circuit, aside from the all-wave feature, is quite orthodox.

Evened Amplification

For broadcast reception there is a special feature, however, in the building up of response on the low radio frequencies to make the sensitivity curve relatively flat. This is done by putting a radio frequency choke coil of 300 turns, wound honeycomb fashion, in the grid circuit of the first tube, relying on the antenna-ground capacity to resonate this particular circuit mildly at below the broadcast band of frequencies. A capacity of .0001 mfd. would resonate the circuit at 450 kc, but a larger antenna capacity would make the resonant frequency still lower. A side advantage of this system is that the tendency of such a receiver to squeal at the higher frequencies of the broadcast band is avoided. This is simply acknowledgment of the fact that there is not a greatly disproportionate amount of amplification at the high frequencies, as compared to the low.

Another consideration is that, for broadcast work, an antenna of large capacity is suitable, since antennas of large effective height are usually long enough to have such large capacity. But for short waves quite the opposite is required, so a series condenser of .0001 mfd. will take care of that situation. Include two antenna binding posts, connecting the aerial to one (at left in Fig. 1) for broadcast work, and to the other for short-wave reception.

Notice that the antenna input is to the plate circuit of the first tube, which is really out of circuit when short waves are tuned in. The object is to use one fewer tube for short waves in the interest of stability.

Coil Winding

The binding posts you probably have, also the series condenser, or, if you haven't .0001 mfd. you may use some capacity near that, even if as large as .00025 mfd. The choke coil has an inductance of 1,400 microhenries, and while it is possible to wind a coil of this inductance by hand, it would be a bulky affair, so if you have a choke of 1 millihenry or so you may use that, or obtain the 300-turn honeycomb.

A small shield may be put around the small-sized choke coil, but larger shields, about 3 inches diameter, 3 1-2 inches to 4 1-2 inches high, aluminum or copper, should enclose the transformers with tapped secondaries. These transformers you can wind on 1.75 inch diameter bakelite tubing. If you use a .0005 mfd. three gang condenser the total number of turns for the secondary would be 85. If you use .00035 mfd. the total number of turns would be 117. Use No. 28 enamel wire throughout.

Counting from the ground end, the secondary winding for .00035 mfd. would be, 4 turns, tap; 13 turns, tap; 44 turns, tap; complete to 117 turns. The numbers are cumulative. Include in the count the number of turns put on previously. For .0005 mfd., counting from the ground end, put on 3 turns, tap; put on 10 turns, tap; put on 30 turns, tap; continue the winding to the completion of 85 turns. Again the figures are cumulative. Include in the count the turns already put on.

The primaries in all instances may consist of 20 to 25 turns, spaced at least 1-8 inch from the secondary, but not more than 1-4 inch away. The primaries and secondaries are on the same form, side by side, and the polarities of connections are unimportant, except that whatever method is chosen should be followed throughout. A common way is to connect plate to beginning of primary, at outside, B plus to end of primary; ground to beginning of secondary that adjoins end of primary, and grid to the secondary's outside terminal.

Information on Switch

The switch arms are grounded, and the inductance is changed by shorting out turns. This is a good method, and it works. Many say that the shorting method is preferable when the number of turns to be suppressed is large compared to the number remaining. It is large in all instances here.

The switch you probably haven't got. It is a triple selector type, four point triple throw.

The biasing resistor for the radio frequency tubes is 50 ohms. If you have two of 100 ohms put them in parallel. If you have three of 150 ohms put them in parallel. If you have 150 ohms and 100 ohms put them in parallel, since the effective 60 ohms is satisfactory, too, because of the use of variable mu tubes. The biasing resistor value is in no sense critical, as the bias increases with increase in screen voltage, and as the volume control is worked, the bias shifts.

The bypass condensers across two biasing resistors and from r-f screens to ground are marked as 0.1 mfd. each, as you may have a block of three of these, but if not, use individual con-

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LIST OF PARTS

Coils

One shielded 300 turn radio frequency choke coil, duolateral wound (honeycomb)
Three shielded radio frequency transformers, wound and tapped as explained in the text; three brackets
One push-pull input transformer
One push-pull output transformer
One power transformer
One B supply choke coil

Condensers

Three 20-100 mmfd. equalizers, two used at full capacity as series condenser in aerial circuit and in detector plate circuit
One three-gang tuning condenser, .00035 mfd. or .0005 mfd.
One 60 mmfd. manual trimming condenser
One block of three 0.1 mfd. condensers
One 0.0015 mfd. mica fixed condenser
One 0.01 mfd. mica fixed condenser
Two 1 mfd. bypass condensers
Two 8 mfd. electrolytic condensers with brackets

Resistors

One 50 ohm flexible biasing resistor
One 0.1 meg. pigtail resistor
One 25,000 ohm potentiometer with A-C switch attached
One 2,250 ohm fixed resistor
Two 2,250 ohm fixed resistors for series connection to equal 4,500 ohms
One 0.02 meg. (20,000 ohm) pigtail resistor
One 0.25 meg. (250,000 ohm) pigtail resistor
One 1 meg. (1,000,000 ohm) pigtail resistor
One 5,000 ohm pigtail resistor
One 400 ohm rheostat, placed at rear

Other Parts

One chassis, 17 x 9½ inches
One front panel, 7 x 12 inches for console, 7 x 18 inches for table model cabinet
Seven UY (five-prong) tube sockets
One UX (four-prong) tube socket
One vernier dial
One coil selector switch, four-point triple throw
Two knobs to match the selector switch knob (for use on trimmer and potentiometer)
Three 235 variable mu tubes, one 224, one 227, two 247 and one 280 (fifth connection on 247 goes direct to B plus maximum)
Two antenna, one ground binding posts
One twin jack assembly for speaker
One roll of hookup wire
Three dozen 6/32 nickel plated machine screws and three dozen nuts to match

densers of any capacity from .00025 mfd. up, except that the unit across the 20,000 ohm detector biasing resistor should not be less than 0.1 mfd. and cannot possibly be too high.

Location of Trimmer

It is preferable to use a manual trimmer for improving sensitivity. This should be located across the second or middle section of the gang, affecting the third radio frequency stage of amplification. The reason is that antenna-ground capacity is in the first circuit, and so is a fixed trimmer, while the detector stage usually develops a high input capacity, leaving the middle section as the most desirable one to operate on. However, if you find the trimmer more effective elsewhere, use it there. It is simply a matter of shifting one lead.

The potentiometer is marked 25,000 ohms. It need not be that, but should be 3,000 ohms up, without limit. The resistor dropping the plate voltage to the maximum screen voltage should be about four times as great as the value of the potentiometer, however. A limiting resistor may interrupt the potentiometer's connection to ground, and any value may be used from 2,500 ohms to a few hundred ohms, or it may be omitted. The object is to prevent a negative screen voltage, so that a greater part of the potentiometer's sweep is effective for volume control.

Wattage of Plate Voltage Resistor

No voltage divider carrying large current is used, therefore we must drop the maximum voltage of around 275 to 300 volts to about 150 to 180 volts for the plates of five of the tubes. A resistor of from 4,000 to 4,500 ohms will be suitable, but must be a current-carrying device, rating at least 10 watts. Usually resistors commercially obtainable are in the 1 watt or fractional watt class, or 25 watts and up, so use the 25 watt type. The actual wattage is about 4.5 watts, but this should be at least doubled when considering commercial ratings.

The voltage for the detector screen is dropped through a resistor of 1 meg, of the usual grid leak type. Computation showed that a value of 1.3 meg. would be suitable, but 1 meg. is the nearest commercial unit readily obtainable, or you may use 1 meg. and 0.25 meg. in series, to constitute 1,250,000 ohms, which is virtually the theoretical preference. Across this resistor, for radio frequency purposes only, a bypass condenser is placed, and should be no lower than 0.0015 mfd. and may be as high as possible. Omission of a condenser at this point robs the circuit of about 40 per cent. of its sensitivity.

The biasing resistor for the first audio tube, a 227, is 5,000 to 7,500 ohms, not critical, and across it goes a condenser of 1 mfd. or higher capacity, the higher the better.

A push-pull transformer you have or should obtain, and hook it up as shown. The grid return goes to ground. The bias for the output tubes is obtained through a resistor, across which no bypass condenser is placed, as none is needed, the current being equal but opposite in phase, when the push-pull stage is a balanced one, and the resistor presenting then no impedance to the signal.

Power Transformer

Since a power transformer intended for the 245 tube, with higher plate voltage (around 300 volts) may be on hand, a 400 ohm rheostat enables fixing the bias so that the total current of plates and suppressor grids of the pentodes does not exceed 80 milliamperes (40 ma per tube). The set as a whole will draw less than 100 milliamperes.

Filtration is provided by a 30 henry choke, a husky one, due to the high current, and by two 8 mfd. electrolytic condensers.

The power transformer should have windings suitable for heating the heaters and filaments and supplying the rectifier plates. A transformer with a 2.5 volt secondary, 10 ampere rating or higher, will do for the three r-f tubes, detector and first a-f. The 247's use a separate winding of 2.5 volts, 3 amperes. The 280 filament takes 5 volts, and the high voltage winding may give 275 to 300 volts d-c under load.

Other transformers may be pressed into service. If you have one that has a 5-volt extra winding (besides the one for the rectifier) then connect two of the heaters in series across the 5 volts. If there is a high current 1.5 volt winding on your transformer, if you heat one 235, 224 or 227 tube with it the result will be about 2 volts, which is sufficient. Also, it is practical to heat the heaters and the 247 filaments with one 2.5 volt winding, provided the rating is 12 amperes or more. If there is no center tap on the 2.5 volt winding to serve the 247's, use a center-tapped resistor of about 30 ohms, but nothing around 200 ohms or so. If there is no center tap on a winding to serve only heater type tubes, don't bother with putting a resistor across to obtain center.

The power transformer should have a primary suitable for the voltage and frequency of the alternating current. This is usually 110 volts, 50-60 cycles, in the rating, and will take care of not only the frequency difference stated, but also voltage differences that usually arise, without causing any harm.

The output transformer is necessary if you have a magnetic speaker, or a regular dynamic that has a one-sided but not a push-pull output transformer built in. If the speaker has a suitable transformer for push-pull, use it, ignoring the diagram to that extent. The inductor dynamic may be obtained with center tapped magnet coil, and then no transformer is needed, even though one is not in the speaker, for the push-pull impedance connection is excellent. If you have a center-tapped audio choke coil you may use that in place of a transformer, connecting speaker to plates of the tubes directly, the center of the choke to B plus. If your speaker has a field coil around 3,000 to 5,000 ohms, that may be used instead of the 4,500 ohm resistor, or if 400 to 800 ohms, in place of the B choke.

When you have completed the receiver you will find it a good performer and will be glad that you put your surplus parts to such use.

* * *

[Readers having parts they desire to use in this circuit, or in similar circuits, may write to the author, and he will advise them on the subject. Address Mr. Hapgood Force, care of RADIO WORLD, *145 West 45th Street, New York, N. Y.*—EDITOR.]

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Readers Tell Their

Converter Tuning Divergence and Noise

[When the Short-Wave Club was started recently the statement of objects included the exchange of ideas and experience through these columns, and readers were asked to join the club at no obligation, and send in report letters for the benefit of their fellows.

No doubt many of the letter-writers will be repaid by reading something valuable from the pen of others, and also all readers will gain an advantage, whether members of the club or not. However, it is respectfully suggested that if you are interested in short waves that you join the club, using the coupon on the opposite page, or sending in the same information on a separate sheet of paper, even a postcard, if desired, so that you may be enrolled.

Publication of your name as a member of the club, which will follow soon after your enrolment, also will bring you literature from manufacturers of short-wave apparatus, and thus you will improve your insight into present-day short-wave activities.

Large stacks of letters have been received, and this week we are beginning their publication. Some of the letters to follow will require diagrams for illustrating circuits used by readers, with which they obtained exceptional results. That is certainly one fine advantage, to be able to capitalize on the other fellow's experience, and thus steer clear of a great deal of trouble in a field of endeavor that admittedly is not wholly free from trouble.

Much is yet to be learned about short waves, and it is hoped that the Short-wave Club will be instrumental in disseminating a great deal of helpful and valuable knowledge on this subject.—EDITOR.]

Trouble With Resistance Audio

IN my experiments with television amplifiers using screen grid tubes in resistance coupled circuits I have had a great deal of trouble from oscillation. It seems that no matter how few stages I use the oscillation persists. For example, when I use only two tubes, one a screen grid tube and the other a pentods, there is a strong oscillation. The theory of motorboating which you have expounded says that a circuit having only two plate circuits is the most stable and that it cannot oscillate. My experience seems to refute the conclusions. Yet in circuits using three element tubes, the theory is apparently correct. I have been unable to find any cause for the misbehavior of the screen rid resistance coupled amplifier. If you have the correct solution of the problem an article on the subject would be valuable for there are many who have run into the same difficulty, judging from the total absence of screen grid resistance coupled amplifiers of high gain.

On suggestion regarding the cause of the trouble may contain the solution. This says that the trouble is due to secondary emission of the plate of the screen grid tube. If this is correct the difficulty could be solved by using a pentode amplifier, if a suitable tube of this type with high gain could be found.

Another possible explanation of the trouble is found in the theory of motorboating. You have said that a resistance coupled amplifier having four plate circuits on the same power supply is stable except when the frequency is so low that the stopping condensers change the phase of the signal considerable. According to this oscillation would be possible at the very low frequencies if the gain is high enough. Is it possible that the gain in a two stage amplifier and the phase shift in the stopping condenser in a two tube circuit are high enough to cause oscillation? If it is, the oscillation should stop if the stopping condenser is large enough and also if the grid leak resistance is high enough.

I should like to see a full discussion on this subject and I should also like to hear what others have found in this connection.

JAMES W. MERRILL,
New York, N. Y.

His Efforts Repaid

I HAVE played around a great deal with short-wave converters, and on the whole I have been quite successful. However, my success did not come without effort.

At first I had some trouble just because I did not realize the difference between short and broadcast waves. One thing that gave me some trouble was the assumption that the radio frequency tuning coil and the oscillator coil should be the same as to inductance when I used the same size condensers. When I made allowance for the difference in frequency between the two, the difference being the intermediate frequency, I began to get good results.

Before, the change in the coils reception seemed to be very erratic. Sometimes I would have a large oscillator coil and a small r-f coil when the results were best. At other times I would have a small oscillator coil and a large r-f coil. Now I always get consistent results and I can log my stations. The oscillator coil is now always smaller than the r-f coil. I have your articles to thank for the tip which led me to good results, especially the clear expositions by your master mind, J. E. Anderson.

Another difficulty I had at first was noise and interference. The noise, I found, was largely due to too close coupling between the oscillator and the detector. I tried various methods of coupling and it does not seem to make much difference which method is used just so there is not too much of it.

As far as results without effort are concerned, I have had best luck with the circuit in which the input to the detector was untuned, but as far as real distance is concerned I have much better luck with a stage of tuned radio frequency, the tuned circuit being between the first tube and the detector.

Often it is difficult to find distant stations with this type of circuit, but the finding is made easier by logging stations and hunting around on the dials where the distant stations are supposed to come in. I have got so now that if I don't find a station after a minute of hunting, I conclude that it is not on the air.

One peculiarity with the converters which I have noticed is that when I put my hand near the oscillator the signals become much stronger. I attribute this to the antenna effect of the body and direct coupling between that antenna and the oscillator. Perhaps this is not the correct answer.

If someone else has noticed the same effect and has a different explanation, I should like to hear about it. I realize that as my hand approaches the oscillator coil the frequency is changed, and it may be that the hand acts as a vernier tuner to fit the generated frequency to the intermediate frequency. However, I have investigated this and it does not seem to be the correct explanation of the increased volume.

I have a suggestion to make. We fellows need a lot of dope on coil winding, and you can increase the value of your paper by supplying it. We need accurate wire data, formulas and methods for computing coils for different diameters of forms, different wire sizes, different frequencies, and different tuning condensers. Give us all you can dig up.

ARTHUR F. DAVIS.
Milwaukee, Wisc.

* * *

All Set, But Not Started

WELL, well, well! I am all set to go on a de luxe superheterodyne but I cannot make up my mind which one to build. I have collected about all the superheterodyne circuit diagrams that have appeared during the last five years but most of them are out of date because of the introduction of new tubes.

If I am to build something good along this line I want it to be up to date in every respect. If you have something in the making that you plan bringing out early this Fall I shall wait for it.

When and if you bring out a good super, please give the details so that we fellows can build it from the ground up.

And that reminds me what I have in mind. Why not bring out a set that is built in tiers on the grandfather clock pattern? Such a receiver should be designed so that it can be built in sections to be mounted vertically. The radio frequency tuner might be in one section, the intermediate frequency amplifier in another, the audio amplifier in still another, and so on. Perhaps the audio amplifier and the power supply could be built in one section. It would not be a bad idea to include a phooograph turntable in the arrangement, and even a short-wave converter.

I hope you will overlook my presumption in making these suggestions, for I make them on the assumption that there are many more fans who are looking for the same type of receiver. I know several who are looking for something exceptionally good.

WILLIAM A. PATTERSON.
Atlanta, Ga.

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[Herewith is a list of new members of the Short-Wave Club. Read coupon below.]

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William Armstrong, 424 West 26th St., New York, N. Y.
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Speaker-Operating

Pentode Tubes Used

By J.E. Anderson

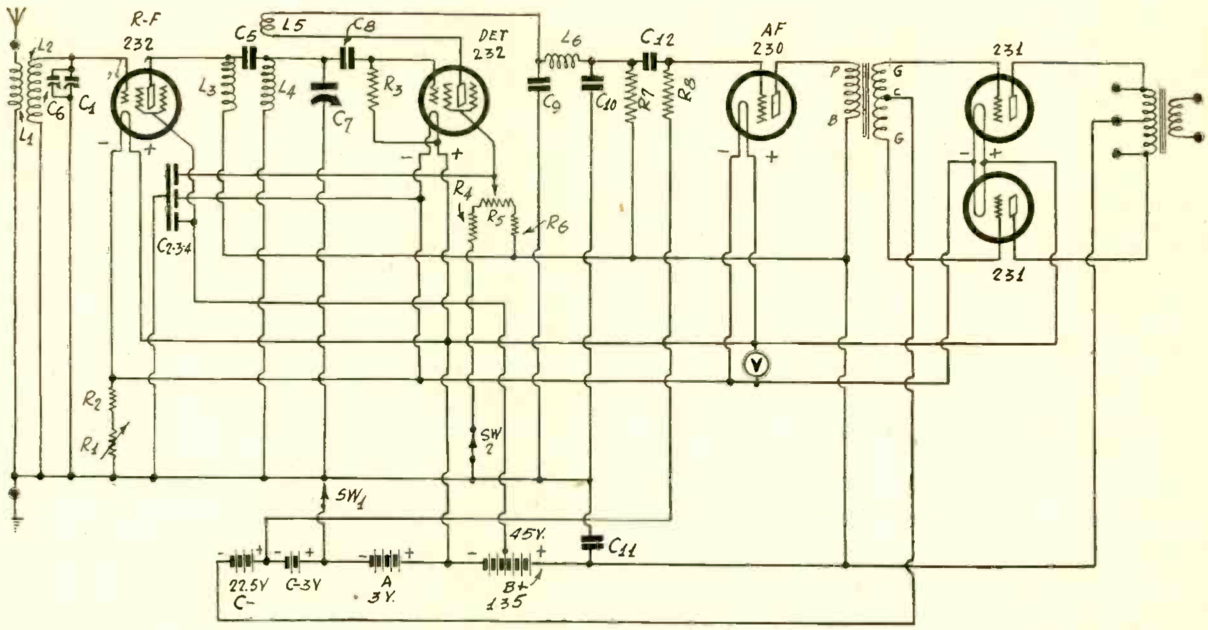

Fig. 17

A short wave set for operation from a 3 volt battery source, using 2 volt tubes, two 232, one 230 and two 231 in push-pull. The 231 tubes draw 0.13 ampere each, and it is not economical to use 2 volt pentodes in this circuit with a dry battery A supply.

[This is another of the series of articles dealing with the construction of short-wave receivers. Previous circuits had to do with earphone reception, but this week the circuits are for loudspeaker operation. Other articles in this series will follow—EDITOR.]

SINCE the circuits discussed so far were intended for earphone use, with one stoge of resistance coupled audio included, only one more stage of audio frequency amplification need be included to provide loudspeaker reception.

However, to produce suitable volume that extra stage has to be transformer coupled because of the step-up ratio of the transformer, which increases the voltage in the secondary in proportion to the ratio of the number of primary turns to the number of secondary turns. Other systems would require three stages of audio frequency amplification to attain about the same volume, or a little more, as compared to the present circuits. The others would be of the direct-coupled type, either resistance or impedance coupled or combinations of resistance and impedance coupling.

While there is one more stage of audio frequency amplification, two more tubes are required, because in every instance the output stage is arranged as a push-pull circuit. Where transformer coupling is used it is well to select push-pull, as the tone quality is better. There is no greater amplification from a push-pull stage, but there is greater power handling capability, that is, a larger input can be handled without distortion, hence so can a larger output. The maximum undistorted power output is about four times as great as with a single-sided stage.

The Coupling Transformer

The coupling between the first audio tube and the push-pull stage is made through an interstage push-pull transformer. This has an untapped primary and a center-tapped secondary. The primary is connected in the plate circuit of the first audio tube, and therefore it is preferable to use a general purpose tube in this position, since a screen grid tube of any type will not be properly accommodated by a transformer primary, the winding being of too low inductance. In fact, it is scarcely practical to wind a coil that will provide as suitable an impedance for the plate circuit of a screen grid tube as is the primary of any good transformer for the plate circuit of a general purpose tube, e.g., 201A, 230, 237 or 227.

The two extremes of the secondary are connected to the grids of the two output tubes, while the center tap is connected to C minus. In battery operated sets C minus is a position on the C battery, while in AC sets it is grounded B minus in these circuits, the negative bias resulting from the voltage drop in a biasing resistor interposed between filament and grid return. Since B minus is the most negative point, and since there is a voltage drop, the filament is therefore positive in respect to the grid return, or grid, and the grid bias is naturally negative.

Pentode Tubes

Where practical, pentode tubes are shown in the output. These have a much greater amplification factor, or mu factor, as it is preferably called, than any other output tubes. In one instance it is not economical to include the pentodes, despite the greater gain, because of increased filament current and limited current capacity of the A voltage source. For instance, where you have only four dry cells, two in series each time to produce 3 volts, the series pair in parallel to increase the current capacity, the A battery thus constituted would not last long if the drain exceeded 0.5 ampere. Since the 2-volt pentode draws 0.26 ampere, a pair of these tubes in push-pull would draw 0.52 ampere (already exceeding the limit) and the three other tubes would draw 0.18 ampere more, the total is 0.7 ampere, which is far too much.

It would be necessary, then, to use three or four series sets of dry cells, all of the series then in parallel, which condition approaches, if indeed it does not exceed, practical economical operation.

Pentodes on Storage Battery

However, if a 6 volt storage A battery is used then the pentodes may be included, the three tubes ahead of the pentode having their filaments in series, and the pentode filaments being in parallel with the A source, a resistor dropping the 6 volts to the desired 2 volts. The theoretical value of this resistor is 7.7 ohms, but for practical purposes 8 ohms may be used, and may consist of two 4 ohm units in series, as 4 ohms is a readily obtainable value, being the resistance otherwise used to drop volts to 5 volts for operating one 201A tube or other 0.25 ampere filament tube of the same filament wattage.

Connections to Speaker

For push-pull output a special coupling is required. This is either a push-pull output transformer, as diagrammed, or it may be simply a center-tapped audio frequency coil or center-tapped B supply choke coil (single winding). If a transformer is used, the primary has the larger number of turns and is connected in the plate circuit, with extremes of the winding to the respective plates, and center tap to B plus maximum voltage. The speaker is then

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Short Wave Sets

in Output Wherever Practical

and Herman Bernard

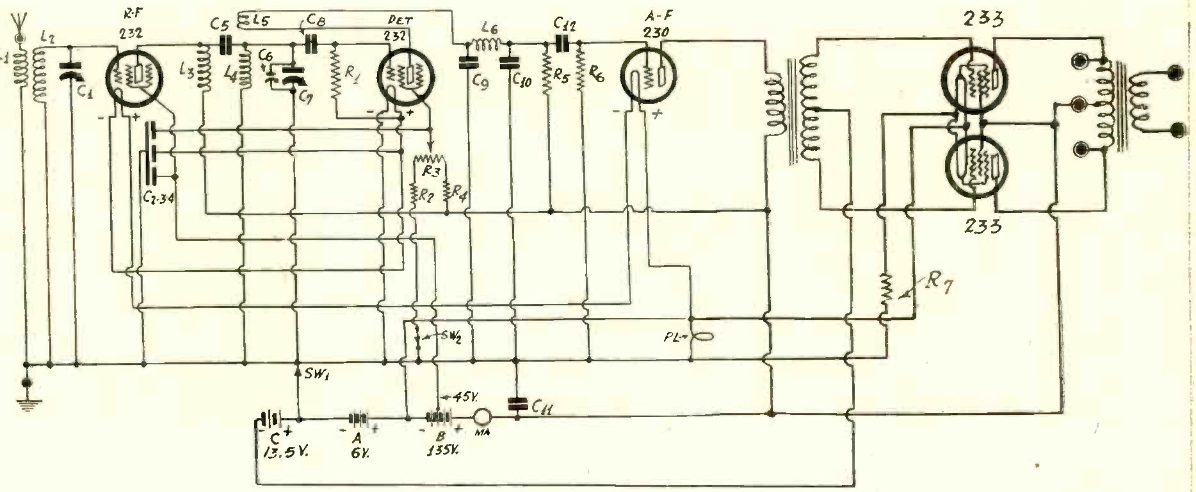

FIG. 18
The same circuit as that shown in Fig. 17, except that a 6-volt storage battery is used, and the output tubes are pentodes, two 233's.
The three other tubes have their filaments in series across the 6 volts, giving each tube the required 2 volts. The pentodes' filament voltage is approximately 2 volts when the filament resistor is 8 ohms.

connected to the secondary.

If a center-tapped impedance is used, which may be visualized by disregarding the secondary of the diagrammed output transformers, then the speaker may be connected to the respective plates directly, and no direct current will flow in the speaker's magnet coil.

Some types of inductor dynamic speakers—a variety that does not require any power to actuate the coils in the speaker except that supplied from the plate circuits of the output tubes—have a center-tapped magnet coil, and the connections are those for any center-tapped impedance. The middle lead, usually of a different color than the two others, goes to B plus, the two similarly colored tipped leads to the plates. Binding posts or jacks in such an instance would be connected to the plates to facilitate introducing the speaker cord tips to a firm anchorage.

Dynamic speakers are popular, and these are of several different types. One type has only the voice coil, with posts to which to connect an output transformer's secondary. Such a speaker would be used with the circuits diagrammed herewith. Another type has an output transformer built in, but the transformer is of the single-sided type, not suitable of itself for push-pull, since there is no center-tap on the primary.

Coupling Considerations

In such an instance the speaker's output transformer may be connected to the set's output transformer, or the speaker's output transformer may be disregarded, and the output from the set's transformer connected to the voice coil. However, this connection would require tampering with the speaker, and those not fully conversant with dynamic speaker construction should not attempt the substitution. Moreover, the output transformer in the dynamic speaker, even though of small size and not always of the best frequency characteristics, at least has a secondary with impedance fairly well matched to the impedance of the voice coil, whereas with a random, output transformer in a set connected to the voice coil of a dynamic speaker, where the impedances of neither is known, probably would give not so good results as the use of the two transformers.

The other instance is that of a dynamic speaker with a push-pull output transformer built in. When such a selection is made it is well to choose a speaker that has a transformer matched for the tubes to be used. For instance, there are many dynamic speakers on the market with push-pull output transformers designed especially for pentode tubes. These tubes have a much higher output impedance than other power tubes.

Matched Impedances

Matching of impedances, where vacuum tube plate circuits are compared with loads put on them, does not mean that the impedance should be equal, but that the load impedance should be twice as great as the tube's plate impedance. This produces the greatest undistorted power output, not the greatest transfer of energy. For greatest transfer of energy the impedances should be equal. However, the chief interest is quality, since the audio amplifier provides the necessary gain.

The pentode tubes are relatively new on the American market, therefore some may not be familiar with their connections. The only heater type pentode is the 238 of the automotive series, and since it has a cathode there are six connections: two for the heater, one for cathode, one for suppressor grid, one for plate—these five being represented by prongs on the base, connecting to a UY socket, —while the control grid is the cap on top of the glass envelope. Hence this tube resembles in general appearance the familiar screen grid tubes, 222, 232, 224 and 35, but is smaller in size.

The heater is comparable to the filament of filament type tubes, so far as connections are concerned, although the heater does not emit electrons but simply supplies heat to the emitting cathode. The suppressor grid is the one connecting to the same high B voltage as does the plate return. The object is to reduce greatly the secondary emission, or the bouncing of electrons from plate back to the filament, which would retard the electrons newly darting from the emitter to the plate and thus would keep the mu low. The suppressor grid is really a screen, therefore all pentodes are screen grid tubes.

The 233 and the 247

Where an extra grid or screen is shown as connected to the filament, this is made in the tube as part of the construction, and requires no external connection.

All the pentodes require UY (five-spring) sockets and all of course have five-prong bases.

The 233 is a filament type pentode, the filament having a grid or screen attached to it as a constructional adjunct, and the 247, the alternating current tube, is of the same general physical structure, although on a larger scale, and requires the same general connections. The unusual one is that the fifth prong (the cathode connection for the 227, 237, 224 and 235 types) goes to the maximum B voltage, the same as the plate does, and represents the suppressor grid.

The control grid is the G post of the socket or equivalent prong of the tube, the plate is the familiar plate, while the filament goes to the A source. In battery sets, for the 233, the battery voltage, suitably dropped, is supplied to the filament, and bias results from connection to a C battery.

The C biasing voltages shown in the diagrams are the applied C voltages, and do not designate that the battery voltage as stated shown are cumulative. Where 22.5 volts are specified, for instance, lower voltages for C biasing of other tubes may be taken off the same battery the total voltage of which is 22.5 volts. The sum of the voltages is not meant.

The 247 pentode tube, being fed by the secondary of a filament transformer or power transformer, has its bias provided by the drop in an interposed resistor, as explained, so that only in respect to the method of bias attainment do the two tubes differ in connections.

[*Fig. 19 on front cover*]

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Straight Frequency Line Con

Problem of Frequency Difference in T

By Herma

ONE of the most interesting subjects to-day is that of the all-wave superheterodyne. Many different ways of attaining the desired results have been discussed, some of which alter the capacities in the tuning circuits, some the inductances, and some both.

When the inductance is altered it may be done by the tapped coil method, either shorting out undesired turns or leaving them in circuit but outside the tuned part. But it is also practical, as has been shown a few times in these columns, to use different coils, and simply pick up by a switching arrangement the particular inductance for the band to be covered. This method takes up more room but has certain advantages.

If a straight line frequency condenser is used for tuning, then there is no necessity for using a padding condenser arrangement in the oscillator, but the two companion coils for each tuning range, modulator and oscillator, may be made of different inductive amounts to take care of the needs.

Make Oscillator Higher

If the frequency of intermediate amplification is 175 kc., then the two coils would have to be so constructed that at any given setting the tuning would be 175 kc. apart, and preferably the oscillator tuning should be the higher frequency. So, to bring in 1,000 kc. the modulator would be tuned to that, and the oscillator to 1,175 kc. But only with straight frequency line condensers can the inductance be relied on to give the necessary difference on all-wave coverage. Even gang condensers with specially shaped plates for the oscillator would be reliable only for the broadcast band.

It can be seen from the diagram how simply the system can be worked out, when using a two-gang .00035 mfd. tuning condenser with straight frequency line plates.

If series capacity is used in the antenna circuit, to remove as far as necessary the capacity effect of the antenna-ground system, and if a dynatron oscillator is used, then all you need is a single winding for each of the coils. Two equalizing condensers with maxima of 200 mmfd., in parallel, used as a series-connected unit in the antenna circuit, will enable adjustment, so that differences in antenna capacity in various installations will cease to be a problem.

Coil Construction

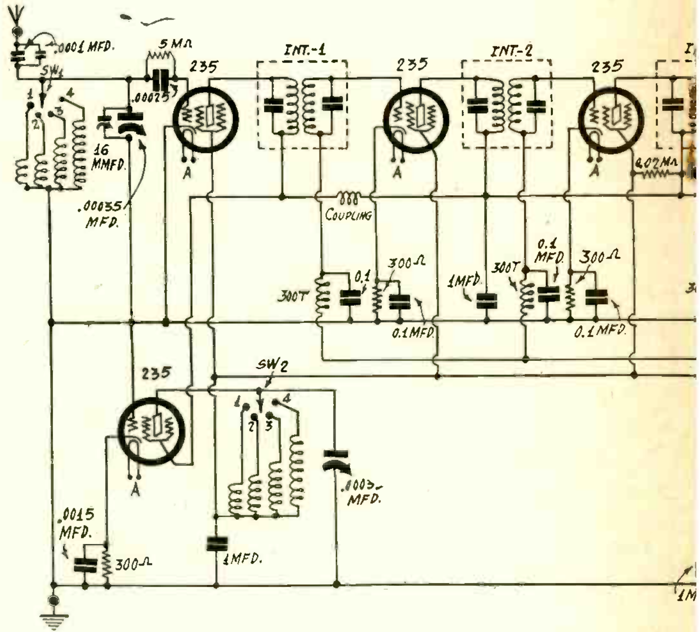
While coils to cover short waves usually have to be determined empirically, an idea of the number of turns can be gleamed from the knowledge of what is required for broadcast band tuning and what the frequency ratio is for a given tuning capacity. Here we have .00035 mfd. If no shielding is used, and the diameter is 1.75 inches, then the number of turns for the modulator tuning, to cover the entire broadcast band, would be 70, the size of wire not being of much importance, but No. 28 enamel is suggested. This winding is easily accommodated on tubing 1.5 inches high, as No. 28 enamel wire winds 74.1 turns to the inch, thus about .5 inch is left for a mounting bracket. Coil No. 4 is in mind for the modulator.

Since the frequency is approximately proportionate to the number of turns we can determine how many turns the oscillator should have. Take for convenience a frequency near the geometric mean of the broadcast band, 1,000 kc. (actually the mean is 908 kc.). The oscillator will be 175 kc. higher, or 1,175 kc. Therefore the oscillator will have a total number of turns 1,000/1,175 of the modulator total, or 40/51. The modulator has 70 turns, so the oscillator will have 40/51 x 70, equals 54.12 turns. To assure overlap in tuning from one band to another, make the oscillator total 56 turns. Any compensation can be taken up by the 16 mmfd. (or higher) capacity trimmer in the modulator circuit. This is manually operated.

When the Ratio is Lower

The coil will tune from about 550 to 1,500 kc. The frequency ratio is 1-to-3, approximately, and is nearer than disclosed, because the coil will tune higher than 1,500 kc. and a little lower than 550 kc. Therefore the modulator would require, for coil No. 3, one-third as many turns as the previous coil, or 1/3 x 70, equals 23.33 turns. Again for overlap purposes, make this winding 25 turns, and the lowest frequency will be about 1,300 kc., while the highest will be 3,900 kc. The geometric mean is 2,270 kc., so we may use 2,500 kc.

Performing the same arithmetic method as before, the oscil-



FIG

A 10-tube superheterodyne for all-wave reception, about 20 also a rectifier type detector with resistance coupling to a output transformer built in, include only the three p

lator tune should have a number of turns equal to 2500/2675 of the other, or 100/107 x 25, equals, 23.36 turns, which we will make 23.5 turns, because the frequencies are beginning to run high, and modulator trimmer will take up large frequency discrepancies.

For the next two coils we can rely on the trimmer entirely, and make the number of turns the same on both windings. The frequency ratio does not obtain now, due in part to the distributed capacities being relatively more effective, and to the heightened skin effect, the result being less actual inductance than we might suppose without a knowledge of these special factors. Instead of reducing turns by 66.6 per cent., we shall reduce them by 40 per cent. Thus instead of 1-to-3 the ratio is 1 to 2.5. The amount left is not one-third but two-fifths of the number of turns on the previous coil.

We had 25 turns, and 40 per cent. of that is 10 turns, for coils. At broadcast frequencies it may be permissible to have 4 turns.

In the case of coils Nos. 2, 3 and 4, larger size wires may be used than No. 28, indeed, is preferable. For instance, coils No. 3 and 2 may have No. 18 wire, coils No. 4 No. 16 or No. 14 wire.

When Shielding Is Used

The previously cited cases do not include data if shields are used. The usual type of shield, about 3 inch diameter aluminum, 3½ inches high, requires 117 turns instead of 70 turns, to cover the broadcast band, while the proportionality of the number of turns may be worked out on the previously cited basis.

Shielding, if used, should not be close to either of the coils. At broadcast frequencies it may be permissible to having the shielding as close as one radius to the coil but at high frequencies it should be greater in proportion to the frequency, at least as far as practical. The coupling may be reduced by keeping the coils far apart, or at right angles, by isolating the circuits by means of series chokes in the supply leads and by-pass condensers across the leads. These precautions, however, are not substitutes for shielding. They should be additional. While it is possible to build a short-wave superheterodyne that works without all the precautions it is safer to observe them.

The coil marked "coupling" serves to unite the modulator and

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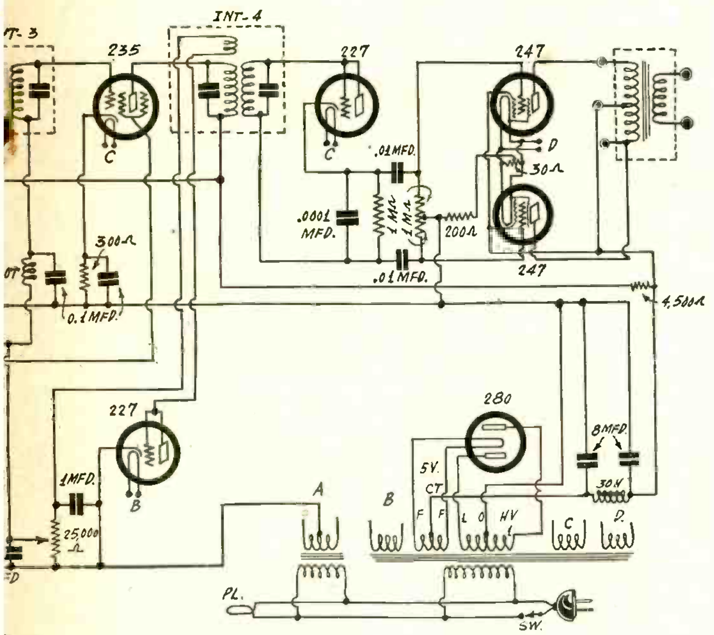
densers for All-Wave Supers

wo Tuned Circuits Greatly Simplified

Bernard



G. 1

meters to below 545 meters. A dynatron oscillator is used, push-pull pentode output. If you use a speaker with push-pull sts at left in the output, otherwise only the two at right.

the oscillator circuits. It may consist of 15 turns of any convenient size wire on a diameter about that of a pencil. This would be fine for the higher frequencies. If the coil were made large, so that coupling would be strong in the broadcast band, it would be too strong for the short waves, particularly the very short ones. So it is suggested that the coupling consist of the small coil as mentioned, and that in addition, in series therewith, a radio frequency choke coil of about 1 millihenry inductance, with a small condenser across it, say, 0.0001 mfd., be used. The condenser is across the choke only. On the short waves the choke-condenser combination will act as a condenser principally, while on the broadcast waves it will act as a choke principally, therefore the coupling will be greater the lower the frequencies, which is what is desired.

When the oscillator is coupled by means of a small winding around the oscillator coil and connected in the grid circuit of the modulator the coupling is likely to be too close even when the winding consists of only one or two turns when the frequency of the signal is of the order of 10,000 kc. In fact, in some cases a quarter of a turn has proved to be too much. Likewise when the coupling is by means of a loop threading the oscillator and radio frequency tuning coils the coupling is likely to be too close when there is a single turn loop, or half a turn on each coil.

Coupling in Plate Circuit

When the pick-up coil is connected in the plate circuit of the modulator there is not so much danger of getting excessive coupling because the tuned circuits are then separated by the modulator tube, if coupling is to modulator grid.

The coil switch used is a dual selector rotary type, known as four-point double throw. One knob actuates both switches. The shaft should be electrically insulated, that is, connected to nothing electrically, serving only a mechanical objective.

The modulator is of a standard grid leak-condenser type. The oscillator, however, is a dynatron, which functions on the basis of a negative resistance being created in the tube by applying a higher voltage to the screen than to the plate. If the usual voltages are reversed this object is fulfilled. The 235 variable mu tube performs the function capably, especially as it is never desired to obtain a large output from an oscillator in a superheterodyne, less the modulator be greatly overloaded.

The intermediate channel consists of three stages, feeding a special type of detector. The primaries and secondaries are 800-turn honeycomb coils, the condensers across them adjustable from 20-100 mmfd.

Automatic Volume Control

An automatic volume control is introduced in the intermediate channel, the potentiometer (25,000 ohms) serving also as the manual volume control.

Part of the voltage in the coupler uniting the third intermediate stage to the detector is fed by a 300-turn honeycomb coil into the 227 automatic volume control tube, which is hooked up as a simple diode, or single-wave rectifier. The rectified current then flows in the potentiometer, and as much of it is taken off for additional negative bias as desired. A grid bias, of 1.5 volts negative, obtained in usual manner, is the minimum, while the volume control increases the bias by a relatively large voltage, if so selected, even beyond 10 volts. This depends considerably on the closeness of coupling of the pickup coil in the fourth intermediate coupler.

The special detector is very much like the automatic volume control hookup. However, the rectified current is made to flow through the 1 meg. resistor between the cathode and return of the anode. Due to the independence of the output from any grounding it is practical to feed this resistance coupling to a push-pull stage. Two 1 meg. resistors are used on the power stage side of the 0.01 mfd. isolating condensers.

LIST OF PARTS

Coils

Two sets of four coils to cover the band, 20 to 560 meters, total eight coils.
Three shielded 175 kc intermediate transformers (Int. 1, 2 and 3).
One 175 kc intermediate transformer with pickup coil for automatic volume control (Int. 4).
One coupling to unit for modulator and ocsillator (see text).
Three 300 turn honeycomb choke coils on 1-2 inch diameter.
One push-pull output transformer.
One power transformer.
One B supply choke coil, 30 henries.

Condensers

Three 0.0001 mfd. condensers (20-100 mmfd. equalizers at maximum).
One two-gang 0.00035 mfd. straight frequency line tuning condenser.
One 16 mmfd. manual trimming condenser.
One 0.00025 mfd. grid condenser with clips.
One 0.0015 mfd. fixed condenser.
Four 1 mfd. bypass condensers.
Two blocks, each containing three 0.1 mfd. fixed condensers.
Two 8 mfd. electrolytic condensers.
Two 0.01 mfd. mica condensers.

Resistors

Four 300 ohm flexible biasing resistors.
One 5 meg. tubular grid leak.
One 0.02 meg. (20,000 ohm) pigtail resistor.
One 25,000 ohm potentiometer with A-C switch attached.
Three 1 meg. pigtail resistors.
One 200 ohm 25 watt resistor.
Two 2,250 ohm 25 watt resistors in series to constitute 4,500 ohm.
One 30 ohm center tapped resistor.

Other Parts

One chassis, to accommodate ten tubes.
Nine UY (five-prong) and one UX (four-prong) sockets.
Antenna and ground binding posts.
One twin jack assembly post for speaker.
One vernier dial.
One coil switch, four-point double throw (shaft insulated), knob.
Two knobs, one for volume control and one for manual trimmer, to match coil switch knob.
One front panel.
Five 235 tubes, two 227 tubes, two 247 tubes and one 280 tube.
Four dozen 6-32 machine screws and four dozen nuts to match
One roll of hookup wire.

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Status of Television

Experts Agree Present Results in Homes

DR. C. B. JOLLIFFE

Chief Engineer, Federal Radio Commission

THE very idea that pictorial events ultimately may be flashed through space into the homes of the nation has captured the public fancy and has aroused interest everywhere. It may be frankly stated that this almost frenzied expectation on the part of the public is not warranted.

Unfortunately, as occurs in the case of every novel development having revolutionary possibilities, unscrupulous individuals and organizations are taking advantage of the widespread publicity being given television. Fictitious television companies apparently have been organized by the score, offering to the gullible public worthless stock with promises of fabulous profits.

Widely divergent statements as to the status of television have been made by figures in the industry. A consensus seems to be that it will become a practical mode of public entertainment and enlightenment within a year, with some contending that it is sufficiently good now to warrant public acceptance, while, at the other extreme, five years is predicted as the minimum time needed.

In so far as the engineers of the Commission are concerned, they hazard no guess as to how much time will be required, but feel that much remains to be done that might change the whole complexion of visual broadcasting. A vital factor, which the public is inclined to ignore, is that of the space available in the ether to accommodate television, even should the apparatus for the transmission and reception of radio pictures be perfected.

To obtain proper definition of the images transmitted it appears today that a wide band of frequencies will be required. While later developments may overcome this obstacle, the situation exists now, and there is not sufficient room in the usable portion of the radio spectrum to accommodate television on anything like national scale.

Four television channels 100 kilocycles in width, or ten times as wide as the ordinary broadcast frequency, have been set aside in the continental short-wave band for experimental television, and are hardly sufficient to accommodate any appreciable number of stations except on a strictly local coverage basis.

In addition, however, four channels in the ultra-high frequencies, above the 23,000-kilocycle limit established internationally as the usable portion of the band, have been designated for experimentation, and it already has been ascertained that they are useful for local service of a rather limited character. Since these frequencies are unused except for general experimentation, there now appears to be ample space for numerous "local" television stations.

These frequencies—ranging above 43,000 kilocycles as high as 80,000 kilocycles and above—are so high as to simulate the effect of light when used in transmission. In other words, it seems that visual pictures may be transmitted on these channels to any point from which the transmitter itself is visible and not obstructed by other high structures or the contour of the earth.

For that reason several of the experimenters in the ultra-high frequencies, are planning tests from great heights in order to procure maximum coverage. Since the effect of ultra-high frequency transmission is similar to that of a beam of light emitted in all directions, these experiments are designed to avoid obstructions which would block off or absorb the impulses sent from the visual transmitter.

Since it seems likely that these ultra high frequencies will be used for television of the future, and that their coverage will be purely local, the question of "chain" television, like chain broadcasting, may arise. Chain broadcasting stations are linked by telephone lines of wide frequency ranges, in order to reproduce the programs with fidelity. In the case of television, wires with ranges vastly superior to those now used must be developed to link stations and to permit the transmission of visual pictures over long distances from the "key" station and studio.

While it is technically possible to provide such lines of high frequency ranges, the cost for the coverage of appreciable distances at the present time would be prohibitive. Experiments over a three-mile distance with special visual broadcasting lines entailed an expenditure of many thousands of dollars, and the lining up of a whole network to carry television programs with such apparatus would be out of the question.

Television experimentation largely is being centered in the development of transmitting apparatus. Some television receiver models now are being marketed to pick up the programs of the score of licensed experimental stations, most of which now are operating on regular program schedules.

From the industry it is reported that it will be another year or more before television in its earliest form will be available for the public. Most manufacturers have agreed that they should not plan to present television, even in its earliest stages, before the Fall of 1932.

—From "The United States Daily."

* * *

ADVISORY COMMITTEE ON ENGINEERING

of the National Advisory Council on Radio in Education

Dr. Alfred N. Goldsmith, vice-president and general engineer, Radio Corporation of America, chairman; Dr. W. C. Cady, Wesleyan University, Middletown, Conn.; Orestes H. Caldwell, former Federal Radio Commissioner; E. K. Cohan, chief engineer, Columbia Broadcasting System; Lloyd Espenschied, high frequency transmission engineer, American Telephone & Telegraph Company; W. E. Harkness, Electric Research Products, Inc.; Prof. Erich Hausmann, Brooklyn Polytechnic Institute; John V. L. Hogan, consulting engineer, New York City; C. W. Horn, plant engineer, National Broadcasting Company; Dr. L. M. Hull, Radio Frequency Laboratories, Inc.; C. M. Jansky, radio engineer, Washington, D. C.; Ray H. Manson, vice-president and chief engineer, Stromberg-Carlson Telephone Manufacturing Co., and R. H. Marriott, radio engineer, New York City.

TELEVISION broadcasting is in an advanced experimental condition at this time. It has not yet been possible to establish transmitting stations capable of giving reliable television service over a considerable area, nor to provide on a commercial scale receivers which give a clear, bright picture of an acceptable color, adequate detail, satisfactory size, freedom from flicker, of sufficiently wide angle of view, and of the requisite steadiness of position. The problems involved are under active investigation, and there is a likelihood that within the next few years equipment of this sort will be commercially available and that at least a moderate number of television broadcasting stations capable of supplying program material to those having suitable receiving equipment will be in operation.

Television from the viewpoint of governmental regulation presents one of the most serious problems. Whereas telephone broadcasting requires channels approximately 10-kilocycles wide, television broadcasting of adequate quality and detail requires channels ten times as wide or more, that is, one hundred kilo-

Stations Sending Television

Following is a list of active television transmitting stations, showing that of the 20 listed, 12 definitely subscribe to the 60-line method:

2,000-2,100 k.c. (149.9 to 142.8 m.)

Call Letters	Company	Location	Power (watts)	Lines per Frame
W1XAV	Shortwave & Television Lab., Inc.,	Boston, Mass.	1,000	60
W3XK	Jenkins Laboratories,	Wheaton, Md.	5,000	60
W2XCR	Jenkins Television Corp.,	New York, N.Y.	5,000	60
W2XAP	Jenkins Television Corp.,	portable	250	60
W2XCD	DeForest Radio Co.,	Passaic, N. J.	5,000	60
W2XBU	Harold E. Smith,	Near Beacon, N. Y.	100	48
W9XAO	Western Television Corp.,	Chicago, Ill.	500	45

2,100-2,200 k.c. (142.8 to 136.3 m.)

Call Letters	Company	Location	Power (watts)	Lines per Frame
W3XAD	RCA Victor Co.,	Camden, N. J.	500	60
W2XBS	Nat'l Broadcasting Co.,	New York, N.Y.	5,000	60
W2XCW	Gen. Elec. Co.,	S. Schenectady, N. Y.	20,000	..
W8XAV	Westinghouse Electric & Mfg. Co.,	E. Pittsburgh, Pa.	20,000	60
W2XR	Radio Pictures, Inc.,	L. I. City, N. Y.	500	60
W9XAP	Chicago Daily News,	Chicago, Ill.	1,000	45
W3XAK	Nat'l B'dcasting Co.,	Bound Brook, N. J.	5,000	60

2,750-2,850 k.c. (109.0 to 105.2 m.)

Call Letters	Company	Location	Power (watts)	Lines per Frame
W2XAB	Columbia Broadcasting Sys.,	N. Y. City.	500	60
W9XAA	Chicago Federation of Labor,	Chicago, Ill.	1,000	48
W9XG	Purdue Univ.,	W. Layfayette, Ind.	1,500	..
W2XBO	United Research Corp.,	L. I. City, N. Y.	500	..

2,850-2,950 k.c. (105.2 to 101.6 m.)

Call Letters	Company	Location	Power (watts)	Lines per Frame
W9XR	Great Lakes Broadcasting Co.,	Downer's Grove, Ill.	5,000	24
W2XR	Radio Pictures, Inc.,	L. I. City, N. Y.	500	60

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Agitates Best Minds

Are Crude—Scanning Lamp Awaited

cycles wide or even several hundred kilocycles wide (unless some radical and unforseen development occurs). The problem of "fitting-in" television channels is engaging the serious thought both of the engineers and of the regulatory authorities, but up to this time it has not been successfully worked out. There are several directions which offer some promise, but the entire project of successful transmission and the location of the requisite wavebands is still in a state of flux. The formulation of definite plans for television for educational purposes can not therefore be advised at this stage.

It should be pointed out that much confusion exists among the public as to the exact meaning of the term "television." Comparatively blurred, dim, flickering and unsteady images, carrying little detail and simultaneously visible to only one or two persons at a given receiver (and then only in a darkened room) are claimed by some to constitute successful television. Equipment capable of yielding such limited results is on the market to a slight extent, but is obviously of no significance to educators. From the viewpoint of the educator a picture of an entirely different and greatly superior character, somewhat as specified in a preceding paragraph, is strictly necessary. Any educational project based upon pictures which do not meet reasonably high specifications will find the application of television a handicap rather than an assistance, inasmuch as a poor picture is rather a distraction than an instructional agency.

Television is at present in a state such that in general the mode of transmission and its romantic interest attracts a major portion of the attention of the observer. In consequence it parallels the condition of radio telephone broadcasting at the time when the quality of transmission was at such a level that criticism of the program or of the artist was not practicable because the medium of transmission was not sufficiently precise or constant in its action to enable such criticism to be well-founded. Until television reaches a stage where the mechanics will be forgotten and attention concentrated on the program itself, its utility in education will be small.

And so the experiment of today promises to become the institution of tomorrow. The gap between those who believe that television entertainment is already here and those who concede that it is still around the corner, is steadily closing up. We shall soon be in perfect agreement as to the entertainment possibilities, interpreting those possibilities in our respective ways. Of one thing we are now certain; the television era has definitely dawned.

* * *

THOMAS CALVERT McCLARY

in August 1st issue of "Forbes"

As it exists today, visual broadcast and reception is in a crude elementary stage which is comparable with the early crystal set days of radio in '21 and '22.

The public has a preconceived idea that television programs will compare with talking movies. This is the average fan's notion as a result of too much publicity. Those who expect any such spectacle immediately will be sadly disappointed.

Some stations are broadcasting a 45-line screen, but the majority uses 60 lines. Sixty lines means that the television image is made up of thirty-six hundred little dots of varying light and shadow intensity. Actually, only one of these dots is brought to the eye at a time, but the eye retains the impressions for one-twentieth of a second, during which time all other dots appear in their proper component position on the screen.

However, even the sixty-line image leaves much detail to the imagination. This problem will be overcome automatically when a receiver and broadcast equipment eliminating the necessity for moving parts is perfected. Progress in this direction has been made by a twenty-four-year-old youth on the Coast named Philo Farnsworth and by Dr. Vladimir Zworykin of the RCA-Victor Company, working independently of each other.

Both men are working to perfect the cathode ray tube system of scanning. Patent rights involving millions of dollars are at stake and the utmost secrecy is being maintained by both groups. However, it is known that Farnsworth is using a 400-line screen. U. A. Sanabria, another youth of twenty-five, recently demonstrated 3 x 3, 6 x 6, and 10 x 10-foot images. His system may have theatre possibilities, as the method of lighting which he uses is ample for large screen projection.

The important thing is that, at last, television is here.

* * *

EDGAR H. FELIX

in his new book, "Television, Its Methods and Uses"

The most important needs to produce a practical television service are minds and imaginations which approach its technical problems with a fresh point of view and which do not merely accept the orthodox methods already exhaustively investigated by numerous inventors.

The problems of television are not insuperable, nor are they more difficult than those which faced the inventors of any generally accepted entertainment or communication device. Their solution will have the inherent simplicity characteristic of every practical invention. We are familiar with so many elements of the ultimate television system that it is no strain to predict that television is "just around the corner." The probabilities, however, are that most of us are congregated hopefully on the wrong corner.

* * *

MERLIN HALL AYLESWORTH

President, National Broadcasting Company

Technically and commercially, television today compares well with the pre-broadcasting days of sound broadcasting. It is just as experimental, just as crude, yet just as promising as the feeble attempts at propagating entertainment via radio telephony prior to 1920. Technically, it compares with the crystal detector and earphone stage of radio reception. Commercially, it enjoys about the same status as early telephone stations which catered to a handful of listeners possessed of infinite patience, courage and insatiable curiosity. Artistically, television again compares with pre-broadcasting efforts, in that whatever is lost in detail is willingly supplied by the imagination of the audience. The thrill of receiving programs flashed through space largely compensates for shortcomings in artistry.

* * *

[The foregoing statements regarding the status of television give a clear picture of how impartial experts appraise the subject.—EDITOR.]

List Prices of Tubes

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

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

*This tube comparable to the 235.

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Effect of Frequency

In Altering Coil Resistance and Inductance

By Brunsten Brunn

IT is not usually realized that the inductance as well as the resistance of a radio frequency coil changes with the frequency. The change in the resistance is due in part to the skin effect and in part to the losses in the insulation. The change in inductance also is in part due to the skin effect and in part to the distributed capacity. The change in inductance is mostly a change in apparent inductance.

A given coil adjusted at the Bureau of Standards to have an inductance of 291 microhenries at 1,000 cycles per second was found to have an apparent inductance of 299 microhenries at 550 kc. and an apparent inductance of 355 microhenries at 1,500 kc. Thus there was an increase of 56 microhenries through the broadcast band. The coil in question was a single layer solenoid wound with No. 28 wire with double cotton covering.

From this change we may obtain the pure inductance as well well as the distributed capacity, assuming that the change in the apparent inductance was due entirely to distributed capacity. The pure inductance turns out to be 291 microhenries and the distributed capacity 10 mmfd. Thus the pure inductance is the same as the inductance as 1,000 cycles. These values of pure inductance and distributed capacity were obtained on the supposition that the coil had no resistance.

Variation of Resistance

The radio frequency resistance of this coil varies considerably throughout the broadcast band. At 550 kc. the effective resistance is 6 ohms and at 1,500 kc. it is 14 ohms. Thus the resistance of this coil increased almost in direct proportion to the frequency. This increase, however, is not great compared with the increase in other forms of coil. For example, a honeycomb coil wound with the same size wire had a resistance of 12 ohms at 550 kc. and 77 ohms at 1,500 kc. Thus the effective resistance of this coil changed by a factor of 6.4 whereas the frequency changed by a factor of only 2.7.

The variation of resistance with frequency is not the same for all wire sizes. A solenoid wound with No. 28 solid wire varied from 5.5 ohms to 14.3 ohms in the broadcast range. A similar coil of equal inductance wound with No. 30 wire but with turns spaced as if it had been wound with No. 28 double cotton covered wire varied from 5.8 to 13.6 ohms in the broadcast band. Thus the coil with finer wire had less resistance in most of the band than the coil with heavier wire. The resistances of the two coils were equal at 630. This shows that the spacing and the material between the turns contributes a large share of the effective resistance.

A coil wound with No. 16 double cotton covered with to an inductance of 291 microhenries, also a solenoid, had a resistance of 4 ohms at 550 kc. and 17.7 ohms at 1,500 kc. This variation in the resistance is so great and the effective resistance in most of the broadcast band is so large, that it is inadvisable to use No. 16 wire if selectivity is the object. For uniformity of resistance it would seem that No. 30 wire spaced like No. 28 double cotton covered is the best.

A coil wound with No. 24 double cotton covered wire has a resistance lower than one would with No. 28 below about 1,400 kc. but several ohms higher at 1,500 kc. Hence a coil wound with this wire is good for radio frequency tuners.

Advantage of Litz

Litz wire is usually better than solid wire in similar windings. Litz of 32 strands of No. 38 wires braided together and insulated from each other with enamel is equivalent to No. 23 solid wire at low frequencies. A 291 microhenry single layer solenoid wound with this Litz has a resistance of 2.7 ohms at 550 kc. and 10.6 ohms at 1,500 kc. Thus the resistance of this coil is low throughout the band. Within the band the variation of the resistance is very nearly proportional to the frequency.

The selectivity factor of a coil is usually taken as the ratio of the inductive reactance to the effective resistance. The inductive reactance is the product of the inductance in henries and the frequency in cycles and 6.2832. Since the coils we have been discussing all have an inductance of 291 microhenries, the reactance is 1.83F, where F is the frequency in kilocycles. At 1,500 kc. the selectivity Q of the Litz-wound coil is therefore 259. This is excellent. At 550 kc. the selectivity is 373, which is still better.

The coil wound with No. 28 double cotton covered wire has a selectivity of 183 at 550 kc. and 192 at 1,500 kc. The coil wound with No. 30 spaced like No. 28 double cotton covered wire has a selectivity of 174 at 550 kc. and 202 at 1,500 kc.

It is often assumed that the selectivity is constant but it is clear from the above examples that there is considerable variation in this so-called constant. In some cases the selectivity increases with the frequency, and that is as it should be, but in most cases it decreases with the frequency. The reason it is desirable that the selectivity should increase with frequency is that stations are crowded more closely at the upper end, this is, more closely on a relative basis. In order that the effective selectivity should be the same throughout the broadcast band the selectivity factor should increase directly as the frequency. Unfortunately, this does not happen.

The variation in the selectivity factor is so large that it is not permissible to assume that it is constant in any considerable frequency band. However, when dealing with side band suppression it is quite permissible to assume that it is constant over the width of the two side bands and the value is that at the resonance frequency. This assumption is usually made rather than the assumption that the selectivity factor remains constant throughout the broadcast band.

Use of Binder and Shielding

In most instances it is desirable to apply a binder to keep the turns of the coil in position. All binders add to the radio frequency resistance and for this reason they should be used sporingly. The best binder is collodion, for this introduces the least resistance into the coil. A thin layer of collodion, sufficient to hold the turns in position, adds so little to the resistance that the advantages outweight the disadvantages.

Shielding of coils changes the practically every conclusion about a coil. The self-inductance of the coil is reduced, the self-capacity is increased, and the effective resistance is also increased. However, if the shielding is large compared with the dimensions of the coil there is only a small change in all these factors. It may be said that if the shielding is large compared with the dimensions of the coil there is only a small change in all these factors. It may be said that if the shield is circular its diameter should be three times the diameter of the coil. But this makes the shield unwieldy. If the shield is twice as large as the coil there is still little effect on the constants of the coil within it.

Effect of Tubes

It is not to be supposed that the selectivity of a tuned circuit is the same in a receiver as it is when it is not connected to anything. If the primary is wound and coupled so to the tuned circuit that the transfer of power is the greatest from the tube to the tuned circuit, the selectivity is only one-half as great as it is when the coil is not connected to the tube. The grid circuit of the tube following the tuner also puts a load on the resonant circuit which lowers the selectivity. This load is small when the bias on the tube is negative but it may be very large when the bias is zero or positive.

Due to the various losses that are introduced into the tuned circuit by shielding, circuit connections, and other factors, the selectivity finally may be only a small fraction of what it is when the coil and the tuning condenser are alone. It is necessary to use many tuned circuits, all adjusted to the same frequency, in order to get the necessary selectivity in the receiver. Another source of loss of selectivity arises from the fact that many tuned circuits are put on the same tuning control. It is not easy to adjust a circuit so well that four or five tuned circuits can be kept in resonance to the same frequency at any setting of the tuning condensers.

Small Coils and Large

The modern tendency is to make extremely small coils for receivers, especially the popular midgets. These coils are wound on tubing as small as one inch in diameter, and even smaller, and the wire is made small in proportion. It used to be that a coil was not considered good unless it had a diameter of three inches and wound with wire as heavy as number 20. Now wire as fine as No. 36 is used for the tuning coils and wire as fine as No. 40 for the primary. There is nothing at all against using wire as fine as No. 40 for the primaries but if the wire on the secondaries and tuned windings is too fine it is not possible to get any selectivity out of the circuit. Sensitivity can easily be obtained in any desired degree in these days of screen grid radio frequency amplifiers, power detectors, and pentode output tubes. But selectivity is not so easily obtained when coils of diminutive size are used in the circuits and put in shields the size of a thimble. But midgets are popular just now.

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Converter Output Vital

Selection of Coupling Coil Improves Results

By L. Bruce Fallow

CONCERNING short-wave converter output circuits, it is usually found that tuning the output is helpful not only to sensitivity but also to selectivity.

One of the chief troubles is to get the proper transfer of energy, and there is nothing like a tuned circuit to do it. Moreover, no matter what type of input circuit there is in the receiver, if it is suitable it may be used, as is, by connection of converter to the antenna post of the broadcast set. A sensitive intermediate frequency is selected in the set, and the converter's output may be tuned to that. Thereby tuning is retained in the input to the first radio frequency amplifier, literally the first intermediate stage, when the converter is properly regarded as the mixer, and the broadcast set as the rest of the superheterodyne thus constituted.

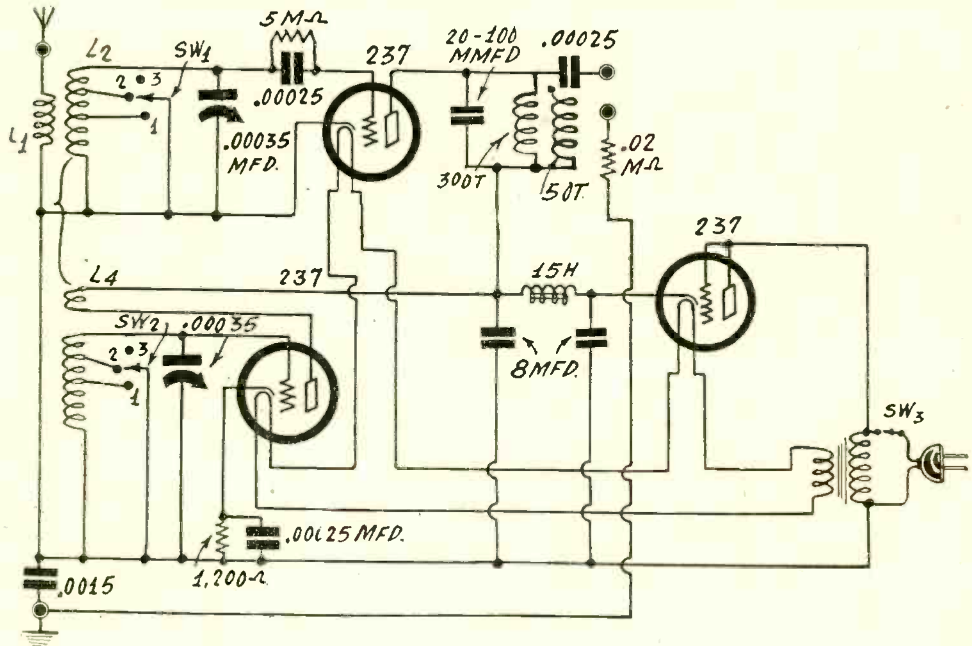

Fig. 1

To attain best results there should be a match between the output of a short-wave converter and the input to the receiver with which it is worked. Here two different coils are picked up, one of 300 turns, the other of 50 turns, so that sensitivity results no matter what intermediate frequency is used.

Wide Provision

The diagram herewith shows the converter circuit published last week, with only a single change, that of two coils in the output, either of which may be selected by switching. If 300 turns are used, then the tuning condenser, of the setscrew type, across the inductance will take care of intermediate frequencies at the low frequency end of the receiver, while by switching in the 50-turn coil, frequencies at the high end will be accommodated.

In this way it is possible to provide, in a general manner, for any intermediate frequency, that is, any setting of the dial of the broadcast set, although it is understood that for purposes of avoiding interference by direct reception of broadcast signals that some frequency below the lowest or above the highest in the broadcast band will be preferred. Such frequencies might be 530 or 1,600 kc.

As for coupling to the set, as explained last week, the usual method should be tried first. This consists of connecting the output of the converter to the vacated antenna post of the set, since aerial is now connected to the converter. A lead is run from converter ground post to set ground post. Those are the only connections up to now. The converter furnishes all its own power, A, B and C, and is alternating-current operated.

Now, suppose that the coupling is not what it might be. The other method is to connect the output to the grid of the first radio frequency amplifier in the set. If a screen grid tube is in this position, simply remove the clip from the cap, and put on a new clip, running a wire therefrom to the output of the converter. Now there would be no grid return for the first tube, so put a piece of wire accross the two posts at right in Fig. 1, to give a grid return to the tube.

Frequency Distribution

No matter which method is used, the optional output resonance must be used. In general, frequencies above 900 kc are better served by the 50 turn coil, those below 900 kc by the 300 turn coil. Remember that the 20-100 mmfd. condenser across the coil in either instance is adjustable. Use a wooden dowel or bakelite rod, sharpened down at the end, to make the adjustment.

The tuning is not critical, and it is intended not to be critical, so if you find the adjustment not very effective until the condenser is screwed down almost the wire way, that is quite all right. In a few minutes you will find which intermediate frequency is best with your set, and how the trimmer should be adjusted across the proper coil to capitalize this sensitivity. The switch that puts either coil in is a wire lead picking up posts.

In the layout of the top panel, a diagram of which was published last week, if the electrolytic condensers are to be put in the holes at extreme left and right, these holes should be 1⅜ inches in diameter. The holes for the three sockets may be 1 1/16 inches in diameter, or, if preferred, also may be 1⅜ inches, this difference not being of any importance. But the 1 1/16 inch diameter will not be large enough to pass the electrolytics, which are of the inverted type, with bakelite "breather" at top, and cap at bottom, under the panel. The illustration of the laboratory model, to be published next week, will clear up this point.

Automotive Tube Uses

The tubes used are of the new automotive series, and they draw very little current. It is estimated it costs only 1/10 cent per hour, electrical consumption, to run this converter.

The switching for wave band changing also is accomplished by picking up the desired taps with flexible leads, using posts or jacks.

[*Details regarding the layout and assembly of this simple, inexpensive and very efficient short-wave converter 20 to 200 meters, will be published next week in the August 22d issue*—EDITOR.]

LIST OF PARTS

Coils

Two radio frequency transformers with tapped secondaries (described in last week's issue, August 15th)
One 50 turn honeycomb coil and one 300 turn honeycomb coil
One 20 volt filament transformer (heaters of tubes in series)
One 15 henry B supply choke coil

Condensers

Two .00035 mfd. tuning condensers
One .00025 mfd. grid condenser with clips
Two .00025 mfd. fixed condensers
Two 8 mfd. electrolytic condensers with brackets
One .0015 mfd. fixed condenser

Resistors

One 5 meg. tubular grid leak
One 1,200 ohm wire wound fixed resistor
One 0.02 meg. fixed resistor (20.000 ohms)

Other Parts

One A-C cable and plug
Six binding posts
Two dials
Hardware for coil switching, coil mounting and dozen nuts and bolts
One 10 x 8 inch panel, drilled
Three UY (five prong) sockets
Knockdown parts for cabinet to house the converter (3 inch height inside)
One A-C toggle switch
Three 237 tubes

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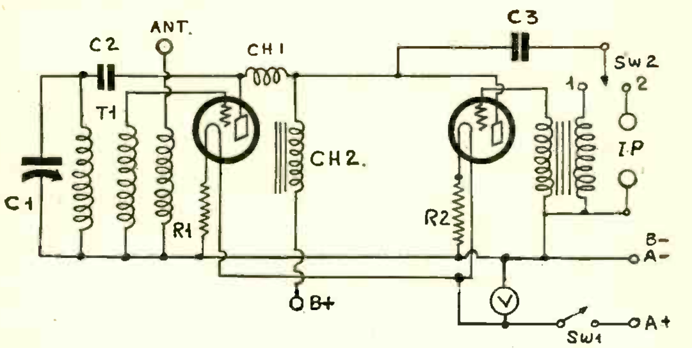

FIG. 944

The circuit of a modulated oscillator which can be used in testing receivers. By the use of suitable plug-in coils any frequency from about 100 kc up to 30,000 kc can be obtained.

Modulated Oscillator

WILL you kindly publish the circuit of a modulated oscillator and give values of the various constants? I prefer a circuit for battery tubes. I have a set of short-wave coils which I intend to use in the circuit. These are wound on forms which fit into a UY socket.—W. G. E.

You will find a good modulated oscillator circuit in Fig. 944. If you use 2 volt tubes, that is, 230s, use a battery voltage of 3 volts and make each of R1 and R2 15 ohms. C1 may be a small variable condenser of 125, 150, or 200 mmfd. C2 may be 0.01 mfd. and C3 1 mfd. Ch1 is an an 85 millihenry choke of very low distributed capacity and Ch2 may be a 30 henry choke or the secondary or primary of any audio frequency transformer. The transformer in the grid circuit of the second tube is any audio frequency transformer. When you set switch Sw2 on (1) the second tube is an audio frequency oscillator and it will modulate the radio frequency oscillator. When you set this switch on (2) the second tube is an amplifier and it will then impress on the radio frequency oscillator any signal that is impressed across the terminals IP. Across these you may put either a microphone or a phonograph pick-up, or the output of a radio receiver provided that you cut down the volume.

* * *

Substitution of Resistance Coupler

THE audio frequency transformer between the detector and the first audio stage in my receiver has burned out and I have been unable to find a substitute that will fit into the space that is available. I have been wondering whether it would be possible to substitute a resistance coupler. If so, will you kindly tell what changes should be made in the circuit and what values to use? Will this change lower the sensitivity of the receiver appreciably?—W. J. L.

This is quite possible. Connect a condenser of 0.01 mfd. between the plate of the detector and the grid of the next tube. Also connect a 250,000 ohm resistance from the plate of the detector to a point on the voltage divider where the voltage is about 135 volts, or somewhat higher. Also connect a grid leak of about one megohm from the grid of the first audio tube to ground, or C minus for the first audio tube. If grid bias detection is used and the bias is obtained from a resistor, it will be necessary to increase the resistance to about 15,000 ohms. There will be a decrease in the output of the receiver because there is no step-up in the resistance coupler. But the quality will be better.

* * *

Medium Intermediate Frequency Coils

I HAVE in mind making an all-wave superheterodyne receiver with an intermediate frequency about 300 kc. If you think this is all right will you kindly give the number of turns required on a form 1.75 inches in diameter, No. 32 enameled wire, and a tuning condenser of 0.0005 mfd? The condenser is arranged so that the capacity may be varied about this value about 10 per cent. both above and below.

If you wind 118 turns of this wire without spacing more than the natural spacing of the wire you will get an inductance which will resonate with a 0.0005 mfd. condenser at 300,000 cycles per second. Variations must be expected in the diameter of the form, the diameter of the wire, in the wire spacing, but the probable value of all variations is less than 10 per cent. the variation possible in the tuning condenser. The untuned winding, if a transformer is to be made, depends on the use and position of the untuned winding and on the tube before the transformer. If the primary is tuned and the secondary untuned, the secondary may have as many turns as the primary, and the coupling may be just as close as possible. If the secondary is tuned and the primary untuned the ratio of turns may be about one-to-five.

* * *

No Ground Needed

IN my receiver it makes no difference whether I use a ground. It is a late model AC operated receiver. Do you think there is anything wrong with the ground connection? What should I do to improve it?—B. M.

Nothing is necessary to improve it. The circuit is grounded through the power supply system. It makes a slight difference if you reverse the plug in the outlet from which you get the power, but if there is no change there is nothing to worry about.

* * *

Obtaining Decibels

WILL you kindly explain how to get the number of decibels by which two similar quantities differ, such as two signal voltages, one the input of one tube and the other the input of the next in the amplifier?—V. A.

First divide one number by the other. For example, if the voltage on the grid of the second tube is 25 volts and that on the grid of the preceding tube 5 volts, the ratio is 25/5, or 5. Next take the common logarithm of the ratio, that is, of 5 in this case. The common logarithm to the base 10 can be found in tables or on most slide rules. Then multiply the common logarithm by 20 and the result is expressed in decibels. In this particular example, the gain in decibels is 13.98 db because the common logarithm of 5 is 0.699.

* * *

Relation Between Gauge and Diameter

CAN you give a simple relation between the diameter of a wire and the number? I should like a relation that is easily remembered and easily used.—B. W. F.

The common logarithm of the diameter expressed in inches is very nearly equal to $-(n+10)/20$, in which n is the B. & S. number of the wire. This relation is not exact but it is fairly close. As an example of the use of the formula let us assume that the number of the wire is 22. Then the numerator is 32 and 1/20 of this is 1.6. The minus sign means that the reciprocal should be taken. Hence 1.6 is the common logarithm of the reciprocal of the diameter. The antilog of 1.6, to the base 10, is 39.8. Hence the diameter is 1/39.8, 0.0251. In wire tables the diameter of No. 22 B. & S. bare copper wire is given as 0.02535. For this particular wire the formula is about one per cent. in error. Another case. Suppose we take a No. 40 wire. We have 50/20, or 2.5 as the common log of the reciprocal of the diameter. The antilog, or the number the log of which is 2.5, is 316. Hence the diameter of the wire is 1/316, or 0.00316. Wire tables give 0.003145. The error is about 0.5 per cent.

* * *

Home Receivers with 6-volt Tubes

IS it practical to build receivers with 6.3-volt heater tubes throughout when these receivers are to be used in a home? What would be the advantages and disadvantages of these tubes over the regular 2.5 volt tubes?—S. E.

Sure it is practical. They are all good tubes. The advantages would be smaller size of set and greater economy of operation. One disadvantage would be lower output since the power tubes in this series do not handle nearly as much power as the power tubes in the 2.5 volt series.

* * *

Frequency Variation and Superheterodyne Reception

IT has been said that the superheterodyne cannot be used successfully for receiving ultra-short waves because of frequency fluctuation. If that is correct, which frequency fluctuates, the signal frequency or the frequency of the local oscillator?—A. N. B.

Both frequencies fluctuate but undoubtedly the local frequency fluctuates more in most instances because the signal frequency is usually controlled by a piezo crystal or other constant-frequency master oscillator. On extremely high frequencies it is difficult to maintain the frequency of oscillation constant even with a thermostatically controlled piezo crystal. It is the relative frequency fluctuation which causes the trouble. Since the intermediate frequency of the receiver is comparatively low and also comparatively constant, a very small variation in the fre-

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quency either of the signal or the local oscillation will suffice to swing the beat frequency through the resonance characteristic of the intermediate tuner.

* * *

Double Detection Receiver

WHAT is a double detection receiver? This term appears quite frequently in radio literature but so far I have not been able to find a definition of it.—W. H. T.

A double detection receiver is a superheterodyne receiver. It is so called because there are two detectors in the circuit, one which converts the signal frequency to the intermediate frequency and another which converts the signal to audio frequencies.

* * *

Use of Litz Wire

IS there any real advantage in winding coils with Litz wire when the coils are to be used in up-to-date superheterodynes? If so, what type of coils are the best?—E. W. L.

There is little advantage in using Litz in multi-tube receivers. While a coil wound with Litz is better than one wound with solid wire of equivalent cross section there is a possibility of getting the circuit entirely too selective. If the receiver consists of only four tubes with two tuners, one of which is regenerative, Litz could well be used advantageously. The best coil, considering simplicity and effectiveness, is the single layer solenoid in which the ratio of the diameter to the length of the winding is about 2.4.

* * *

Toroidal Coil

I WISH to make a toroidal coil having an inductance of 150 microhenries. I know how to do the mechanical work because I have made many. I first wind a long solenoid on a smooth cylindrical rod and then slip it off and bend it around in a circle. I want to know the number of turns required and the diameter of the rod on which to wind the turns, and also the length of the solenoid.—G. W. H.

You might make the diameter of the rod one inch and the length of the solenoid 12.6 inches. You will then need 306.5 turns of wire that winds 24.3 turns to the inch. This is based on the assumption that on the inside of the torus the turns are close together. The mean radius of the torus will be 2.5 inches and the overall diameter will be six inches.

* * *

A Correction

IN the August 15th issue you have the circuit of a dynatron oscillator in which there appears to be a short of the 67.5 volt section of the B battery. How can this be remedied?—L. A.

In the original drawing there was a 0.01 mfd. condenser in the lead joining the 67.5 volt terminal and the ground lead. If this condenser is put in the circuit will be all right. The rotor of the tuning condenser C should go directly to ground as it does. The condenser may be larger than 0.01 mfd. if desired.

* * *

Low Selectivity in Impedance Coupling

WHAT is the reason circuits using tuned impedance coupling are not nearly as selective as circuits using the same number of tuners with secondary windings tuned?—W. F. J.

The reason is that the plate resistance of the tube ahead of the tuner and the grid to cathode resistance of the tube following are in shunt with the tuned circuits. Any shunt resistance is equivalent to a certain series resistance and the lower the shunt resistance the higher is the equivalent series resistance. The higher the series resistance the lower the selectivity. For this reason the lower the plate cathode resistance of the tube the lower the selectivity.

* * *

Resistance Coupled Amplifier

PLEASE publish the circuit of a resistance coupled amplifier for use with one 235 and one 247 tubes. I should like to have the values that are needed.—F. W. R.

In Fig. 945 is such an amplifier. The following values are suitable: P, one half megohm potentiometer; R1, 5,000 ohms; R3, 250,000 ohms; R4, one megohm; R5, 400 ohms; R6, 50,000 ohms; R7, 10,000 ohms; Co, 2 mfd. or more; C2, 0.01 mfd.; C3, 8 mfd.; C4, 2 mfd. T1 should be a good output transformer matching the 247 tube and the loudspeaker used. The total voltage applied between B plus and B minus should be from 250 to 300 volts.

* * *

Adapting Old Sets to New Tubes

WHAT changes will be necessary to adapt an old receiver using 226 tubes to 227 tubes? Will it be necessary to get a new filament transformer?—E. R. M.

Very likely it is necessary to get a new transformer because sets built for 226 tubes have a filament transformer that will handle only one 227 tube. Many circuit diagrams have appeared in which the tubes were 227 and 245. One of these having the same number of tubes as your own can be used as a model. Get a filament transformer that will handle all the new tubes. The current rating of the 2.5 volt winding is obtained by multiplying the number of tubes by 1.75. There should preferably be a separate winding for the power tubes, a 2.5 volt, 3 ampere winding for two 245 tubes and a 5 volt, half ampere winding for two 171A tubes.

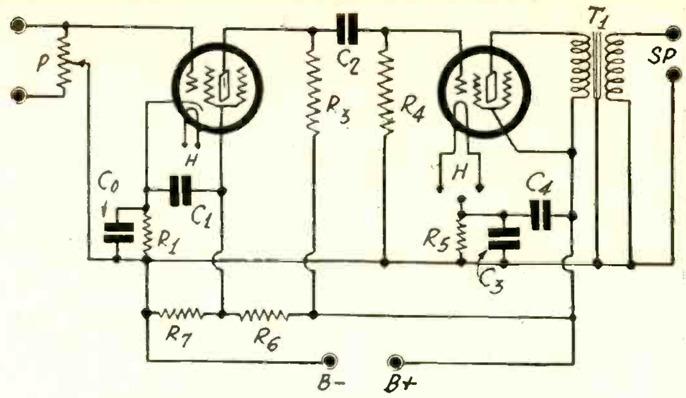

FIG. 945
The circuit of a two stage resistance coupled amplifier using one 235 and one 247 tubes. This is suitable for use whenever high quality is desired.

* * *

Behavior of Converter

I HAVE a short-wave converter with one radio frequency tuner and one oscillator. When I use equal coils in the two coil sockets I find that I get loudest signals when the radio frequency tuner condenser is wide open. Sometimes when the oscillator condenser is set near its minimum I can also tune in with the radio frequency condenser when this is near maximum. However, there is one spot where I don't get anything but noise. Is this the right behavior of the circuit? If not, what can I do to improve it?—C. T. F.

That is the way converters of this type act. It signifies that the radio frequency coil is not large enough. The two coils should not be equal but the radio frequency coil should be considerably larger, except the smallest coil in the set, which should be very nearly the same as the corresponding oscillator coil. The noise you hear is undoubtedly due to overloading of the detector when the radio frequency coil is in resonance with the signal frequency. The remedy is to loosen the coupling between the oscillator and the detector. That is, you should decrease the number of turns on the pick-up.

* * *

Frequency Meter

I HAVE a 200 mmfd. tuning condenser and some 2-inch tubing. I wish to use this material in making a wavemeter that will cover the 80-meter band. Will you kindly specify the number of turns and the wire necessary?—F. G. S.

Wind 13 turns of No. 20 double silk covered wire. This will make a coil that will tune slightly above 80 meters and considerably below.

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A THOUGHT FOR THE WEEK

JOHN F. ROYAL, director of programs for the National Broadcasting Company, says that televised programs are going to bring the true actorial method to radio—and John F. knows, for he has been connected with the theatre and broadcasting in important capacities for a good many years. In other words, television calls for action and pantomimic gestures which mere broadcasting, without visualization, does not demand, for reading from a script for folks who listen without seeing does not call for the same technique at all. Mr. Royal is a radio official who believes that acting is still an art and that this will be made apparent when radio players actually learn their lines and, discarding their scripts when appearing on a television program, are compelled to appeal both to the eye and the ear.

RADIO WORLD

Title Reg. U. S. Pat. Off.

The First and Only National Radio Weekly

Tenth Year

Owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, president and treasurer, 145 West 45th Street, New York, N. Y.; M. B. Hennessy, vice-president, 145 West 45th Street, New York, N. Y.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. E. Anderson, technical editor; L. C. Tobin, advertising manager.

Television Pressure

THE impartial experts are assaying television. None of them says that television is anything better than crude just at this time, all of them acknowledge that advances have been made and many of them feel that methods being tried now are relics of another generation of invention. But not a single one treats the subject as a joke. This is comforting to engineers, after what happened to Fulton with his steamboat when he demonstrated it in the Hudson River and was jeered by engineers from the shore.

However, maybe a few jeers would do some good. The human machine is as mechanical as it is human. An author recently said that the scanning disc of fifty years ago is in use to-day. Maybe if the jab were put into more pungent words greater advance would come from the television laboratories. There is nothing like a sting to speed the army of engineers. How fast the hand squats the mosquito!

It may be argued that patience and gradual, scientific development are to be preferred, but it seems that premature hullaballoo has warmed the public to expect television on a practical, legible, dependable basis. Manufacturing interests, on whose behalf the engineers in other laboratories are really working, are preparing for their "pre-commercial" television sets in the Fall of next year. So the laboratory is being rushed somewhat. And why not? A little high pressure work is all right on an engineer, for it is well known that if you give an engineer a problem you have to seize the solution from him.

When the sales manager or so-called sales engineer scents a hot market, a few volts of hopping current from the big boss makes the engineers teem with activity and results. All of us need some prodding and it is not at all certain that the premature attempts to put television in the public's hands will lead to disaster.

Certainly television to-day is worth experimenting with, and those who operate television sets know they get a real kick out of the fun. Also, they, best of all, will appreciate the improvements that seem about to come, including the use of a scanning tube to replace the whirring disc, and a good means of projection, to dispense with the straining influence of the peephole.

All hands are awaiting television's practical development. No fear need be felt about putting out receivers before television is perfect. If one has to await perfection there will never be a start on the public track. Such a negation of perfection marked the advent of sound broadcasting that, save for the growth to present high standards, we would be half ashamed to even think of what was done in those days in the name of art, science and commerce!

Ours is a go-getter country, we don't like our leisure until we're around seventy, when we're still too busy to enjoy it, and so the present method of giving the engineers to understand that production starts next year (and meanwhile they must ascertain on what) isn't half bad. It's positively interesting and exciting, and we love interest and excitement.

The Number of Sets

TALK about the radio set market being nearly saturated, on the basis of some 15,000,000 sets in use in the United States, had better be subdued right now in the light of the incomplete returns of the census figures, showing that about one-third of the families have sets. What the total number of sets will prove to be can not be more than guessed, but with half a dozen of the most populous States omitted, the tabulated total now shows around 4,000,000 families have sets.

The accurate figures will be of assistance to the radio trade. Each concern, or association, will have to draw its own conclusions, however. For instance, suppose Connecticut shows up as having the largest percentage of families with sets in the Union. Does that mean Connecticut is a great stamping ground for set sales, since the people buy sets readily, or does it mean that the ground has been well covered, and that attention had better be paid to States wherein the percentage is low?

The highly concentrated populations tend to show a large percantage of families that have sets, and therefore on this basis it is expected that New York, Missouri and other States not already counted, will increase the total percentage for the nation to above 33.3, possibly reaching closer to 40 per cent.

The Bureau of the Census issued its preliminary compilation this month, but about two months prior we compiled our own summary from the Bureau's list, showing that out of 26 States for which figures then were tabulated, 26.9 per cent. of the families had sets, and we estimated the total percentage finally would be near 40. The total number of families was 8,220,485, and the total number of sets was 2,374,293. Connecticut was then listed—in the June 6th issue—as highest, with 54.9 per cent., just as it is highest in the Bureau's later summary.

The figures are valuable because as accurate as can be obtained in practice. It will be remembered that during the 1930 census the radio set tally was taken, and it was feared by some that the object was to see where the ground lay for imposition of a tax on sets. But that suggestion brought quick denial from the Federal Government. The real object was to assist the radio trade, and also the Government in its administration of radio and its service to the industry and public.

What the trade does with the final figures, when available, will largely determine what is the value to it of the radio census.

We suggested in June, and repeat now, that the census discloses that there are so many families without sets, that it would be well for the trade to establish a clearing house and arrange to have trade-in sets, otherwise classed as junk though useful to non-possessors of sets, furnished to deserving families, who would pay the packing and transportation expenses. In this way a large tube outlet would be created at once, and a dormant part of the public would become alert to radio.

Better Than 50 Cycles

THE number of stations deviating from assigned frequency by less than 50 cycles is increasing. Next June the Federal Radio Commission's order that all must stay within the 50-cycle limit, instead of the present 500-cycle limit, goes into effect. Then all must obey, but meanwhile ample proof is afforded that the order was entirely practical, involved no great extra expense to stations, and was in the public interest.

When there is deviation of less than 50 cycles, the result of two adjoining waves beating is a heterodyne outside the audio frequency limits in most receivers. That means less interference will be heard, and the less heard, the pleasanter this life.

Cardwell Announces Split Stator Condensers

The Allen D. Cardwell Mfg. Corporation, 81 Prospect Street, Brooklyn, N. Y., has produced split stator tuning condensers, not only for broadcast receivers, but also for medium power and high power transmitters.

The receiving condenser, known as model 202-E, is especially designed for use in push-pull radio frequency circuits. The two sets of taper plate stators are insulated from each other, although a common rotor is utilized. The taper plate results in a tuning curve midway between straight wave-length and straight frequency. The split stator condenser is extremely flexible as regards the capacity ranges it can cover. The two stator sections in parallel give a maximum capacity of 300 mfd., since the capacity of each section is 150 mfds. The two stator sections in series give a resultant maximum capacity of 75 mfds. This is excellent for use in tuning down as low as 5 meters in a push-pull circuit.

Push pull r.f. amplifiers are finding much favor with the experimenter, but until recently, split stater variable condensers have not been available. The big feature of push-pull r.f. amplification at short waves lies in the fact that the tube and circuit capacities are in series and naturally have less effect on the tuning circuits. This results in greater selectivity and also in greater amplification per stage. Increased gain and greater stability in comparison with the conventional short-wave amplifier are claimed.

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Sparkles

By Alice Remsen

•

The Weaver of Dreams

(WOR, Thursdays, 10 a.m., E. D. S. T.)

Out of the night as I sat in my chair
A wonderful voice came to me through the air;
With magic of words wove a mystical spell,
And under the charm of the weaver I fell.
As I listened he wove me a dream so divine,
Of gossamer texture and lovely design,
He made me forget all my worries and schemes—
No wonder they call him The Weaver of Dreams.

•

GENE RODEMICH NO SOONER had finished with the Forhan program than he was called upon to conduct for the newest thing in air creations—"Radio's Greatest Lover." The gent with this high-sounding title lives up to it as far as personal appeal with the voice is concerned. He probably has thousands of female hearts palpitating already. In case you'd like to know, his name is Carlo Le Mar and he's worth hearing; so is Gene's orchestra. Wednesday nights at 10.45 and Saturday nights at 7.45. Station WJZ.

* * *

WHEN IT COMES TO FAN MAIL I guess Kate Smith is running Morton Downey a close second. These two songbirds feature heart throb ballads, which only goes to show you that the radio public is a sentimental bunch. Where there's sentiment there must be kindness—so Mr. and Mrs. Radio Listener must be okay.

* * *

THE LATEST RADIO ARTIST to succumb to the air in a literal sense is Ben Alley, Columbia tenor. He will take aviation lessons while on his vacation. A pilot from his native West Virginia will be the tutor.

* * *

A. HAMILTON GIBBS, the novelist, is one of Ann Leaf's most enthusiastic fans. Recently he sent her one of his latest books inscribed: "To Ann Leaf, who can say it on the organ better than I can on the typewriter."

* * *

COLUMBIA'S COMIC COLONEL STOOPNAGLE was asked by a friend what he thought of television. Just then the beautiful and blonde Harriet Lee passed by. "Well," returned Stoopnagle, "I don't know much about it, but I can certainly tell a vision when I see one." (Ouch, Colonel!)

* * *

AN INTERESTING PROGRAM is that of Allen Broms, WOR 9 p.m. on Saturdays. He speaks on fossils, the earth, the moon, stones, and other things, telling us plenty that we never knew before.

* * *

Sidelights

COUNTESS OLGA ALBANI, NBC soprano, likes to play poker . . . MARY McCOY is crazy about dancing, preferably with a very broad-shouldered man . . . FRANCES ALDA always wears a jade bracelet when she broadcasts . . . MURIEL WILSON must wear a favorite necklace when she faces the microphone . . . LITTLE JACK LITTLE never wears a hat . . . "SKEETS" MILLER, midget director, for N.B.C.'s special events, is called "The finger-snapping man" . . . ARCHER GIBSON is the proud possessor of a fan letter from Mrs. Calvin Coolidge . . . JOHN FOGARTY is taking aviation lessons . . . ROBERT SIMMONS still looks with awe upon the tall buildings of New York . . . WILL OSBORNE will turn musical comedy star in the Fall . . . THE BOSWELL SISTERS like television . . . HARRY SWAN has a pet monkey. Its name is Napoleon.

* * *

BIOGRAPHICAL BREVITIES

The Career of Alois Havrilla

MR. HAVRILLA, N.B.C. announcer for several years, now special program announcer and bass vocalist, was born in Pressov, Austria-Hungary. He came to the United States when he was four years old. The family settled in a Slovakian community in Bridgeport, Conn. There he received his elementary education, attending a school where his native language was spoken. His father was a pharmacist.

When Alois was only seven years old, James Baker, an old English music master of the Bridgeport Trinity Church, heard him sing. Alois had a beautiful alto voice, with a range of three octaves, a novelty among boys. Baker immediately began tutoring him. One year later the boy sang an alto role in Handel's "Messiah," and was heard in other oratorios in several New England cities. His music teacher, who gave him a place in the Trinity Church Choir, also taught him the English language.

Young Havrilla decided to follow civil engineering, but he continued to sing at Trinity until sixteen years of age in addition to working in the civil engineering department of a New England railroad.

His voice changed from alto to bass and he became soloist in several Bridgeport churches. During this time he met Miss Marion Munson and three years later they married. Mrs. Havrilla is a descendant of John Howland, of Mayflower fame. Their only child, Constance Howland Havrilla, was named after the distinguished ancestor.

It was while he was appearing as soloist with Percy Grainger, at a Carnegie Hall musicale in 1923, that he met Graham McNamee and Elliott Shaw. Mr. Shaw suggested an announcerial position at WJZ, then only a small radio station, but Havrilla declined and went on the stage instead.

He worked for Charles Dillingham in "Hassan" and "Madame Pompadour." In "Louis the XIV" he played the juvenile role, first played by Harry Fender, who was taken ill. Havrilla jumped into the role without a rehearsal.

After finishing his studies at New York University, which he had continued along with his show career, he accepted a teaching position at Briarcliff Manor, N. Y. While there he directed the Congregational Church choir and a unit of the Westchester Choral Union.

After being there only eight weeks he received an offer from the N.B.C. to join the announcerial staff of WEAF. Through the cooperation of school officials he was able to continue both jobs until the following Spring, since which time he has been associated solely with broadcasting.

* * *

The Boswell Sisters

MARTHA, Connie and Helvetia (Vet) Boswell were born in New Orleans and are three-quarters French. They grew up in a home steeped in cultural traditions. Their father and mother were musicians with a classical bent and so it was early decreed that the three little girls should learn to play instruments that would later be blended into a salon combination—violin for Helvetia, cello for Connie and piano for Martha.

Their work together was so good that plans were made for them to make concert tours as soon as they matured. While she was still in pinafores, Connie played first cello in symphony concerts for the Philharmonic Society of New Orleans and later her two sisters joined her in the orchestra of a Passion Play at the old Opera House, and then the Opera House burned down and that was the first blow to their classical career.

Soon after that their father was called away on a trip to Florida. While he was gone the girls took to the saxophone and before Dad came home they had also learned to sing close torrid harmony and the banjo had entered their lives.

Local popularity led to vaudeville tours of the South and engagements over Station WSMB in New Orleans. Nothing but success met the girls; from vaudeville to pictures, from pictures to radio.

Nowadays, Vet plays the banjo, Martha the piano and Connie the saxophone. In the vocal registers, Vet sings the top harmony, Connie carries the lower strains, and Martha sings "all the other notes," which usually but not always means that she's handling the melody. They do all their own arranging, and Martha has written upwards of 150 of their songs.

All three girls took courses in commercial art and won prizes at art exhibits. Martha is the cook of the trio and her creole gumbo, shrimp a la Creole and other Southern delicacies have cured the girls of eating in restaurants for all time.

Vet sews, designs costumes and tap dances. Connie has a passion for modeling little figures. She also plays musical glasses and once ruined her mother's best crystal set perfecting this accomplishment. They are full of ideas; are slim, young and good to look at; and they never quarrel except at rehearsals—and that really doesn't mean anything.

* * *

Sundry Suggestions for Week Beginning August 23

Lew White, Organ recital	**WEAF**	**10:30 a.m., Aug. 23**
Red Lacquer and Jade	**WOR**	**7:15 p.m., Aug. 23**
The Happy Vagabond—Jack Arthur	**WOR**	**11:15 a.m., Aug. 24**
Veronica Wiggins and Frank Parker	**WEAF**	**8:30 p.m., Aug. 24**
Hearing America With Guion	**WOR**	**8:00 p.m., Aug. 25**
Death Valley Days	**WJZ**	**9:30 p.m., Aug. 25**
Kathleen Stewart—Pianist	**WEAF**	**2:15 p.m., Aug. 26**
Footlight Echoes	**WOR**	**9:15 p.m., Aug. 26**
John Charles Thomas—Baritone	**WJZ**	**9:30 p.m., Aug. 27**
Little Symphony	**WOR**	**9:00 p.m., Aug. 28**
Alice Remsen	**WOR**	**10:00 p.m., Aug. 29**
Little Jack Little	**WEAF**	**11:00 p.m., Aug. 29**

[*If you would like to know something of your favorite radio artists and announcers, drop a card to the conductor of this column. Address Miss Alice Remsen, care* RADIO WORLD, *145 West 45th Street, New York, N. Y.*]

www.americanradiohistory.com

SETS IN USE IN U. S. FAR UNDER TRADE'S GUESS

Washington.

The much-quoted trade estimate of the total number of radio sets in use in the United States is in for a sharp reduction if it is to conform to a "scientific accumulation" of facts and figures. The estimate is 15,000,000 sets, but—

The United States Department of Commerce, Bureau of Census, reports 4,096,181 families out of 12,296,408 have sets, or about one-third. The compilation isn't complete, as populous States, e.g., New York, Illinois, Massachusetts, New Jersey, California and Ohio, are not included in the 12,296,408 count. However, it is obvious that the total number of sets will be far under 15,000,000.

Midget Sets to Swell Figure

The Bureau of the Census also gave out the following information:

Since the radio census was taken as a part of the population census, however, many sets have been sold, including a large number of "midget" receivers, of comparatively low price. Moreover, included among the States which have not yet been accounted for in the tabulations are among the most populous areas of the country, and unquestionably will show high ratios of radio sets in proportion to their number of families, thereby increasing the total as well as the percentage of coverage. Included among these States are New York, Illinois, Massachusetts, New Jersey, California, Ohio and Missouri.

The latest estimates made by the industry and by the Department of Commerce placed the number of sets in the country at between 15,000,000 and 15,500,000. These, however, were based on data obtained from various areas, and not on any "scientific" accumulation of facts or figures. The Census Bureau's analysis represents the first accurate count of receivers ever attempted.

Of General Value

This information will be of value not alone to the radio industry, but to the Federal Radio Commission in its administration of radio, and to the broadcasting industry. To the Commission accurate information will be of value in its allocation of facilities, so that stations may be distributed where the radio sets are the thickest. Manufacturers learning the number of receiving sets in particular areas, may concentrate their sales efforts on "underradioed" areas, while broadcasters will be better acquainted with the size of their audience and thus enabled to show a particular listener coverage for their programs.

Latest releases of the Census Bureau relates to Michigan, Virginia and Minnesota. Michigan had a total of 1,103,157 families as of April 1 last year, with 599,195 receiving sets, or an average of 50.6 per cent. Minnesota had 608,389 families with 526,026 or 47.3 per cent reporting sets. The aggregate number of families in Virginia was 530,092, with 96,569 reporting sets for an average of 18.2 per cent.

Connecticut leads all other States in the returns thus far tabulated with an average of 54.9 per cent of its families owning sets. The District of Columbia is second with an average of 53.9. Wisconsin third with 51.1 and Michigan fourth with 50.6 per cent. Others are below 50 per cent, with Mississippi the lowest, having an average of 5.4 per cent.

Summarized List Of Census Figures

Washington.

A summary of the "radio population" returns thus far tabulated by the Bureau of the Census follows:

Number of families, A; persons per family, B; number of radios C; per cent, D:

	A	*B*	*C*	*D*
Alabama	592,530	4.5	56,491	9.5
Arizona	106,630	4.1	19,295	18.1
Arkansas	439,408	4.2	40,248	9.2
Colorado	268,531	3.9	101,376	37.8
Connecticut	389,596	4.1	213,821	54.9
Delaware	59,295	4.0	27,183	45.8
Dist. of Col.	126,014	3.9	67,880	53.9
Florida	377,823	3.9	58,446	15.5
Georgia	654,009	4.5	64,908	9.9
Idaho	108,515	4.1	32,869	30.3
Indiana	844,463	3.8	351,540	41.6
Iowa	636,905	3.9	309,237	48.6
Kansas	488,055	3.9	189,527	38.8
Kentucky	610,288	4.3	111,452	18.3
Maine	198,372	4.0	77,803	39.2
Maryland	386,087	4.2	156,465	42.9
Michigan	1,183,157	4.1	599,196	50.6
Mississippi	472,354	4.3	25,475	5.4
Montana	137,010	3.9	43,809	32.0
Minnesota	608,398	4.2	287,880	47.3
Nebraska	343,781	4.0	164,324	47.8
Nevada	25,730	3.5	7,869	30.6
New Hampshire	119,660	3.9	53,111	44.4
New Mexico	98,820	4.3	11,404	11.5
North Dakota	145,382	4.7	59,352	40.8
Oklahoma	565,348	4.2	121,973	21.6
Oregon	267,690	3.6	116,299	43.5
South Dakota	161,332	4.3	71,361	44.2
Utah	116,254	4.4	47,729	41.1
Vermont	89,439	4.0	39,913	44.6
Virginia	530,092	4.6	96,569	18.2
West Virginia	374,646	4.6	87,469	23.4
Wisconsin	713.576	4.1	364,425	51.1
Wyoming	57,218	3.9	19,482	34.0

Alden Has New Posts for Antenna-ground

A new Alden post cuts the cost because the entire design is simple. The wire guide takes any size wire easily and keeps the wire in place and away from the chassis.

Many electricians believe a ground should be a No. 8 or some other large size wire. This new post will accommodate this and all sizes of wire equally well.

Only a single eyelet is needed to hold the device to the set. This forms the ground. A tinned solder tab is provided for the other connection. The tops cannot be unscrewed and lost. It is made by the Alden Manufacturing Company, 715 Center Street, Brocton, Mass.

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Readers desiring radio literature from manufacturers and jobbers concerning standard parts and accessories, new products and new circuits, should send a request for publication of their name and address. Send request to Literature Editor, Radio World, 145 West 45th Street, New York, N. Y.

Bob Potts, Albany, Oregon.
A. J. Howell, 557 Arquello Blvd., San Francisco, Calif.
Kenneth J. McCarron, San Jose, Calif.
The Radio-Craft Co., Mfrs. (Lit. on tubes, parts, etc.), 351 W. 79th St., Chicago, Ill.
Jacob Wheeler, 319 Second St., Johnsonburg, Pa.
A. Robert Navé, 44 Park Place, New Brighton, S. I., N. Y.
Stephen M. Skovran, 828 Peralto St., N. S., Pittsburgh, Pa.
Joe Krentz, 1232 13th St., Douglas, Ariz.
J. E. McCright, 442 Quincy Ave., Ottumwa, Iowa.
H. H. Randall, 1207 Forbes St., Kalamazoo, Mich.
Isa William Jacob, Infanta Luisa No. 8, San Juan, P. R.
C. W. Newman, 17 Wallace St., Duncan, Greenville, S. C.
City Electric Shop, Box 696, Olustee, Okla.
James L. Carter, Box 43, Chatham, Va.
David Batdorf, 541 N. 13th St., Reading, Pa.
W. C. Cayot, Cayot Radio Co., Box 44, Westphalia, Kans.
W. Yarborough, 206 No. Michigan, Roswell, New Mexico.
M. Reeves, Apt. No. 12, 2230 Geary St., San Francisco, Calif.
Steve J. Truth, Box 97, Fair Oaks, Pa.
O. B. Elliott, D.D.S., 824 Edmond St., St. Joseph, Mo.

Forum

Not Asking Too Much

GLAD to see "Our Side" in this week's issue of Radio World. Now we know where you stand in regards to the mistakes and omissions of data on the circuits you publish. Only an occasional reader of your magazine until about two years ago, I now should not care to miss a single copy, in spite of the errors we like to credit you with. Yes, I felt the same as some of your readers do about the omissions.

What are we going to do about it? The majority of us have two normal legs. We seem to be using them more for kicking than walking, but let us not mislead ourselves. The Missouri product holds all titles, past, present, and future to this form of recreation. Let's do a little self-analyzing and see whether a little thinking in the place of kicking will not help.

I hope that we will always have the beginner with us, and he does need help, but are we not asking too much when requesting the value of a filament resistance, or the number of turns required on a conventional RF coil. Such information ought to be quite superfluous to the majority of us. We have seen this given time and time again in former issues, not only in this publication but others as well. We saw fit to pass it up then. Now let's get busy and dig up those old copies and get acquainted with them.

Again we refuse to study the simpler fundamentals of electricity and now kick because of the lack of that knowledge. We cry when others ask for technical articles because we're not interested. I feel that since I'm not the only reader of Radio World, it is out of order to expect the publisher to cater to me. Because articles of interest to them do not interest me, have I a right to complain? Not at all.

Admitted that the problem of LC ratio is difficult, a search through former articles will help us out. To wind a coil and then expect it to function exactly as it did for another constructor is asking much. We know it because we have been told so and because in actual practice it usually turns out so. Why this is so ought to be readily answered by those of us who pin E.E. and R.E. after our names.

Arthur E. Hein,
1720 Gates Ave., Brooklyn, N. Y.

* * *

We Wish

I HAVE read in Radio World and other magazines about short-wave reception, advertising single control short-wave radios.

I have experimented with radios for seven years and at present I have a two-dial set. I find out that a single dial short-wave superheterodyne is no good, as the oscillator circuit and r-f circuit has to be tuned 300 kc apart. Where you have only one dial you can't do this. I have also made up my mind that the single dial radio will be obsolete in a short time. It is not as efficient as a two-dial set, and the old style three-dial will beat it on tuning any day.

I will never buy a single-dial radio as long as I live. You can put this in Radio World if you wish.

S. J. Nessa.

Story City, Iowa.

New Incorporations

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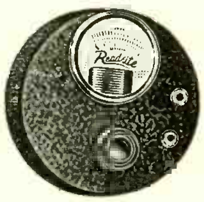
Often it is desired to determine the resistance value of a unit, to determine if it is correct, or to measure a low voltage, and then a continuity tester that is also a direct-reading ohmmeter and a DC voltmeter comes in triply handy.



So here is the combination of all three:

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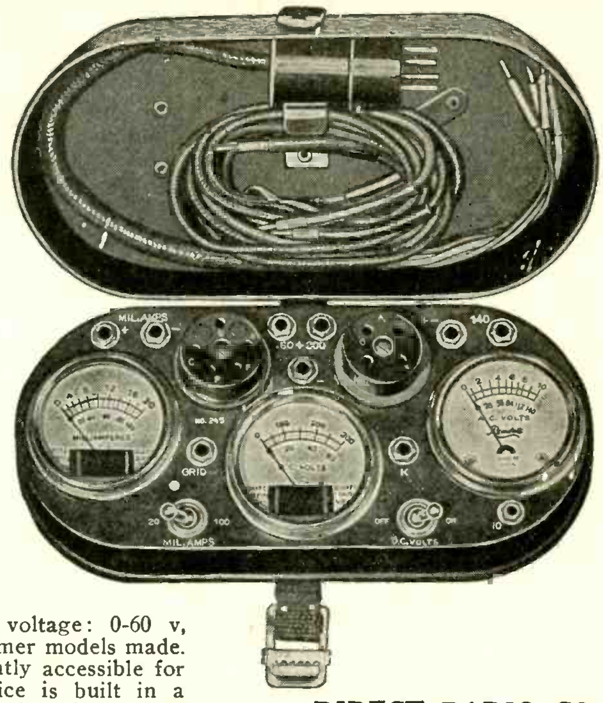

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