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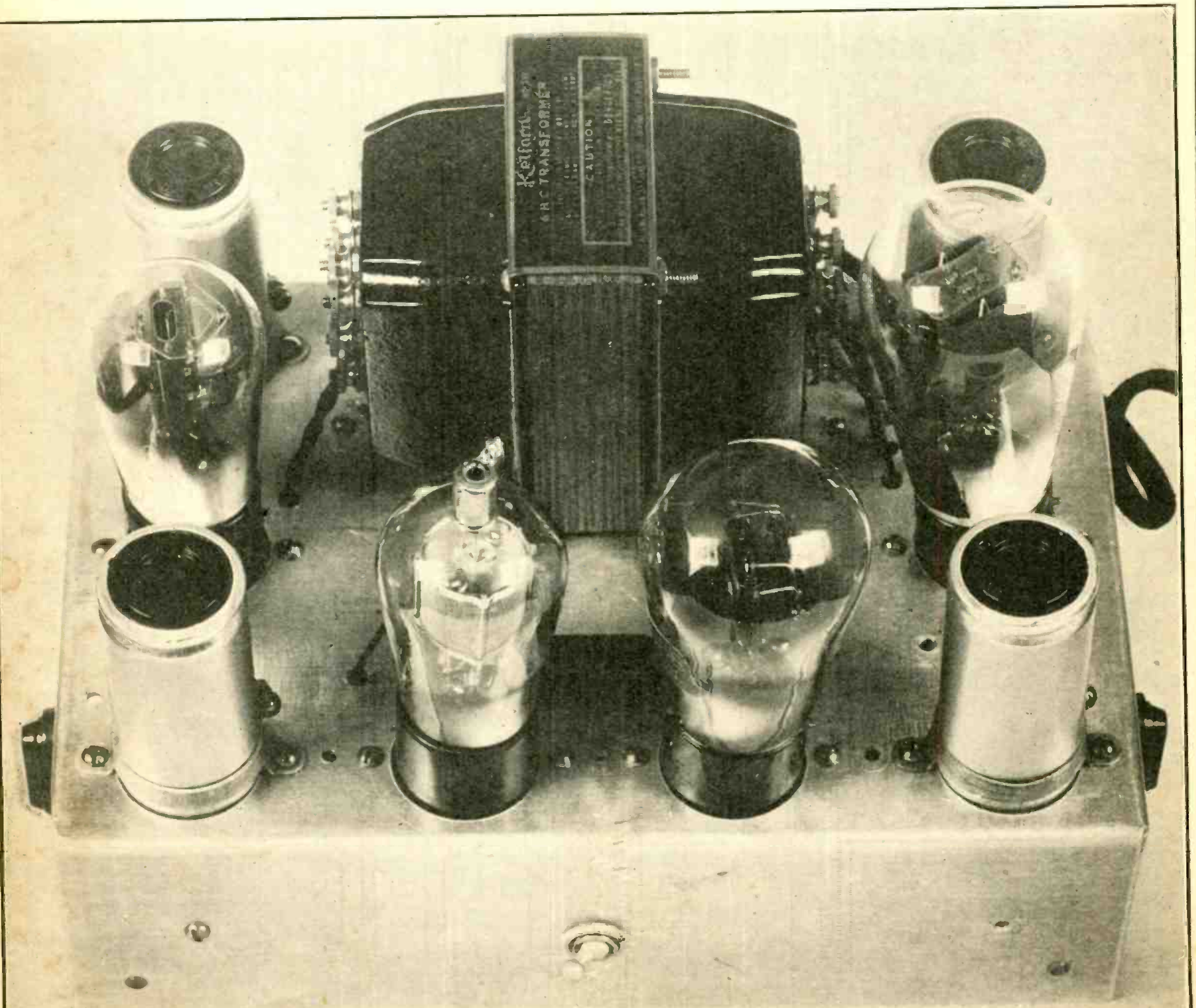
488th Consecutive Issue—TENTH YEAR
PRICE 15c Per Copy

Short-Wave Relay Transmitter

Equalized R-F Amplification

PENTODE TELEVISION AMPLIFIER



A Power Amplifier Using 247 Pentode Output. See Page 14.

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Equalized Amplification

Compensation of Rising TRF Characteristic

By J. E. Anderson

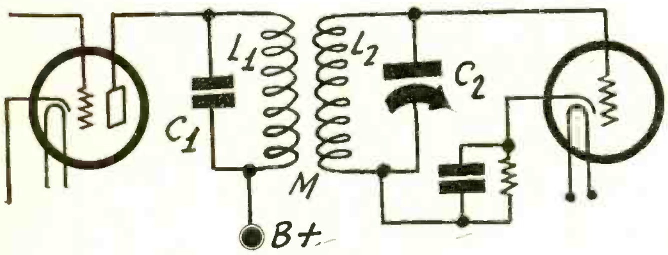

FIG. 1

If C1 and L1 in this circuit are chosen properly the rise in the amplification with frequency is partly compensated for.

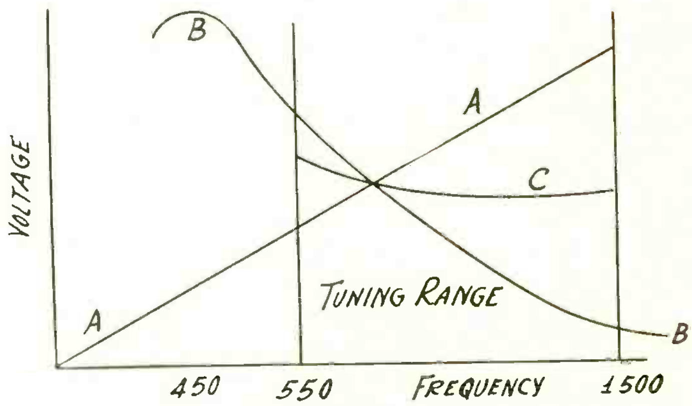

FIG. 2

The amplification due to transfer of voltage by mutual inductance rises as curve AA. This rise may be counteracted by a circuit having a characteristic like BB, resulting in a characteristic like C.

THE rising characteristic has always been a problem in radio frequency amplification. What is the rising characteristic in this respect? It is the increase in amplification with increase in the frequency and is mainly due to the fact that the voltage induced in the tuned secondary is proportional to the frequency provided the mutual inductance between the primary and the secondary and the primary current remain constant. The rising characteristic is also due in part to regeneration through the plate-grid capacity, which increases as the frequency increases.

Neutralization prevents regeneration by feedback through the plate-grid capacity but it does not affect the effective mutual coupling between the primary and the secondary windings of a coupling transformer. Hence even in neutralized circuits, such as the Neutrodyne, the amplification is usually much higher at the higher broadcast frequencies than at the lower.

There is still another effect which works in the same direction of increasing the amplification as the frequency increases, and that is the fact that the ratio of the inductance to the capacity in the tuned circuit increases with frequency. As this ratio increases the voltage across the tuning condenser, and hence on the grid, increases.

Equalizing Amplification

It is desirable so to design the radio frequency transformers that the amplification is virtually independent of the frequency, that is, so that it is just as high at 550 kc as at 1,500 kc. This is not a very difficult problem, although in every instance the complexity of the circuit is increased. More condensers and coils must be used to make the amplification characteristic level.

There are many circuit arrangements that may be used for making the amplification nearly independent of the frequency, and we shall discuss the principle of some of them.

Consider Fig. 1. Here, apparently, we have two tuned circuits L1C1 and L2C2 with the coils L1 and L2 coupled magnetically. A circuit of this type may be designed so that the voltage transfer from one tube to the next is practically independent of frequency. On closer inspection it will be noted that only C2 is variable, while C1 is fixed. Circuit L1C1 is not tuned to any frequency in the band of frequencies covered by L2C2 but to a frequency somewhat below the lowest frequency to which L2C2 tunes.

Since the voltage induced in L2 is proportional to the current flowing in L1 and also to the frequency, if by any means we can vary the current in L1 so that it is inversely proportional to the frequency, the voltage induced in L2 will be independent of the frequency and the amplification will be practically constant. If we make the current vary more rapidly in the same direction we can also compensate for the increase in ratio L2/C2 as the tuned circuit is tuned to higher frequencies.. This is possible by proper choice of L1 and C1 and the resistance of this circuit.

Tampering with Current Variation

Now suppose that L1C1 resonates at 500 kc. Then when L2C2 is set at 550 kc the first circuit is well up on the resonance curve and a considerable current flows in L1. Hence the voltage induced in L2 is high. As L2C2 is tuned to higher frequencies the operating point on the resonance curve of L1C1 is lower and lower down. Therefore the current in L1 is less and less the higher the frequency. Hence the voltage induced in L2 is relatively reduced as the frequency is increased. Actually there should be no reduction in the voltage induced because as the frequency increases the coupling increases, since it is proportional to the mutual inductance and the frequency. By proper choice of the resonant frequency of L1C1, the proper ratio of L1/C1, and the proper resistance in this circuit, the current through L1 can be made to vary in almost the desired manner,

(Continued on next page)

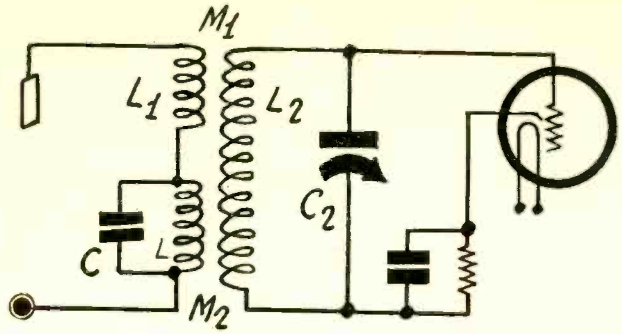

FIG. 3
A method of compensating for the rising characteristic. At high frequencies condenser C diverts signal current from L and thus reduces the amplification. This reduction is proportional to the frequency.

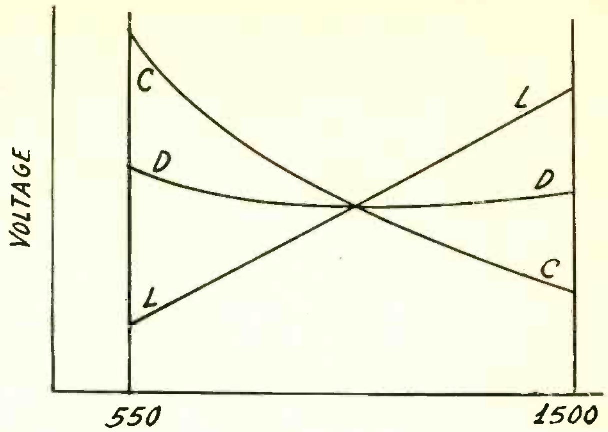

FIG. 5
This illustrates the equalization in the Loftin-White coupler. LL represents the voltage introduced into the tuned-circuit by the primary, CC that introduced by the mutual condenser, and DD represents the combined effect.

(Continued from preceding page)
and the desired manner is that which makes the voltage across C2 independent of frequency. The proper combination must be found by experiment.

The higher the resistance in the first tuned circuit the more slowly does the current vary. Thus if the resistance is too high the equalization will be insufficient and if the resistance is too low it may be that the low radio frequencies will be amplified more than the high. The manner in which the variation occurs with changes in resistance can be seen from the selectivity curves published on page 4, July 25th issue of RADIO WORLD. The curve for Q 12.5 is for high resistance and that for Q 283 is for low resistance. The manner in which the current in L1 will vary is approximately shown by these curves if they are viewed upside down.

Graphic Representation

In Fig. 2 is a graphic representation of the effect of combining the characteristics of the two circuits in Fig. 1. The curve AA represents the voltage induced in L2 by L1, while the curve BB represents the effect of the condenser C1. The peak of curve BB is at 450 kc and the entire range of frequencies covered by the circuit L2C2 lies on the upper side of the resonance curve of L1C1. Curve C in Fig. 2 approximately represents the combined effect. This curve is nearly level with the frequency axis, showing that the amplification is nearly independent of the frequency.

The circuit in Fig. 1 may cause the curve C to fall as the frequency is increased, as is indicated in the graph, or else a great reduction in the amplification at all frequencies. To avoid this a slight modification in the circuit may be introduced, such as is shown in Fig. 3. In this case we have two primary windings, one with a condenser across it and another without a condenser. The voltage induced in L2 by L1 through M1 increases with the frequency. The voltage induced in L2 by L through M2 may be made to decrease with frequency because C robs L of the current. The higher the frequency the more of the current will flow through C and the less through L. Only that which flows through L is effective in inducing a voltage in L2.

The circuit in Fig. 3 is more favorable for rendering the voltage induced in L2 independent of frequency than the circuit in Fig. 1 because the condenser C does not have as much effect in cutting down the voltage transfer at the high frequencies.

The arrangement in Fig. 1 has been used in many broadcast receivers of the tuned radio frequency type as well as in the radio frequency stages of superheterodynes. The arrangement in Fig. 3 likewise has been employed.

Another Method of Equalization

Fig. 4 gives still another method of equalization of the amplification, and this method has also been used in commercial receivers. It is the method originated by Messrs. E. H. Loftin and S. Young White.

In this circuit Ch is a choke coil of relatively high inductance. It has practically no effect on the amplification characteristic. Condenser C1 also is relatively large so that it does not introduce any appreciable change in the characteristic.

The primary circuit is mainly L1 and Cm, through which the signal current flows. The voltage induced in L2 by the current in L1 is directly proportional to the frequency. But the primary current also flows through Cm and thus another voltage is introduced in the secondary circuit, for Cm is a part of that circuit. The voltage across Cm is inversely proportional to the frequency. The total voltage introduced into the secondary circuit is the sum of the two voltages, and this sum is practically independent of the frequency, or can be made so by the proper choice of values.

In Fig. 5 is shown qualitatively the manner in which the voltage is equalized by the Loftin-White method of coupling. The voltage induced in L2 by the current flowing in L1 is represented by curve LL and that introduced into the secondary circuit by the drop across Cm is represented by the curve CC. The sum of the two voltages is represented qualitatively by curve DD, which is nearly horizontal or parallel with the frequency axis. Hence the amplification is practically independent of the frequency, that is, equal for all frequencies within the range of the receiver tuner.

Still Other Methods

These are just a few of the many possible methods. It is possible to devise a large number of circuit arrangements which will have the same effect.

In Fig. 6 is a simple arrangement which helps a little in cutting down the amplification at the high frequencies while it does not cause much reduction at the low frequencies. A small choke coil Ch is connected in the plate lead in series with the primary of the coupling transformer. Of course, this choke causes a reduction in the amplification at all frequencies but it causes a greater reduction at the high frequencies, the reduction being proportional to the frequency. Hence this choke works in the right direction, and it is no worse than some more complex methods. Of course, Ch must have a low inductance, say of the

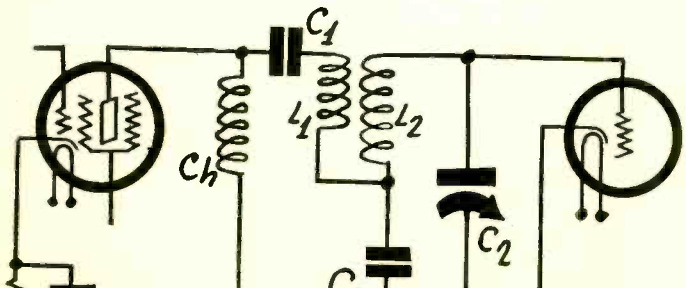

FIG. 4
The Loftin-White method of equalizing the amplification over the entire broadcast band is based on the use of both magnetic and capacity coupling as here illustrated.

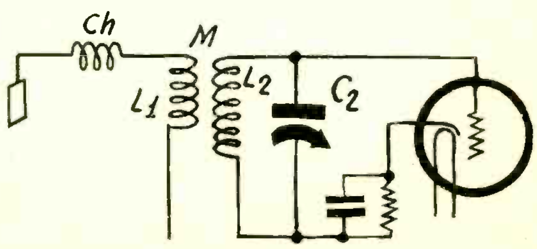

FIG. 6
Excessive amplification on the high frequencies may be prevented by connecting a small choke in series with the primary as shown here. Ch should not be coupled magnetically to L2.

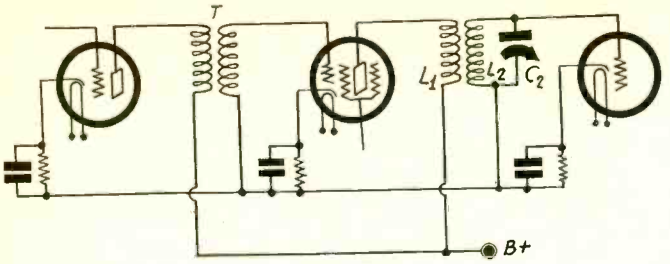

FIG. 7

Equalization can be effected by employing untuned radio frequency transformers in addition to tuned transformers and making one of the windings resonant at the lowest frequency to which the tuner responds.

same value as the mutual inductance M between L1 and L2, or even smaller if L1 is very small.

A similar effect is produced by a small condenser connected in shunt with L1. But this does not differ essentially from the arrangement in Fig. 1 except that the condenser is smaller. The natural frequency of the circuit formed by the condenser and the primary should still be below the lowest frequency to be tuned in by the variable condenser. This means that the primary will have to have a higher inductance than that in Fig. 1.

Using Untuned Transformer

Another method sometimes used is illustrated in Fig. 7. In this case the tuned coupler L1L2C2 has a rising characteristic, since it is of the simple form. But the untuned transformer T in the preceding stage has a falling characteristic. The secondary winding of this transformer is made such that its inductance resonates with the grid to cathode capacity at about 550 kc. At this point then the amplification in this stage will be highest. As the frequency is decreased the transformer will operate higher and higher above the resonance point and therefore the amplification will be less and less the higher the frequency.

The tuned circuit in T must not be too highly resonant, for if it is the amplification at the resonant frequency will be too high relatively and that at frequencies far above the resonance point will be too low. For these reasons the transformer should be wound with very fine wire and the coupling between the primary and the secondary should be close.

This method in Fig. 7 has been used successfully in many good radio receivers. Curves taken on such amplifiers have shown that the amplification had practically the same value at all frequencies in the range covered by the tuners.

Amplifiers of the form shown in Fig. 7 are relatively stable even when the tubes are of the three-element type, as there is little feedback. Moreover, the overall amplification at all frequencies is good because even when T is off resonance there is considerable gain.

Equalizing by Regeneration

Equalization of the amplification over a certain band of frequencies may be effected by means of regeneration. The method is illustrated in Fig. 8. L1L2C2 has a rising characteristic due to the fact that the voltage induced in L2 is proportional to the frequency. The characteristic of the second circuit L3L4C4 is the same. If there are many such circuits in a receiver, the cumulative discrimination against the low radio frequencies would be considerable. To offset the relative loss of amplification on the low notes a certain amount of regeneration can be introduced in one stage. The feedback circuit should be so arranged that the greatest feedback occurs at the lowest frequency to which the tuner in the receiver responds, and the amount of feedback at this point should be under that which causes oscillation. If the maximum were not set at this point, it is possible that the circuit would oscillate at lower frequencies, and oscillation must be avoided

The feedback circuit in Fig. 8 is LC and Rh. To place the maximum feedback at the lowest frequency of the tuner LC is adjusted so that LC equals L2C2 when C2 is maximum. At higher frequencies the condenser C will take the feedback current, and less and less current will flow through the coil as the frequency increases.

If the resistance in the circuit LC is too low the variation will be too rapid satisfactorily to compensate for the rising characteristic of the radio frequency tuners. Hence a variable resistance Rh is put in series with the coil so as to lower the selectivity of this feedback circuit. This resistance can also be used for varying the feedback at maximum so that there will be no oscillation at any frequency. A variable resistance of 0-1,000 ohms should be high enough, or one of even lower maximum value. The coupling between L2 and L should be fairly loose but its best value can only be found by experiment.

All methods of equalizing the amplification are based on the fact that the reactances of inductance and capacity are opposite. That is, the reactance of an inductance is directly proportional to frequency and that of a capacity is inversely proportional to frequency. Taking advantage of this fact it is only necessary to

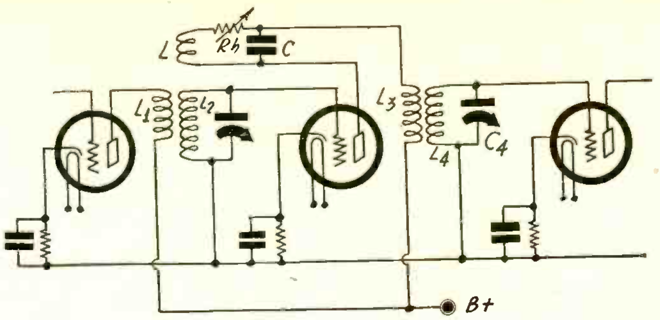

FIG. 8

Equalization can also be effected by introducing regeneration which varies inversely as the frequency. The tuned circuit LC should be adjusted to the lowest frequency to which the circuit tuner responds.

manipulate the relative values and the positions of the parts to effect the desired equalization. The resistance of the tuned circuit or the coil used to equalize is used to change the rate at which the change occurs. How the resistance affects the rate can be seen from the curves in Fig. 9, which are reprinted from the issue previously cited for convenience. When the resistance is high, that is, when the Q of the circuit is small, there is comparatively little change in the effect as the frequency changes but when the resistance is low, or when the Q of the circuit is high, the change is rapid.

There are factors in a receiver which tend to effect equalization without any special arrangement, and for that reason there are many receivers which are not even as sensitive on the higher frequencies as on the lower. One of these is the lack of simultaneous resonance of the several tuned circuit when all are tuned with the same control. When this is the case the amplification on the high frequencies is not only poor but the selectivity is also poor.

Another factor is the distributed capacity across the primary of the radio frequency transformer. While this capacity is small it sometimes has a very great effect in shunting the high frequencies around the primary. Some receivers are so designed that the maximum amplification occurs at the mean frequency of the tuning band. In such receivers the difference in the sensitivity is not very large and sometimes it is not even noticeable.

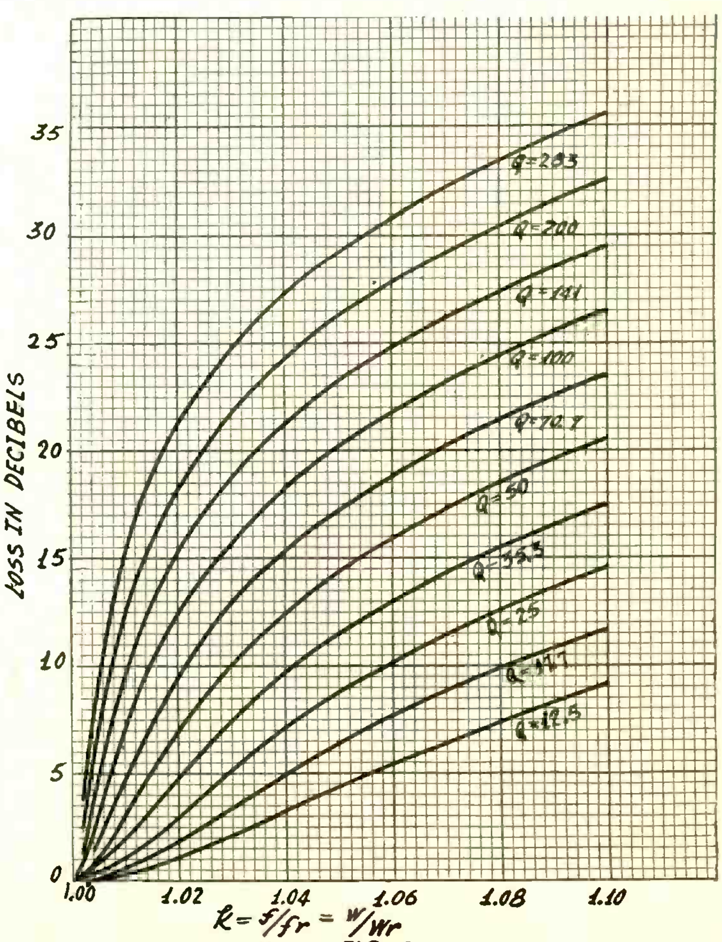

FIG. 9

These curves show how resistance in a tuned circuit affects amplification off resonance. The lower the Q the higher the resistance

Short-Wave Coil Formula

How to Use Broadcast Station as a Starter

By Antonio Marucci

IT is easy to determine the number of turns of different kinds of wire on particular diameters, to be used with certain maximum capacity tuning condensers, for reception of broadcast frequencies, because there are formulas that give the answer. The only practical exception is that, in case shielding is used, the calculated inductance will be greater than the effective inductance when the coil is put inside a shield.

Allowing for the customary separation of 1 inch between the outside of the coil and the inside of the shield wall, a good enough approximation, in fact one that has worked out satisfactorily as often as the author has tried it, is to take the calculated number of turns as two-thirds the number required for shielding use. It is assumed that the shields are of aluminum or copper, certainly not tin or iron.

In the short-wave band it is quite different. In the first place, the usual formulas do not help much, if any, and at the higher frequencies are of no worth whatever. The cut and try method would seem to be the only one, unless experience develops some system. It is the intention of this article to set forth just such a system and to enable expeditious and accurate winding of coils by experimenters in the short-wave field.

Shielding Expected to Increase

Another point is that shielding is not used much in short-wave reception at present, although it is quite probable that such use will grow steadily, and that some day shielding will be as general in short-wave work as in broadcast reception.

The present information has to do with the winding of coils not intended for shielded circuits.

If a coil is wound for a given capacity condenser, so that at a somewhere near the maximum capacity setting 1,500 kc, 1,400 kc or thereabouts is brought in, then we have a starting point. We know what low frequency we will reach.

By using the coil with secondary thus established and by turning the condenser now to minimum capacity setting we can establish the highest response frequency for that combination, determined principally by the distributed capacities, distributed inductance, and the main capacity and main inductance. All we need do is to calibrate this point for the extreme frequency receivable.

Now we know several things. We know the number of turns of a given size and insulation wire on a particular diameter necessary to tune in a definite frequency with a given condenser at maximum and known capacity. If we can determine the highest frequency we need only compare the frequencies and we will obtain the frequency ratio.

This work actually was done with a .0002 mfd. condenser at first. The ratio proved to be 2.4. That is, starting at 1,100 kc which was done because our calibration included the broadcast band and we were on the second coil, the other extreme frequency reached was 2,530 kc.

Factor of Frequency Ratio

Since the frequency is approximately proportionate to the number of turns, the factor may be used in determining how many turns should be put on the secondary of the next smallest tuned winding. What these factors are for the principal capacities is shown herewith:

TABLE I

Maximum Capacity of Tuning Character	*Factor Determined by Frequency Ratio*
.0005 mfd.	3.0
.00035 mfd.	2.8
.00025 mfd.	2.6
.0002 mfd.	2.4
.00015 mfd.	2.0
.00014 mfd.	1.9
.0001 mfd.	1.7

Anyone can build a one-tube receiver to bring in a broadcasting station at 1,500 kc, 1,400 kc, 1,300 kc, or thereabouts, with required turns on the tuned winding for any selected diameter and type and size of wire for the condenser at maximum setting. If he can not measure the highest frequency received, or verify it in any other way, even approximately, as by tuning in a station near the zero end of the dial, he can accept the ratios given. In any event he will get about the same answer. The ratios are based on the usual distributed capacities found in commercial tuning condensers and in short-wave receiver wiring, etc.

Application of Ratio

Knowing the number of turns on the tuned secondary, as stated, he will find that the ratio allows for no overlap.

The ratio is applied as follows:

Divide the number of turns on the tuned winding by the ratio.

Assume that there were 40 turns of wire used with .0002 mfd. at maximum to bring in 1,400 kc. The highest frequency, zero on the dial, would be the lowest frequency multiplied by the factor. The table gives the factor for .0002 mfd. as 2.4. Therefore the highest frequency you can tune in is 3,360 kc. In wavelengths these are 214.2 meters and 89.23 meters.

Dividing the number of turns, 40, by the same factor, 2.4, we ascertain the number of turns needed to begin tuning at 3,360 kc is 25.

Two considerations now arise. We desire some frequency overlap, and the factor will not give any. Moreover, the shape factor of the coil has changed, that is, the relationship of the diameter of the winding to the coil's axial length. We can allow for both by the factor 400 etc. divided by the capacity in micro-microfarads at maximum, the answer in number of turns, adding two turns to the second largest coil. See Table II. Therefore the total number of turns on the tuned winding, usually the secondary, would be 27.

Smaller Coils Different

We can be absolutely certain of the first coil, from experience, a sort of inevitable consequence, and with the extra-turn provision we can be absolutely certain of the second coil, but the ratio will not hold infallibly for coils intended for higher frequencies, because actually the ratio becomes less, due in part to the larger relative percentage that the distributed capacities and inductances bear to the intentional capacities and inductances, as well as to the relatively large effect of the condenser's minimum capacity where the frequencies are of a high order. But we can take care of these requirements by respective factors divided by the number of micro-microfarads, the answer being in number of turns, and add that number to the result for the next coil. Let us apply this.

We have 27 turns in the previous coil, and are using .0002 mfd. The factor is 2.4, so the number of turns required is 27/2.4 plus 200/200, or 11.2 plus 1, equals 12.2 turns.

The next coil would have this number of turns: 12.2/2.4 plus 100/200, equals 5.1 plus, 0.5 equals 5.6.

Turns Stated

The next coil would consist of this number of turns: 5.6/2.4 plus 50/200, or 2.33 plus .25 or 2.58. The next would have 1.5 turns.

If experiments are to be attempted regarding still higher frequencies, the general practice is to make the tuned coil consist of only 1 turn, for the tuned winding, and this may be acceptable for the seven values of capacity listed in the table, or any other capacity in general use. A small one of course is preferred.

(*Continued on next page*)

Formula for Determining Number of Turns on Coil

(1)—*Wind enough wire to tune in a high broadcast frequency,* 1,500 *kc,* 1,400 *kc or* 1,300 *kc. This is coil No.* 1.

(2)—*Divide by the factor of frequency ratio, Table I.*

(3)—*Add turns equal to* 400 *etc. divided by the condenser's maximum capacity in micro-microfarads. This is coil No. 2. See Table II.*

(4)—*Proceed along the same lines for the other coils, noting that for each successive coil the extra-turns factor is halved. See Table II.*

Inductance Formula
How to Wind Short-Wave Coils for Full Coverage

(Continued from preceding page)

Special circuits are required to tune higher than the 1-turn coil permits. With only 60 mmfd. the range might be 30,000 to 50,000 for the single turn.

Further reconciliation is usually established, however, consisting of making the number of turns whole numbers, or easy fractions, by increasing large decimal values to a full turn, or by increasing small decimal values to a half turn.

The coils used therefore would have secondaries as follows, in the stated instance:

Coil No. 1—40 turns
Coil No. 2—27 turns
Coil No. 3—6 turns
Coil No. 4—3 turns
Coil No. 5—1.5 turns.

The coils can be worked out for the other capacities in the same manner. The diameter of the tubing has not been stated, nor has the size of the wire, since whatever they are they will be the same for all coils, with the exception that for the smallest coils the wire may be of much larger diameter, but this is in the direction of only trivially increasing the inductance, unless space-wound, and these differences need not be taken into consideration further than has been done.

The extra-turns factor relates to coils that start at about 4,000 kc, the factor being halved with each succeeding coil:

TABLE II

Coils	Factor	
First	0	Divided by the condenser's maximum capacity in microfarads, equals number of turns to add.
Second	400	
Third	200	
Fourth	100	
Fifth	50	

Frequency-Wavelength
30,000 to 10,000 kc, 9.994 to 29.98 Meters

k.c.	m.	k.c.	m.	k.c.	m.	k.c.	m.	k.c.	m.
30,000	9.994	26,000	11.53	22,000	13.63	18,000	16.66	14,000	21.42
29,900	10.03	25,900	11.58	21,900	13.69	17,900	16.75	13,900	21.57
29,800	10.06	25,800	11.62	21,800	13.75	17,800	16.84	13,800	21.73
29,700	10.09	25,700	11.67	21,700	13.81	17,700	16.94	13,700	21.88
29,600	10.13	25,600	11.71	21,600	13.88	17,600	17.04	13,600	22.04
29,500	10.16	25,500	11.76	21,500	13.95	17,500	17.13	13,500	22.21
29,400	10.20	25,400	11.80	21,400	14.01	17,400	17.23	13,400	22.37
29,300	10.23	25,300	11.50	21,300	14.08	17,300	17.33	13,300	22.54
29,200	10.27	25,200	11.90	21,200	14.14	17,200	17.43	13,200	22.71
29,100	10.30	25,100	11.95	21,100	14.21	17,100	17.53	13,100	22.89
29,000	10.34	25,000	11.99	21,000	14.28	17,000	17.64	13,000	23.06
28,900	10.37	24,900	12.04	20,900	14.35	16,900	17.74	12,900	23,24
28,800	10.41	24,800	12.09	20,800	14.41	16,800	17.85	12,800	23.42
28,700	10.45	24,700	12.14	20,700	14.48	16,700	17.95	12,700	23.61
28,600	10.48	24,600	12.19	20,600	14.55	16,600	18.06	12,600	23.80
28,500	10.52	24,500	12.24	20,500	14.63	16,500	18.17	12,500	23.99
28,400	10.56	24,400	12.29	20,400	14.70	16,400	18.28	12,400	24.18
28,300	10.59	24,300	12.34	20,300	14.77	16,300	18.39	12,300	24.38
28,200	10.63	24,200	12.39	20,200	14.84	16,200	18.51	12,200	24.58
28,100	10.67	24,100	12.44	20,100	14.92	16,100	18.62	12,100	24.78
28,000	10.71	24,000	12.49	20,000	14.99	16,000	18.74	12,000	24.99
27,900	10.75	23,900	12.54	19,900	15.07	15,900	18.86	11,900	25.20
27,800	10.78	23,800	12.60	19,800	15.14	15,800	18.98	11,800	25.41
27,700	10.82	23,700	12.65	19,700	15.22	15,700	19.10	11,700	25.63
27,600	10.86	23,600	12.70	19,600	15.30	15,600	19.22	11,600	25.85
27,500	10.90	23,500	12.76	19.500	15.38	15,500	19.34	11,500	26.07
27,400	10.94	23,400	12.81	19,400	15.45	15,400	19.47	11,400	26.30
27,300	10.98	23,300	12.87	19,300	15.53	15,300	19.60	11,300	26.53
27,200	11.02	23,200	12.92	19,200	15.62	15,200	19.72	11,200	26.77
27.100	11.06	23,100	12.98	19,100	15.70	15,100	19.86	11,100	27.01
27,000	11.10	23,000	13.04	19,000	15.78	15,000	19.99	11,000	27.26
26,900	11.15	22,900	13.09	18,900	15.86	14,900	20.12	10,900	27.51
26,800	11.19	22,800	13.15	18,800	15.95	14,800	20.26	10,800	27.76
26,700	11.23	22,700	13.21	18,700	16.03	14,700	20.40	10,700	28.02
26,600	11.27	22,600	13.27	18,600	16.12	14,600	20.54	10,600	28.28
26,500	11.31	22,500	13.33	18,500	16.21	14,500	20.68	10,500	28.55
26,400	11.36	22,400	13.38	18,400	16.29	14,400	20.82	10,400	28.83
26,300	11.40	22,300	13.44	18,300	16.38	14,300	20.97	10,300	29.11
26,200	11.44	22,200	13.51	18,200	16.47	14,200	21.11	10,200	29.39
26,100	11.49	22,100	13.57	18,100	16.56	14,100	21.26	10,100	29.69
								10,000	29.98

[The above table is reversible. The numbers under kc may be read as meters. The answers, under m, will be in kc.]

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Theory of a Short-

Radio Frequency Action Traced from

By J. E. Anderson

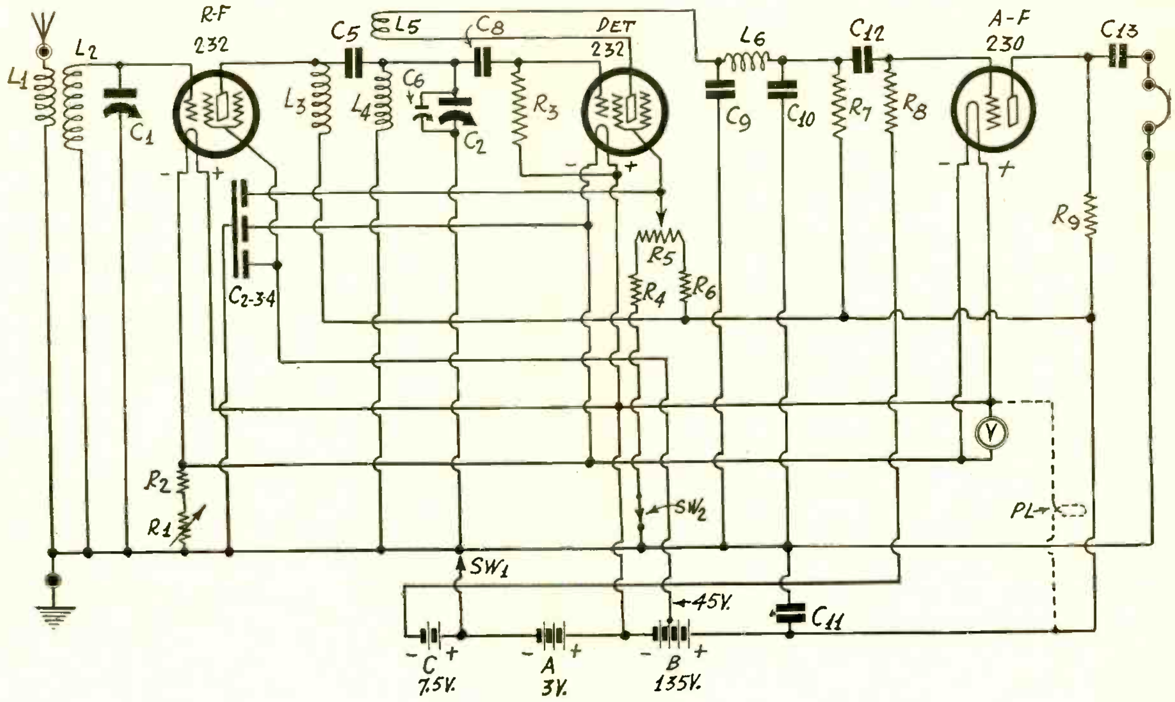

FIG. 12
An excellent battery-operated short-wave earphone set.

[*This is the third of a series of short-wave articles. More will follow.*—EDITOR.]

SINCE the circuit, Fig 12, affords excellent results, let us consider the theory of receiver performance in respect to it, and later discuss construction.

Aerial and ground are connected to the two terminals of the primary L1 of the antenna coupler. Therefore, radio waves impinging on the antenna flow in the winding L1. The radio waves are alternating current. They reverse their polarity millions of times a second. The aerial and the associated antenna winding L1 are virtually non-selective, so we may say that all waves are flowing here.

Even when direct current is passed through a short length of straight wire there is a magnetic field about the wire. That would be steady magnetism. The field has the same properties as a permanent magnet, horseshoe or bar type, for attraction and repulsion.

When alternating voltage is impressed across a coil suitable for the handling the frequency, a magnetic field is set up, too, but instead of being a static field it is an alternating one, of the same frequency as the supplied voltage. If there are several or many frequencies, all these are present.

Different Coils for Different Uses

If the frequency were low, say, 60 cycles per second, then an iron-core transformer or coil would be used, and at this frequency the few turns in L1 are a short circuit. However, at radio frequencies L1 is just as effective as an iron-core coil of many more turns and much finer wire would be at audible frequencies. The reason is that the effectiveness of a winding depends on the frequencies supplied to it, another expression of the fact that coils behave differently at different frequencies, that is, are reactive.

Association of the secondary, L2, with the primary, L1, results in the reversing magnetic field around L1 affecting identically L2, just as the antenna-ground system affected L1. This association is due to physical proximity and it is called mutual inductive coupling. It is mutual because there are more than one coil, it is inductive because the current through the windings generates a changing magnetic field, and it is coupling because the two magnetic fields interlink.

The field goes through the same performance as does the original frequency, rising from zero to maximum, falling to zero again, this action constituting an alternation or half-cycle, and then dipping below the zero line, hence becoming negative, reaching maximum negative and rising again to zero.

The two alternations comprise one complete cycle.

The rapidity of the changes is expressed by the frequency, which is the number of times per second that the wave goes through one complete cycle (two alternations).

The velocity of a radio wave is the same as the velocity of light, which is about 186,000 miles per second. The velocity in meters is 299,820,000, but the figure 300,000,000 is frequently used, although erroneous to 6 parts in 10,000.

Since the velocity and the frequency are known, it is possible actually to measure in some instances, and in all instances to compute, the distance between any two points of successive equal instantaneous values of voltage. Usually the idea of computing from crest to crest of successive waves is used.

The distance between these crests is the wavelength and it is measured in meters.

Since we can compute the wavelength if we know the frequency, we can also compute the frequency if we know the wavelength, for velocity is the factor common to both and is always the same.

The relationships are expressed in the following:

Frequency in cycles per second is equal to the velocity in meters per second divided by the wavelength in meters.

Wavelength in meters is equal to the velocity in meters per second divided by the frequency in cycles per second.

Note that to obtain the unknown, divide the velocity by the known in both instances.

Kilocycles and Megacycles

In radio work the frequencies are so high that they are usually expressed in kilocycles. One kilocycle is equal to 1,000 cycles. Some of the short waves are of a frequency of thousands of kilocycles and are expressed in megacycles (mgc.). One megacycle is equal to one thousand kilocycles or one million cycles.

Use of the factor 299,820 will give the answer in kilocycles, the factor 229.82 the answer in megacycles.

A meter is equal to 39.37 inches. Some of the very highest radio frequencies are of a wavelength of only a few inches, hence less than one meter, so the wavelength is expressed in centimeters. One centimeter is one one-hundredth of a meter or .3937 inch. There are one hundred centimeters in a meter.

There is no uniformity of preference in respect to frequency and wavelength, although there is a popular leaning toward defining the wave in terms of meters and centimeters, rather than kilocycles and megacycles. Most persons fall into one habit or

Wave Receiver

Antenna to Detector, Audio to Phones

and Herman Bernard

the other, and their "sense" of radio waves becomes rather one-sided, so that they think naturally in terms of one mode, only to be stumped for a moment at the other form, or will require a conversion table. Such a table is reversible, gives the corresponding values of frequencies for stated values of wavelengths, and corresponding values of wavelengths for stated values of frequencies. By shifting of decimal points the table becomes useful for determining all possible values of both.

Frequency Meth od Growing in Use

The frequency method is absolute, in that two waves differing by a certain amount in frequency differ absolutely by that amount. The frequency difference itself can not be converted into equivalent wavelength. Both frequencies first would have to be expressed in their wavelength value, and then the lower wavelength subtracted from the other, to give the wavelength difference. For the same absolute frequency difference the wavelength difference between one pair of frequencies may equal 10 meters, whereas the same absolute frequency difference between another pair of frequencies of much lower wavelength would show the difference in wavelength to be 100 meters. That is one reason why the frequency method of expression is better, and its use is growing, even in discussion of broadcast waves. Many broadcast sets now have dials calibrated in kilocycles.

It is necessary to the proper understanding of short-wave receiver theory that the frequency-wavelength relationship be understood. When it is said that L1 will present a suitable impedance to frequencies of from 1,500 to 4,500 kc, the reader should be sufficiently frequency-conscious to attach significance to the statement. The highest broadcast frequency is 1,500 kc, usually referred to as 200 meters, but actually equal to 199.9 meters by the more accurate computation involving the factor 299,820.

From 1,510 kc to Near Infra-Red

So L1 is understood to handle well the frequencies from the high frequency end of the broadcast band to three times that frequency. Since wavelength is inversely proportionate to frequency, the wavelengths would be 199.9 meters to 66.63 meters.

The fewer the number of turns on the winding, generally the higher the impedance to higher frequencies, so we can understand why the largest coil, for lowest frequencies in the short-wave band, or highest wavelengths, would have more turns than the coil for the opposite purpose.

The short-wave band is not distinctly defined. It used to be regarded as that region below 100 meters, when amateurs were first experimenting with short waves and doubting their effectiveness, but since then not only have bands of lower frequencies been allotted for specific uses, such as television, but even the 0.75-0.76 meter band has been assigned to amateurs for experimental transmission and reception. This band also may be expressed as from 75 to 76 centimeters. The wavelength in inches is 28.8275 to 29.2212, and the frequencies in megacycles are 399.8 to 394.5. In cycles per second these frequencies are 399,800,000 and 394,500,000. These are the actual number of times per second that the wave goes through one complete period, consisting of periodic recurrence of equal values.

So 1,510 kc, the next frequency 10 kc removed from the broadcast band, may be regarded as one extreme, while the other now is 18 centimeters, relatively close to the lowest light frequencies, infra red.

By international agreement the waves are divided into short, intermediate and long, but general practice is to combine intermediate and short into the single term short.

We have theorized about the action of L1, and we assume that we start just above the highest frequency end of the broadcast band, to tune in short waves, recognizing 1,510 kc as the starting point, with the other extreme of our present receiver finally, with other coils, 19,990 kc (15 meters).

We have for L2 a coil consisting of a suitable number of turns of wire, and across the coil a tuning condenser. Now we encounter for the first time the phenomenon of tuning, which consists of providing an electrical circuit favoring a particular frequency. The condenser is of the variable type, so that when the moving plates gradually are disengaged from their mesh with the fixed plates, less capacity is in circuit. This results in the frequency of response being gradually increased.

It has been said that a coil has reactance, that is, its effect is different in degree at the different frequencies. So, too, a condenser has reactance. Since the reactance of the coil itself is different for different frequencies, we can introduce a variable condenser for tuning purposes, and thus create a situation where at various settings the reactances of the coil and the condenser will be equal, but opposite in phase. This is known as zero reactance, otherwise denoting resonance. So as the condenser is turned we run through a great number of zero reactances, and these are the resonance points for the various frequencies.

Limits of Frequencies

Since the inductance is fixed but the reactance of the coil changes with frequency, and since the condenser is variable, we encounter two limiting points, zero impedance for two extreme frequencies, one lowest, the other highest frequency, and these determine the range of frequencies that can be tuned in with a given combination of fixed coil and variable condenser.

The question now arises, what about the primary, since the secondary is tuned, and their fields are interlinked? It is recognized that the coupling between them is loose. The primary maintains its own independent impedance, or opposition to the flow of alternating current, the secondary its own, despite the coupling. Therefore we have to depend on the secondary for resonance. The only consideration common to both is that the magnetic fields interlink—one field with all frequencies, the other with a selected frequency.

By connecting one end of the secondary to the grid of the first tube, or radio frequency amplifier marked R-F, and connecting the other end of this coil to negative of the A battery, we have established an input circuit to the tube, since the filament is in the external battery circuit.

Voltage Up, Current Down

Let us assume all radio frequencies present in L1, with L2 selecting from the primary the frequency 1,510 kc (198.6 meters). By virtue of the larger number of secondary turns, in respect to primary turns, the voltage in the secondary is increased, in proportion to the number of turns (assuming both windings on the same form or at least on equal diameters). The power is virtually the same in both, for a transformer is one of the most efficient devices, often coming close to 100 per cent. efficiency. Therefore as the voltage goes up in the secondary the current is proportionately less, which follows from the assumption the power is equal. Power equals the voltage times the current.

In the vacuum tube, except in the output tube in some circuits, we are interested in attaining high voltages, and not particularly interested in the amount of current.

The same variations present in the coil-condenser system of course are present in the associated grid-to-filament circuit. Therefore the grid voltage is changing rapidly—at a rapidity determined by the resonant frequency—about the grid bias voltage.

Operation Independent of Signal

Omitting the screen circuit, since its function is an isolating one to render the grid immune from plate voltage fluctuations, we come now to the plate circuit.

A positive plate voltage is applied from the B battery. It may be 135 volts. It is a voltage that is steady in every respect. Not only does it not alternate, that is, fluctuate about a theoretical zero axis line, to positive and negative values, but it does not even assume any unsteadiness on one side of the zero axis line and not on the other. In fact, there is no zero axis line, for the current may be expressed in terms of a straight line, denoting that no change takes place.

That is the situation independent of the signal introduced in the grid circuit.

L3 is the plate load, and it is a radio frequency choke coil of small inductance, and may be only 0.1 millihenry, 100 microhenries. One millihenry equals 1,000 microhenries. The henry is the unit of inductance, but is far too large for radio frequency use.

The direct current resistance of this choke coil is small, perhaps less than 20 ohms, and the plate current will not exceed 5 milliamperes, so the direct current voltage difference between the two terminals of the coil will be small. In such cases no distinction is made between the applied voltage (from negative filament to B battery) and the effective plate voltage (what is left after the drop in the load).

Confusion About Direction

Heating of the filament by the A battery causes electrons to be emitted by the filament. When the A and B batteries are interconnected, which may be done by joining A minus and B minus or A plus and B minus, and the plate voltage is applied, plate current will flow from plate to filament. The path of flow is the

(Continued on next page)

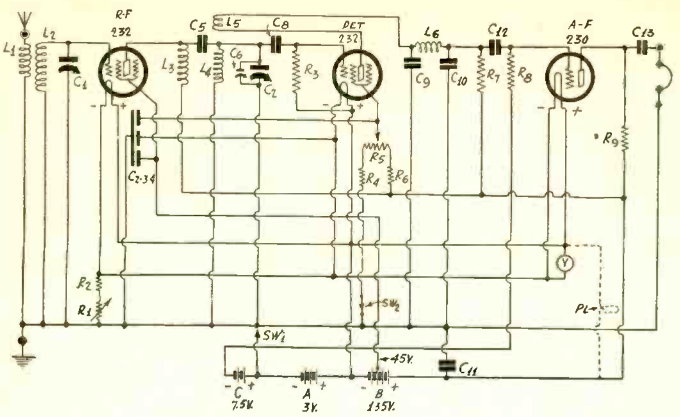

FIG. 12

The diagram is repeated here to spare the reader turning back for reference to the circuit, rendered repeatedly necessary by the text.

(*Continued from preceding page*)

space charge, or conducting stream of electrons bridging the space from filament to plate. The movement of electrons therefore is distinguished from the direction of current flow, as it has been said the electrons are emitted from the filament. They bombard the plate. But the plate current is said to flow from plate to filament.

This confusing situation is the one usually presented, and the confusion arises from the early conception of electricity as a fluid with a certain direction of flow, from positive to negative in external circuits, although the later electron theory is that the electrons move from negative to positive, in a net drift resulting from conflicting movements and rotations. Electrical technique has been built up on the old idea, although probably some day all electricity will be reconciled to the electron theory, and the earlier misconceptions with the anomalies they brought in later years in the application of fiction to fact, will be wholly discarded.

Tube As Variable Resistance

Meanwhile it is advisable to adhere to the theory that the plate current moves against the direction of drift of the electron stream. The fact that the word drift is mentioned is not to say that there is anything sluggish about the action. The electron bombardment of the plate is terrifically rapid.

Now the tube assumes a new aspect, that of a resistance, and we shall see that when used as an amplifier, as here, it has the peculiar property of acting in the manner of a variable resistance.

We are all set now, with all potentials applied, and all save the radio frequency input are steady, unilateral. All movement is in one direction only.

Now we introduce the resonant radio frequency of 1,510 kc, and a great change has taken place. It is one of the most important changes ever recorded in science. The thermionic vacuum tube has received an impulse of radio frequency, and the impulse has changed the voltage about the grid bias voltage, giving an alternating input, whereupon the plate current has changed! The amount of change of plate current proves to be large, compared to the amount of change in grid voltage. Therefore small changes in grid voltage produce a relatively large change in plate current. We have an amplifier! It receives a radio frequency voltage of alternating character, in the grid circuit, and repeats it in the plate circuit, only on a large scale, so if we introduce a suitable coil in the plate circuit, the change in plate current will affect the field of this coil in the same manner as L2 was affected, only on a much larger scale.

Porpoise and Giraffe

This plate coil is L3. Through it is flowing direct current from the B battery. We have found that direct current was steady, unidirectional, non-pulsating. But it need not stay absolutely steady. It is possible to unsteady it about its average value. Indeed, that is exactly what the tube is doing—it is receiving a radio frequency voltage, alternating to be sure, and although passing current in one direction only, is reproducing the frequency in the plate circuit, while the only current that can be passed in one direction only is direct current.

Since the direction of current flow does not change now, and since something does change, it must be that the value of the current changes about the average value. That is exactly what happens. The current is still direct current, but it is called pulsating, because it rises and falls in value. It never goes negative. All change is from zero change to maximum positive change, when there is zero change the steady d-c exists, and when the change is equal to the steady value the plate current stops entirely. This actually happens in overloaded sets.

Imagine a porpoise advancing. The water line is the zero axis. The porpoise advancing in a straight line dives beneath the water line completely, then bobs up and goes through the same geometric action above the water line, and repeats the complete or cyclic operation. There you have alternating current. Now imagine a giraffe. He makes jumps from one point to another along a straight line. He never dives into the earth (to negative values) but is always above the ground. He typifies pulsating direct current.

If you imagine the giraffe standing still, and, suddenly seeing the sportive porpoise, is frightened, and that the giraffe jumps in full unison with the porpoise, only five times as high and five times as far in each leap, even when the mammal is out of sight, then you have a parallel of alternating voltage changes producing magnified direct voltage changes of the same frequency.

So the plate current changes at a rapidity equal to the frequency of the impressed alternating voltage in the grid circuit.

Action of the Grid

Between the plate and the filament the grid is located, and it may be biased positively or at zero or negatively, depending on what the tube is intended to do. For amplification the bias is always negative. The larger the negative bias, the less the plate current, for a given effective plate voltage. Therefore the grid is a control, like a faucet. Its voltage affects the resistance value of the plate-filament circuit. So if a steady negative bias is applied, for instance 1.5 volts on the r-f tube in Fig. 12, the signal voltage will cause the grid voltage to change about this steady value.

It is not hard to realize, therefore, that the signal corresponds to an alternating C bias, hence the resistance of the tube continues to change at the pace of the delivered frequency. That this is true is proven by the fact that, with the same plate voltage applied, the plate current changes. And this change in plate current causes equal change in the magnetic field of the plate coil. Once again alternating current is generated. It must be alternating, for that is the only kind that constantly will pass through a condenser (C5 in Fig. L2) or enable inductive coupling.

L3, the plate coil, and C5, the blocking condenser, constitute a series circuit which is in parallel with L4. Therefore C5 must be of small capacity, otherwise there will be too tight coupling to enable L4 to act independently on a frequency basis.

Standard Plug-in Coils

The reason for including L3 is to accommodate standard plug-in coils. We provide a suitable means of putting the plate voltage on the tube and derive the resonant frequency from the plate circuit with L3 there positioned. To use a transformer here, with primary, secondary and tickler, would require six different connections, and as plug-in coils normally have no more than five terminals, as for insertion in UY sockets, and often only four, as for UX sockets, almost any commercial plug-in coils may be used.

Now, the detector input is tuned in the familiar way, but rectification takes place in the grid circuit, because of the grid leak and condenser, and the return to positive A.

The first tube, the r-f amplifier, was worked in such a manner that the changes in plate current were wholly proportionate to changes in grid voltages.

The detector hookup results in just the opposite. There is a decided inequality. Taking into consideration the two alternations of a radio wave's cycle, positive and negative, if the bias is positive, as here, the negative cycle is rectified. Thus the grid becomes more negative (in respect to the grid return point), for the plate current decreases with signal voltage increase. The positive cycle has some stray effect, compared to the other. Whenever you have much inequality there is a rectification. The recurring one-sidedness gives rise to a pulsating current in the grid circuit that varies as the modulation of the carrier. Thus we eliminate the carrier and have only the audio frequency result.

Detector Filter

How completely we have eliminated the carrier in the grid circuit we do not know, but experience prompts us not to take too much for granted as to this elimination, otherwise radio frequency might get into the audio amplifier, and cause squealing or blurry reception, particularly since the resistive type of audio amplifier is a good radio frequency amplifier. Therefore we insert the customary plate circuit filter, consisting of two small condensers, C9 and C10, and a radio frequency choke coil of relatively low inductance.

The plate output of the detector tube is in part fed back to the grid circuit to reinforce it, and for this to be true surely there must have been some radio frequency that got into the plate circuit. The feedback or regeneration is controlled by a potentiometer that affects the screen grid voltage.

Now we are ready to go forward with the audio amplifier, here consisting of one stage.

The filter is therefore put at the end of the plate winding, that otherwise would go direct to B plus, but here a resistor, R7, is interposed, so that the pulsating direct current again can be capitalized. The direct current voltage drop in this resistor determines to a considerable degree the input to the next tube. Effectively in parallel with R7 is the grid leak, R8, the only objects of the condenser C12 being to keep the high positive plate voltage from the intended negative voltage on the grid of the audio tube, and of passing the signal along.

Where Meter Can't Measure

In R7 we have an example of a high resistance, say, 250,000 ohms, 0.25 megohms. One megohm, usually written meg., is equal to one million ohms.

No matter if the plate current is only 0.1 milliampere, the voltage drop in R7 will be considerable (25 volts). Because the current in such a circuit is so small it is less than the current drawn by even high-resistance meters, so the drop and the effective voltages should be read on a vacuum tube voltmeter.

Here we see that the applied plate voltage and the effective voltage are quite different because the plate load is a high resistance, and particularly because the plate current will be considerably greater than stated. The effective voltage is likely to be considerably less than half of the applied voltage, that is, the voltage drop in the load resistor may be greater than the drop in the tube itself. This is an advantage in a resistance-coupled amplifier, for the reason previously given, that the direct voltage drop in the resistor has such a large effect on the input to the next circuit. We desire as great an input as practical.

The output of the audio tube is filtered, the pulsating direct current flowing through R9 but the alternating current through C13.

There remains only the connection of the phones to the output circuit. The effect of the current variations at audio frequencies in the phone circuit is to set up a changing magnetizing force or field about the small iron-core coils in the phones, and as this field rises and falls at an audio frequency, it pulls on and releases the diaphrams of the phones at the same pace. The vibration produces sound. Thus is electrical current that changes in value at an audio frequency producing finally a mechanical motion that radiates sound. The phones are therefore a reverse microphone, since a microphone changes sound into corresponding electric current variations, while the phones change electric current variations of audio frequency into sound.

Direct Current Circuits

The battery circuits, the voltages they afford, and the adjuncts used in connection with the batteries, now will be discussed.

Fig. 13 shows the essentials of the circuit involving these direct current voltages. The diagram denotes where the returns are made, but omits the plate and grid loads, making these appear short-circuited to make the diagram more readily legible. All condensers and coils are omitted.

We find that the batteries are connected in series. Starting at left we discover C minus. The other side of the C battery, which is positive, is connected to minus of the A battery, while positive A is connected to minus B.

There is no option as to the direction in which any of the batteries are to be connected, although different points might be joined than the ones shown, with different results.

Let us take the example as we find it and trace the results, assuming the use of 232 tubes for r-f and detector, and a 230 for the first audio stage. It is necessary to select particular tubes because the filament voltages and currents differ with different tubes, as do other voltage and current requirements.

The 232 and 230 tubes each draws 0.06 ampere (60 milliamperes) when the voltage across the filament is 2 volts.

Since we desire to include a voltmeter in the circuit to measure the effective voltage on the filament, this meter can give a simultaneous reading for all tubes in the circuit only if it can be connected across all the filaments. This is possible by using a common resistance circuit between negative A and negative filament.

Omitting this resistance circuit from consideration for the moment, let us assume that the A battery consists of two No. 6 dry cells connected in series, that is, with central positive post of one cell connected to outside negative post of the other cell. Then the two remaining posts, negative and positive, have a potential difference of 3 volts, because series connection adds the voltages of the respective units of the series.

Theoretical Value for R2

Neglecting R1, which is a rheostat, we desire to ascertain what should be the theoretical value of R2. The applied voltage is 3 volts, the desired voltage is 2 volts, therefore the voltage drop is 1 volt. We know that the current in the filament of one tube is .06 ampere at the rated 2 volts, and since parallel connection of equal resistors reduces the resistance to the reciprocal of the number of units, then the resistance of the three filaments will be one-third the resistance of the one filament, and since current is inversely proportional to the resistance, the total current through three filaments in parallel will be three times as great as that through one filament alone.

Current, resistance and voltage are united in Ohm's law for direct currents, whereby if two of the quantities are known the third can be computed. The voltage in volts is equal to the resistance in ohms divided by the current in amperes; the current in amperes is equal to the voltage in volts divided by the resistance in ohms; and the voltage in volts is equal to the product of the current in amperes and the resistance in ohms.

The resistance value of R2 is desired. It is equal to the voltage, 1 volt, divided by the current, 0.18 ampere, or 100/18, or 5.55 ohms.

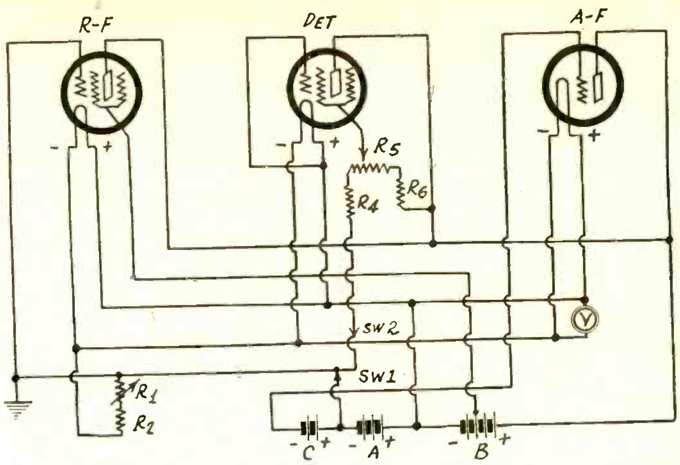

FIG. 13
A skeletonized diagram, showing the battery connections and effective grid and plate returns, with voltage-dividing adjuncts.

Compensation for Battery Change

But this assumes that the A battery voltage will remain at 3 volts effective, whereas due to use or ageing, the battery resistance increases, and this increased resistance reduces the effective voltage whenever current is drawn, for the current flows through the battery resistance. Therefore we desire to compensate for this change, and besides we must maintain the filament voltage at strictly 2 volts because the 232, 230 and 231 tubes, the so-called 2-volt series, are critical as to filament voltage.

We can achieve our goal by making the resistance value of R2, the fixed element, less than what the computation calls for, and provide an auxiliary resistor, this one a rheostat. for bringing the total resistance up to the required amount, or, in to state the true desire, to keep the filament voltage at 2 volts despite change in the battery condition.

Suppose we select 4 ohms for R2. We then have a circuit consisting of two resistance values in series. One of these is 4 ohms and the other is the resistance of the three parallel filaments. We can compute the filament resistance. It is equal, for one tube, to the voltage, 2 volts, divided by the current. 0.06 ampere, or 33.33 ohms. For three parallel filaments the resistance is one-third of that amount, or 11.11 ohms. Or, taking the three tubes in a group, the resistance equals the voltage, 2 volts, divided by the current, 0.18 ampere, equals 11.11 ohms.

Effect of R4 Equals 4 Ohms

The reason for investigating the value of the filament resistance is that there is a slight error in the above calculation, due to the assumption that the current is 0.06 ampere for each tube. That is true only if the voltage applied is 2 volts across the filaments. We found that 5.55 ohms would be required to achieve that, so with only 4 ohms, the voltage will be more than 2 volts, and the current therefore will be greater than 0.06 ampere. We can determine by calculation how much the error is, and but to do so we need to know the resistance of the filament circuit.

In the first instance the total resistance was 11.11 ohms plus 5.55 ohms, or 16.66 ohms. In the estimated condition the resistance was 11.11 ohms plus 4 ohms, or 15.11 ohms. Therefore the current 0.18 ampere is 1511/1666 of the true current when only the 4 ohms are in series with the filament. This difference may be ignored, since the rheostat R1 will be included to take up any difference. It will be necessary to watch the voltmeter, to determine whether the rheostat is at zero resistance value, in which case the voltage will read a trifle high. By adjusting the rheostat the correction is introduced.

We can now select a suitable value of rheostat. The proportion 1511/1666 shows 4 ohms is too small, so we select 3 ohms. The difference between 3 ohms and 5.55 ohms is 2.55 ohms, and the rheostat could have that value theoretically, yet any higher value, within reason, would do no harm, and would enable choice of a commercial value. A 6 ohm rheostat would be suitable.

The Detector Screen Network

The other resistance network concerns the screen voltage on the detector. As the screen voltage is varied, the amplification of the tube—though it is a detector—is altered, and since regeneration depends on the capability of the tube as an amplifier, we can control regeneration by adjustment of the amplification.

We never desire to operate the tube at or near zero voltage on the screen, therefore a limiting resistor R2 is used, which raises the minimum voltage obtainable from the potentiometer R5. Moreover, we never desire the screen voltage to attain the value of the applied plate voltage in this circuit, for only in the special case of the dynatron oscillator does the reversed condition of higher screen than plate voltage obtain.

A Portable Short-

Used for Remote Pick-up by

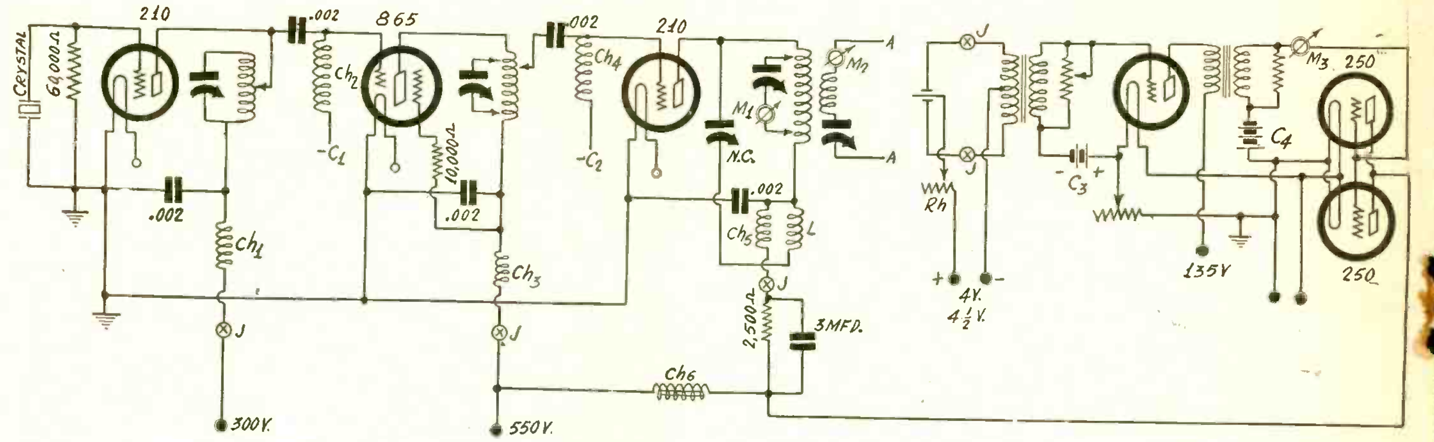

FIG. I
This is the circuit diagram of the 7.5 watt portable transmitter used by W9XAB in reporting the Army Air Show at Chicago over WCFL, the broadcasting station of the Chicago Federation of Labor.

ALL the broadcast stations which endeavor to supply their listeners with up-to-the-second news employ portable radio transmitters that can be taken to the scene of important events so that the reports may be transmitted to the main transmitter of the station while the events are taking place. Some of these transmitters are tiny affairs that can be carried on the back of a roaming announcer while others are larger and require an automobile or a motorboat for their transportation.

During the recent country-wide tour and demonstration of the United States Army Air Forces many of these portable transmitters were brought into play for reporting the action. This enabled many who could not view the "aerial attacks" to follow them through the announcer's description of them.

One of the stations reporting the news in this manner was WCFL, Chicago, the station conducted by the Chicago Federation of Labor. The portable transmitter was W9XAB, which is licensed to transmit on 1,564 and 2,368 kilocycles with a power of 7½ watts. This transmitter was taken in a motorboat off the Chicago lake front where it was directly under the air squadrons during the "attack" and demonstration.

Crystal Controlled Transmitter

The circuit diagram of the transmitter used is given in Fig. 1. It is piezo-crystal controlled and the crystal is maintained at a constant temperature of 50 degrees centigrade to hold the frequency constant. Tests have shown that the maximum deviation from the assigned frequency is only 20 cycles per second, which is a very satisfactory showing in view of the fact that the frequency used was 2,368 kilocycles. This frequency was used rather than the alternative frequency because there was much less interference on the higher frequency.

The oscillator tube, which is a 210, feeds into a screen grid type radio frequency amplifier, an 865 tube. This tube not only serves as an amplifier, but also as a buffer to prevent the reflection of modulated voltages back to the oscillator and frequency variation.

The output and modulated tube is also a 210, which is rated at 7½ watts. This tube feeds into a Hertz antenna of suitable dimensions. The modulation is accomplished by the Heising scheme of varying the plate voltage on the output tube by means of the audio frequency output of an amplifier.

Audio Amplifier

The microphone, which is carried on a regular stand, is of the double button, carbon granule type. It is actuated by a 4½ volt dry cell battery and the current is adjusted by means of a rheostat. The output of microphone is impressed on a receiver type three element tube by means of a microphone transformer. This preliminary audio amplifier is coupled by means of another audio transformer to two 250 tubes in parallel. These two 250 tubes in parallel constitute the modulator and they control the plate voltage on the 210 output tube as previously mentioned.

Bias for all the tubes requiring bias is provided for by suitable batteries. Bias is used on all the tubes except the oscillator. In this tube the piezo crystal acts as a stopping condenser and across it is a 60,000 ohm grid leak. This combination maintains the grid at the proper operating potential.

Direct Coupling Used

In the plate circuit of the oscillator is a tuned circuit which is adjusted to the frequency of the crystal, that is, to 2,368 kilocycles. Only a part of the tuned circuit is connected in the plate of the tube, as well as in the grid circuit of the buffer tube, but a tap on the coil permits the inclusion of different amounts of the tuned circuit. This tap is provided for finding the optimum conditions for oscillation in the crystal circuit.

A stopping condenser of 0.002 mfd. is used between the plate of the oscillator and the grid of the buffer and a choke Ch2 for grid leak of the buffer. Another condenser of 0.002 mfd. is connected from the low side of the tuned circuit to ground and a choke Ch1 in series with the plate return of the oscillator. These are used for the purpose of confining the oscillation to the proper circuit.

The treatment between the buffer and the output tube is similar. However, there is an additional means for adjusting the frequency of the second tuned circuit. Taps are connected on the coil so that both sides of the tuning condenser may be

Banquet Talks

Albert Stevens Crockett, for many years publicity director of the old Waldorf-Astoria Hotel in New York City, and now an executive of the Hotel St. Regis, in "Peacocks On Parade," to be published this Summer by the Sears Publishing Company, says:

"Broadcasting has done much to improve the quality, and at the same time reduce the length, of after-dinner speeches. The realization by speakers that they are facing a huge invisible audience, as well as the dinner guests before them, leads them to prepare carefully in advance what they have to say. I do not believe it is too much to say that more than once that same knowledge has kept a speaker sober. He might make an ass of himself before a comparatively small audience by getting tangled up in his remarks, but to do the same thing with a huge public listening in might ruin his reputation.

"Almost every really important dinner in any first-class ho[tel] ... put on the air. At le[ast] ... This introduces the ... of time, because th[e] ... ually available only ... This has served to ... at public dinners. T[he] ... fitted into the broad[cast] ... main within their ti[me] ... speakers must know ...

Literatur[e]

Carl K. Vincent, James...
T. Adamcyyk, 2318 Ric...
Paul A. McConaughty, ... enne, Wyo.
Harry Kerlin, (esp. elec... Ave., North Birmingh...
James L. Estell, 211 N... bus, Ohio.
Gordon A. Ball, 234 ... Winnipeg, Man., Cana...
H. J. Humphrey, 4239 L...
Daniel Dunne, 3358 N. A...
Edwin A. Gammon, R. F...

-Wave Transmitter

W9XAB in Relaying to WCFL

moved, thus including more or less inductance in the circuit. The input voltage to the output tube is also variable by means of a tap. Since the buffer is a screen grid type tube provision must be made for the screen voltage. In series with the screen lead is a 10,000 ohm resistance and the screen return is made to the same voltage as the plate return. The choke Ch3 serves both the plate and the screen, as does the 0.002 mfd. by-pass condenser. The screen and plate voltages are different because there is a much larger drop in the 10,000 ohm resistance than in the plate coupling coil.

Tuning Antenna

The impedance in the plate circuit of the output tube is similar to that in the plate circuit of the buffer. That is, it has tuned coil with taps for including more or less turns in the circuit. A meter M1 is connected in series with the condenser as an aid in the adjustment for resonance and greatest output.

The antenna is coupled to the plate coil magnetically, that is, by mutual inductance. The Hertz antenna AA is also tuned with a variable condenser and it contains a meter M2 as an aid in adjusting the circuit for greatest output.

There is a so-called neutralizing circuit associated with the output tube, namely, N. C. and L. No information is available as to the values of either the condenser or the coil. However, it is not clear why these two parts should be used at all, or what they neutralize. It is possible that the intention of the designer of the circuit was that the condenser should be connected to the grid rather than to the plate of the tube. If this is the case N. C. should be a very small variable condenser of the neutralizing type, and L should be a few turns of wire coupled inductively to the tuned plate coil. The arrangement will then be the same as that in the ordinary Neutrodyne and the neutralization will be of the plate to grid capacity of the output tube and it will prevent oscillation in this tube. It will make the circuit amplify the radio frequency signals without any regeneration in that tube.

Values of Choke Coils

The designer of the transmitter supplied no information on the choke coils Ch1, Ch2, Ch3, Ch4 and Ch5. However, all must work at a frequency of 2,368 kilocycles. None is required to carry a heavy current so that the coils may be wound with moderately fine wire. They should be wound on long forms of small diameter so as to keep the capacity low. The higher the frequency involved the smaller may the coils be. For a frequency of 2,368 kc each of these coils may have an inductance of about one millihenry.

Ch6 is a filter choke rated at 20 henries and 250 milliamperes. The degree of modulation may be adjusted by means of the variable resistance in the grid circuit of the first audio tube after the microphone transformer. This resistance controls the output of the two 250 modulator tubes and hence the audio frequency variation in the plate voltage applied to the output tube.

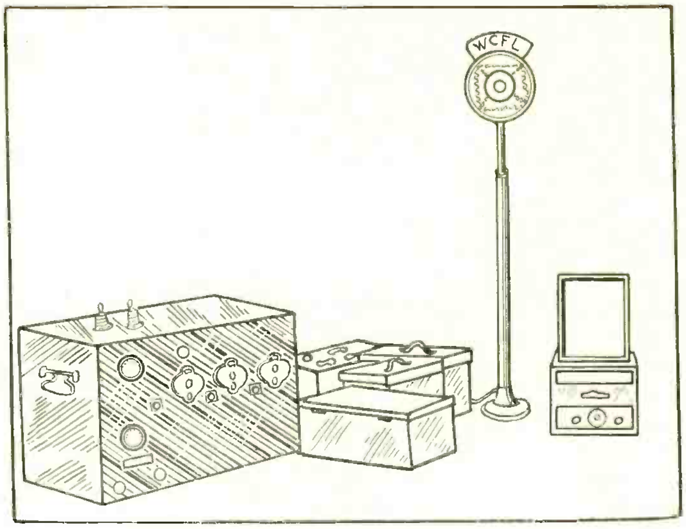

FIG. 2
A sketch of the W9XAB portable transmitting equipment used for reporting the Army Air Show over WCFL.

Jacks J are provided in all the plate ruturn leads of the radio frequency tubes. There is also a jack in each of the leads to the double button microphone which may be used for measuring the current in the two sides for the purpose of equalization. A sensitive d-c meter is connected in the grid leads of the two modulator tubes for the purpose of indicating the grid current. This is really a guard against overloading of these tubes for appreciable current will only flow when the grids are positive during a part of the cycle.

Keeping Frequency Constant

The entire oscillator, including the crystal, of course, was inclosed in a constant temperature cabinet. The temperature in this cabinet was maintained constant by a specially constructed bi-metallic thermo-regulator and a 6-volt automobile headlight was used as the source of heat. The heat from the 210 filament was also utilized and the temperature was maintained at 50 degrees centigrade, or 122 Fahrenheit, within the cabinet.

The steadiness of the frequency was evidenced at the receiver. This was a National Short Wave 5 Thrill Box, which had been pre-calibrated to 2,368 kilocycles by means of a radio frequency oscillator. When the signals from the portable transmitter came in it was not necessary to tune the receiver, the calibration having been done exactly. Moreover, it was not necessary for anyone to stand by during the reception, for so stable was the frequency of the transmitter and the adjustment of the receiver that the signals continued to come in clearly without variation in strength.

Setting Up Transmitter

On the morning of the Air Show the entire transmitting equipment was placed in a boat, transported out to one of the breakwaters protecting the Chicago water front, and there set up for action. Only 20 minutes were required to set it up and place it in operation after the location had been selected.

The transmitting antenna consisted of two half-wave hozizontal wires, each about 198 feet long. These wires were supported on four 15-foot poles and they ran directly away from each other. An antenna current of 0.06 ampere was obtained as indicated by meter M2.

The plate voltages used on the tubes are indicated on the circuit diagram. Thus the voltage on the 210 oscillator is 300 volts, while that on the buffer, the output tube, and the two modulator tubes is 550 volts. Only 135 volts are applied to the first audio frequency tube following the microphone. Batteries were used to supply these voltages as well as the bias and filament voltages on the various tubes.

Not So Awful

Wanted

wn, No. Dak.
Str., Chicago, Ill.
315 McComb Ave., Chey-

tric appliances), 3525 17th
m, Ala.
rth Eureka Ave., Colum-

Hampton St., St. James,
la.
clede Ave., St. Louis, Mo.
shland Ave., Chicago, Ill.
. D No 5, Auburn, Maine.

tel banquet room is
east, a portion of it is.
all-important element
e microphone is us-
for a limited period.
speed up proceedings
The speeches must be
cast time. So, to re-
me allowance, dinner
in advance just about what they are going to say. They must boil their remarks down to the shortest possible and most pungent statements.

"As a veteran listener—and long an impatient sufferer—I believe radio is about the best thing that has ever happened to public speech-making. And certainly, through making it possible to give more interesting dinners than formerly, it has greatly helped increase the dinner business of hotels."

The veteran hotel man, commenting on the influence upon hotel business of commercial radio communications, said:

"As ship-to-shore radio communication was perfected, its effect upon the patronage of certain hotels became manifest. Passengers from Europe who took the precaution to send a wireless message ahead of their arrival found the desired accommodations awaiting them, while less practical travellers often found the hotels of their choice unable to take care of them when they came ashore.

A Television Amplifier

Also Suitable for Phonograph and Broadcast Set

By Brunsten Brunn

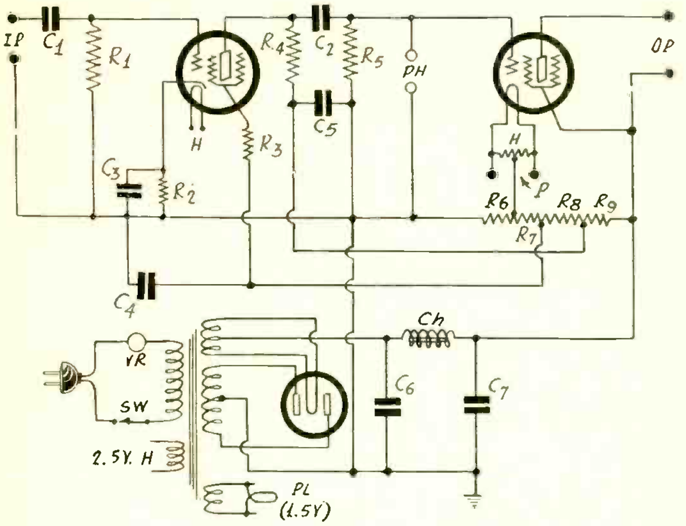

FIG. 1

The circuit diagram of a phonograph and television amplifier and power supply utilizing screen grid, pentode, and full wave rectifier tubes with resistance coupling.

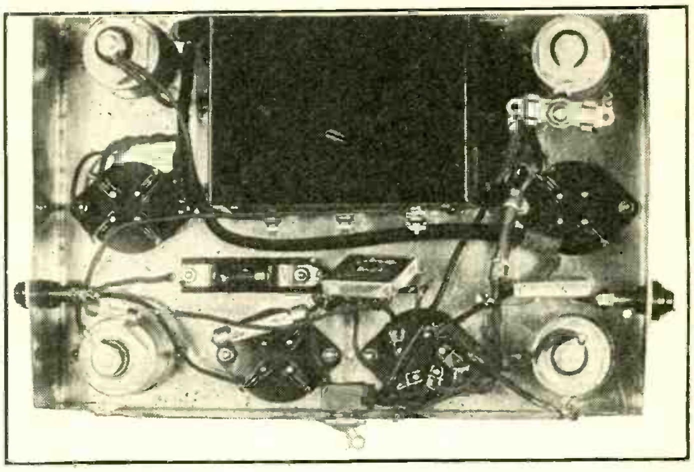

FIG. 2

Inside view of the phonograph and television amplifier.

HERE is a two stage, resistance coupled amplifier that was especially designed and built for electrically playing of phonograph records but which is equally useful for the amplification of television and broadcast signals. It utilizes a 224 screen grid tube in the first stage and a 247 pentode in the power stage. It also contains a power supply with a 280 type rectifier giving in excess of 300 volts. The quality of the output is excellent, since the circuit is resistance coupled throughout, and the maximum undistorted output power is 2.5 watts, the output of the 247 pentode when it is supplied with the maximum recommended voltages.

The filtering in the circuit is especially thorough, which is due largely to the use of four 8 mfd. electrolytic condensers together with full wave rectification. The amplifier was tested on a broadcast receiver, and although a dynamic speaker of good sensitivity on the low notes was used, there was no appreciable hum.

Constants Used

The two stopping condensers C and C_2, had a capacity of 0.01 mfd. each and they were of the mica dielectric type. These condensers are large enough to insure high amplification on notes as low as 25 cycles per second provided that the grid leaks used are not less than one megohm. For this reason the value of R1 in the first stage was 2 megohms and the value of R5 in the second stage was one megohm. Higher values may be used for either or both, but if they are much higher there is danger that the leakage from the positively charged electrodes to the grids becomes greater than the leakage through the leaks and then the grids become positive and the circuit ceases to function properly. With mica dielectric stopping condensers and the leak values cited there is no danger of the grid's going positive if the insulation is at all reasonable.

R2 is used to provide grid bias on the screen grid tube and should have a resistance value of about 2,000 ohms. However, this is not at all critical for values from 300 to 5,000 ohms work well. In order to avoid wave form distortion, however, it is best to use around 2,000 ohms, or somewhat more. A higher resistance is especially desirable when the applied plate voltage is higher than 180 volts, which it may well be.

The condenser C3 across this resistance should have a value of at least 8 microfarads. This capacity is needed in order to prevent degenerative feed back at the very low audio frequencies.

The Coupling Resistance

The coupling resistance R4 should have a value of 0.25 megohm, which gives good amplification. In order to prevent the screen voltage from assuming a higher value than the effective plate voltage on the positive peaks of the signal, a 100,000 ohm resistance R3 is put in series with the screen lead. In order to make this resistance effective there should be no condenser from the screen to ground, but a condenser of 2 mfd. C4 can be used effectively between the positive end of this resistance to ground. The applied voltage on the screen should be 75 volts. This is not the voltage on the screen. To obtain an applied voltage it is necessary to select the proper values of resistance in the voltage divider, which we shall do later.

A condenser C5 is connected between the positive end of R4 and ground for the purpose of stabilizing the applied plate voltage. The value of this condenser is 8 mfd.

The Plate Voltage Supply

The plate voltage is supplied by a full-wave rectifier with a filter containing two electrolytic condensers C6 and C7, each of 8 mfd. capacity, and a choke coil Ch of 30 henries and a current capacity of 85 millihenries.

The voltage maintained by the B supply is about 300 volts. This is a little higher than the voltage actually needed for the pentode, but it is perfectly safe to apply it provided we increase the grid bias proportionately. That is, we divide the 300 volts so that the plate voltage is 281.4 and the grid bias is 18.6 volts.

The plate and the screen currents combined will be about 40 milliamperes. Thus current will flow through R6, the bias resistor for the pentode. The bleeder current will also flow through this resistance, and we are at liberty to choose almost any value for the bleeder, provided the total current does not exceed about 85 milliamperes. Let us add 22 milliamperes so that the total current in R6 is 62 milliamperes. Since we want a voltage drop in R6 of 18.6 volts we need a value of 300 ohms for R6.

The current diverted by the screen is so small in comparison with the 22 milliampere bleeder current we may neglect it. Hence the current in R7 is also 22 milliamperes. In order to get

(*Continued on next page*)

LIST OF PARTS

Coils

T—One Kelford power transformer.
Ch—One 30-henry filter choke.

Condensers

C1, C2—Two 0.01 mfd. mica dielectric condensers.
C3, C5, C6, C7—Four 8 mfd. electrolytic condensers.
C4—One 2 mfd. by-pass condenser.

Resistors

R1—One 2 megohm grid leak.
R2—One 2,000 ohm resistor.
R3—One 100,000 ohm resistor.
R4—One 250,000 ohm resistor.
R5—One 1 megohm grid leak.
R6—One 300 ohm resistor, 3 watt capacity.
R7—One 2,500 ohm resistor, 6 watt capacity.
R8—One 6,000 ohm resistor, 15 watt capacity.
R9—One 4,000 ohm resistor, 10 watt capacity.
P—One 30 ohm center-tapped resistance with adjustable tap.

Other Parts

Three twin jack assemblies.
One 110 volt line toggle switch.
One 1.5 volt pilot light (optional).
Two UY sockets.
Two UX sockets.
One subpanel.

Drum to Avoid Large Discs

Camera Pick-up for Television Being Developed

CAMERAS for television are now making their debut. The direct pick-up takes the place of the so-called flying spot type of pick-up.

In the flying spot type the scanning disc throws a spot of light across the subject in a series of rapidly-drawn lines, and the photo-cells pick up the reflected light from different points of the subject as the spot passes. This method is limited, since it permits the lighting to be only from one direction, making for flatness.

The direct pick-up, primarily developed for outdoor work, where there is much light available, now becomes a possibility for indoor work due to much more sensitive photo-electric cells. This means that the lighting effects which can be achieved in motion pictures can be effected in television pick-up and can be reproduced to a degree, giving results far in advance of the flying spot type.

Direct Pick-up Operation

The direct pick-up or television "camera", consists of a pin-hole type of scanning disc in front of which is a very fast, high-class camera lens and behind which is located a very sensitive photo-electric cell.

As the disc scans the image focused upon it by the lens, the disc passes, in proper sequence, the impulses to the cell behind it. These impulses, in turn are amplified and sent on into the transmitter.

Work with this type of scanning depends tremendously upon the size of the pin-hole to be used. Since in present standard practice 60 holes must be used, even when these are of a small size the disc becomes at least two feet in diameter. But there is not much use in having a fast lens if the light is to be lost trying to get it through two small holes. This then, means larger scanning holes. These, in turn make the disc of huge proportions, a three foot disc being required to get really good light through. This disc, with its high periphery speed and great bulk, is undesirable and limits the flexibility of the camera, which should be capable of quick and easy movement to be most effective.

Will Try a New Stunt

Faced with this problem the engineers of the Shortwave and Television Corporation, Boston, have decided to try a system which permits the use of scanning holes which would ordinarily require a disc 42 inches in diameter. Yet the diameter of the largest moving part is only 14 inches. This is achieved by a shutter and drum arrangement, the drum operating at 3,600 revolutions per minute, not a difficult thing for studio work.

The first camera of this type is nearing completion and when fully tested will be the first of many to be built for use in the studios of W1XAV the corporation's station, as well as for outdoor pick-ups.

List of 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:

Call Letters	Company	Location	Power (watts)	Lines per Frame
2,000-2,100 k.c. (149.9 to 142.8 m.)				
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.)				
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.)				
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.)				
W1XAV	Shortwave & Television Lab., Inc.	Boston, Mass.	500	60
W9XR	Great Lakes Broadcasting Co.	Downer's Grove, Ill.	5,000	24
W2XR	Radio Pictures, Inc.	L. I. City, N. Y.	500	60

An Audio Amplifier for Television, Phonograph or Broadcasts

(*Continued from preceding page*)

75 volts in the screen circuit we must make the drop in R7 equal to 75 less 18.6 volts, 56.4 volts. Therefore R7 should have a value of 2,560 ohms. The nearest commercial value easily obtainable is 2,500 ohms, which is all right.

Voltage on Plate

Ordinarily the voltage in the plate circuit of a 224 should be 180 volts, but better amplification will be obtained if it is higher. It would be perfectly safe to use the full voltage available on the plate, but it is not necessary. Let us determine R8 on the basis of 200 volts on the plate of the 224. Then the drop in R8 should be 200 less 75 volts, or 125 volts. The same current flows through R8 as through R7, according to our previous assumption. Hence R8 should be 125/.022, or 5,700 ohms. Since we may safely use a higher voltage on the 224 than we assumed it is all right to use 6,000 ohms for R8, giving 207 volts. Now we have a drop of 93 volts to account for in R9, and the current may still be assumed to be 22 milliamperes without committing an appreciable error. Hence R9 should be a resistance of 4,200 ohms. If this is not available a 4,000 ohm resistance may be used.

IP are the input terminals, which may be connected to a microphone, a phonograph pick-up unit, or the output of a radio receiver or a detector. If a tube precedes the amplifier there must be provision for plate voltage on that tube. If the output of the receiver is taken directly from the plate circuit without transformer or choke, it is necessary to connect an audio frequency choke across the IP terminals.

PH are two terminals for use when only the power tube is desired. In many cases it is sufficient to use only this tube in order to get the desired volume. It is not practical, however, to use these terminals unless there is amplification ahead. For example, if the output of a radio receiver is not quite sufficient the loudspeaker may be transferred to OP and the output of the receiver connected to PH. OP are the output terminals of this resistance coupled amplifier. A dynamic speaker should be used here and in all cases there should be a transformer between the two and the voice coil.

The Filament Supply

On the power transformer used there is a 2.5 volt winding that supplies sufficient current for the two tubes. It is not center-tapped, however, and therefore a 30-ohm center-tapped resistance P is used across the winding. The center of this resistance is connected to the high end of R7 so as to give the proper bias to the power tube. There is also a 5 volt center-tapped winding, which is used for the filament of the 280 rectifier. A 1.5 volt winding is used for a pilot light, if this is desired.

In the primary of the power transformer is connected a voltage regulator VR. This occupies a socket on the subpanel and is of the automatic variable resistance type. The switch Sw in the primary is mounted on the front side of the subpanel in a convenient position.

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

Radio University

To obtain a membership in Radio World's University Club, for one year, send $6 for one year's subscription (52 issues of Radio World) and you will get a University number. Put this number at top of letter (not envelope) containing questions. Address, Radio World, 145 West 45th Street, New York, N. Y.

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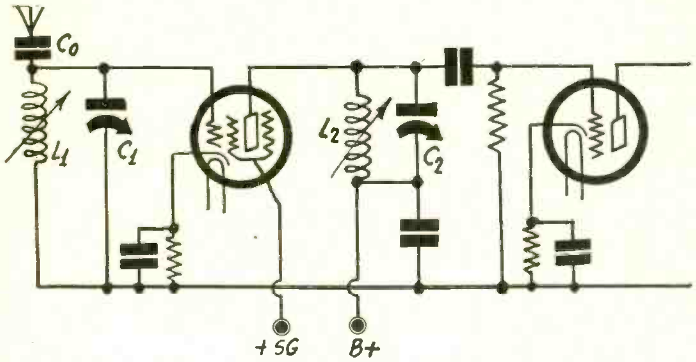


FIG. 938

A circuit illustrating tuned impedance coupling between two radio frequency amplifier tubes. L2 and C2 form the tuned circuit.

Use of Decibels

THE transmission unit decibel is ordinarily used to represent loss. Could it not also be used to represent gain, such as the gain in a stage of amplification or the gain in an entire receiver?—B. D. F.

The transmission unit is used just as often to represent a gain as a loss. The unit is an expression of the ratio between two similar quantities. If the ratio is greater than unity there is a gain and if the ratio is less than unity there is a loss. For example, if the voltage in the grid circuit of one tube is 0.5 volt and the voltage in the grid circuit in the following tube is 5 volts, the ratio of the second voltage to the first is 10. There is a gain of 10 in the amplification. Expressed in decibels we get 20 db. Suppose that the voltage across the grid circuit of the output tube is 50 volts at 400 cycles per second and 25 volts at 5,000 cycles per second. In this case there is a loss of amplification at the 5,000 cycle frequency as compared with the amplification at the 400 cycle frequency. That ratio of the voltage at 400 to that at 5,000 is 2. Hence the amplification at 5,000 is down 3.01 db, or there is a loss of this amount. At some other frequency, say 1,000 cycles per second, the amplification may be such that the voltage is 100 volts. In that case the amplification at 1,000 cycles is up 3.01 db as compared with the amplification at 400 cycles per second.

* * *

Meaning of 10 kc Selectivity

WHAT is really meant by 10 kilocycle selectivity? There are many references to it in radio literature and advertisements, but I have never seen any definition of selectivity that could make the expression mean anything.—W. L. B.

The expression does not mean anything.

* * *

Peculiar Behavior of Receiver

I HAVE a good radio receiver that is both selective and sensitive. It has one peculiarity, however. When WJZ is accurately tuned in it is impossible to understand what speakers are saying. It is not due to overloading because the volume can be turned down to the limit of audibility and the poor quality remains. This does not occur on any other stations. Neither does it happen when the set is detuned a little on WJZ. Will you kindly explain?—S. W. L.

Undoubtedly the trouble is due to excessive selectivity. It may be that the trimmer condensers have been lined up exactly on WJZ, and it may also be that there is considerable regeneration when the set is tuned exactly to WJZ. The fact that the distortion clears up on detuning points to this explanation. You might reset the trimmer condensers, if any, as a permanent remedy. The reason the signals are not understandable is that only the low notes come through.

* * *

Loss of High Frequencies by Shunt Condenser

ABOUT how much attenuation will a condenser of 0.0005 mfd. across a 250,000 ohm plate coupling resistor cause to a side frequency of 10,000 cycles per second? Is the loss enough to justify the use of a smaller condenser?—P. C.

It causes a loss of about 18 db, or it reduces the amplification at 10,000 kc to about 1/8 of the value at very low audio frequencies. It is entirely too much, not only at 10,000 cycles but also at 5,000 cycles.

Measuring Loss in Tuner

I HAVE measured the Q of a certain circuit by the frequency variation method. That is, I obtained the deflection on a current squared meter at the resonant frequency and at the two frequencies off resonance where the deflection is one-half as great as at resonance. The value I found was 91.7 for Q. If this value is correct, what will the loss in decibels be at 5,000 cycles off resonance?—R. W. C.

You did not give sufficient data to solve the problem. To calculate the loss at any frequency off resonance it is necessary to have the frequency ratio, or the carrier frequency so that the frequency ratio can be computed. Assuming that the carrier is 1,000 kc, the frequency ratio is 1.005 and then the loss at 5,000 cycles off resonance is 2.69 db.

* * *

Power Detector Filtering

I HAVE a very sensitive radio receiver with a real power detector. I can connect the loudspeaker directly to it and get all the volume I want. I have been wondering what kind of radio frequency filter to put between the detector tube and the loudspeaker to eliminate the carrier frequency. What do you suggest?—W. J. K.

There is no reason at all why you should have a filter for the carrier. You cannot hear it and there is no tube in which it can be amplified. Even when there is one audio amplifier after the detector there is little reason for putting in a filter. A little by-pass condenser from the plate to the cathode is all that is necessary in this case. The only time a filter is essential is when there is very much audio frequency amplification after the detector and when the amplifier is such that the radio frequency could be amplified.

* * *

Stopping Oscillation

IF in a regenerative circuit a condenser is connected from the plate to the filament or the cathode, will the circuit oscillate or regenerate just as well?—F. W. R.

The condenser so connected usually stops all regeneration because it short-circuits the tickler. Sometimes it is necessary to connect a condenser across the load impedance in the detector circuit in order to induce oscillation, but this condenser must not also go across the tickler. If one side of the condenser is connected to the plate, it is sure to stop oscillation. A condenser so connected makes the load on the tube such as to have a negative reactance, and when it has that, no oscillation can occur.

* * *

Short-circuiting Turns

I AM building a short-wave receiver in which I want to use a tapped coil for changing the wavelength range covered by the tuning condenser. There will be only one tap. When the longer waves are being received the entire coil will be in use but when the shorter waves are being received only a few number of turns will be in use. Which is better, to short-circuit the unused turns or to leave them open?—W. G.

It is better to short-circuit the unused turns. It has been found that the losses in the coil are larger when the unused portion of the coil is left open than when it is short-circuited.

* * *

Cause of Excessive Plate Current

IN my superheterodyne the plate current in the oscillator is much higher than it should be. In fact, it is twice as high as I thought it should be for the plate voltage I use. What is the cause and how can I remedy it?—R. E. L.

It indicates that the grid bias on the tube is not high enough. Possibly you do not have any grid bias at all. Provide a bias either with a battery or a resistor voltage drop.

* * *

Tuned Impedance Coupling

PLEASE explain what is meant by tuned impedance coupling and give a circuit illustrating it. Why is tuned impedance coupling effective?—W. H. J.

Tuned impedance coupling is a form of direct coupling. The plate load consists of a condenser and an inductance in parallel, the two being tuned to the frequency that is to be amplified. Fig. 938 illustrates this form of coupling. L2 is the inductance and C2 the condenser. In the figure both the condenser and the coil are shown to be variable but it is only necessary that one be variable. This form of coupling is effective because when the circuit is in tune its impedance is very high and hence most of the voltage in the plate circuit is transferred to the grid circuit of the following tube. The impedance of the tuned circuit at the resonant frequency is L/RC, in which L is the inductance in henries, C the capacity in farads, and R is the resistance in the circuit in ohms. The impedance is given in ohms and it is a pure resistance. As an example, let L be 200 microhenries, let C be 0.00035 mfd. and R 10 ohms. Then the impedance of the parallel tuned circuit is 57,000 ohms. It will be noticed that the larger the inductance, the smaller the capacity, and the smaller the resistance, the higher is the impedance.

* * *

Small Portable Set

WILL you kindly publish a diagram of a four tube receiver that is suitable for a portable set. I should like to use it with the 2 volt tubes, one 232, two 230s and one 231. Kindly show the proper voltages to use.—B. W. A.

Fig. 939 is such a circuit. The necessary voltages are given on the diagram, as are the other values. The A battery voltage should be 3 volts and the 6 ohm rheostat should be adjusted until the voltmeter reads two volts. About one-half of the resistance will be needed to reduce the excess voltage.

* * *

A Small Converter

I HAVE in mind to build a very small short-wave converter utilizing the two-volt tubes. For tuning condenser I wish to use a 60 mmfd. midget. The intermediate frequency will be 1600 kc because at this frequency my radio receiver is very sensitive. What frequency range can I expect to cover with the midget condenser? Could I go from 100 to 10 meters without using plug-in coils or taps on the oscillator coil?—F. W. A.

In order to cover the 100-10 meter band, using 1,600 kc for intermediate frequency, the oscillator would have to cover a frequency range of 4,600-31,600 kc. The ratio of these frequencies is 6.87. Therefore the ratio of the maximum to the minimum tuning capacity would have to be 47.2. About the best you can do with the 60 mmfd. condenser is 13, and this you cannot attain without taking every possible precaution to get a low minimum capacity in the circuit. Hence you need at least two coils if you use plug-ins, or one tap on the single coil if you use that system. If you can make the zero setting capacity so low that you get a capacity ratio of 13, you will be able to tune from 100 meters to 20 meters, provided the intermediate frequency is 1,600 kc. It is quite possible to arrange the circuit so that you can cover the three amateur bands, 80, 40 and 20 meters.

* * *

Distortionless Screen Grid Amplification

IT is now well known that when a screen grid tube is used in a resistance coupled circuit for amplification of audio frequency signals there is much distortion when the plate current is large, that is, when the signal voltage is low. What are the best means of preventing this distortion? I presume there are methods whereby it may be prevented—R. E. H.

The only way to prevent the distortion is to make sure that the screen voltage is always considerably less than the effective plate voltage. There are two alternatives. One is to put a high resistance in the screen circuit and return the screen to a voltage about one-third as great as the applied voltage in the plate circuit. The other is to use no resistance in the screen circuit and return the screen to a voltage about 1/12 or 1/10 of the applied plate voltage. In case the first method is used the applied plate voltage might be 180 volts and the applied screen voltage from 60 to 75 volts. The plate load resistance might be 250,000 ohms and the resistance in series with the screen 100,000 volts. If the other method is used the plate load resistance and the applied plate voltage might be the same as in the other case but the screen voltage should not be more than about 15 volts. Either method reduces the possible amplification but this sacrifice is necessary in the interest of quality. Even so, there will be a very high amplification as compared with that obtainable with a three element tube, even if that tube is of the high mu type.

* * *

Excessive Selectivity

IF it were possible to make a tuned circuit without any resistance whatever, could broadcast signals be received with such a circuit? If you will answer this you will settle an argument which we have had for some time about this subject. We realize that it is not possible to make such a circuit, except possibly by the use of regeneration, but we are just assuming. —A. F. A.

No. If there were no resistance in the tuned circuit broadcast signals could not be received. Even if the circuit had some resistance but very small, it would not be possible to receive broadcast signals. It is quite possible by means of regeneration to make the circuit so selective that no intelligible signals can be received. The resistance in the tuning coil and condenser is very useful.

* * *

Choke for Ultra-Short Waves

WILL you kindly give the design of a choke suitable for waves about 5 meters long. The chokes are to be used in the plate and screen leads to prevent the radio frequency currents from straying. Also, will you kindly suggest chokes to be used in the filament leads. The tubes are the 2-volt type.—J. A. F.

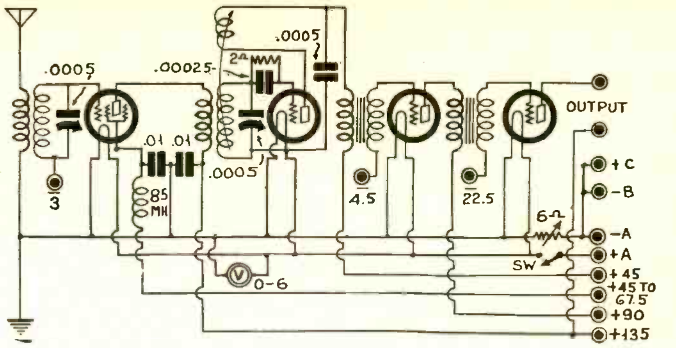


FIG. 939

This four tube circuit is suitable for a portable set when utilizing the 2-volt tubes.

Not a great deal of inductance is needed and the coil should be wound with the least possible distributed capacity. It might be wound on a form the diameter of a lead pencil or on no form at all but with about the same diameter. Inductance should then be obtained either by using fine wire or by making the coil long, or by both methods. A coil one quarter inch in diameter and two to three inches long should be all right. The wire might be No. 36 double silk covered. This coil would be suitable for any lead not carrying much current. For the filament circuit chokes the wire should be made heavier, say No. 22 double silk. To get about the same inductance the diameter could be increased a little and the length could also be increased. A choke wound with No. 36 double silk covered wire on 1/4 inch diameter to a length of 3 inches will have an inductance of about 25 microhenries. At 5 meters this will have an impedance of nearly 10,000 ohms, provided the distributed capacity is negligible.

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 table comparable to the 235.

A THOUGHT FOR THE WEEK

DO you know the name of the owner of the pleasantly soothing voice that sings the theme song for the RKO program over the air each week? Well, it's Tom Kennedy, and we understand that the singer of the tuneful ditty also wrote it. Tom Kennedy was formerly in vaudeville and then became a booking agent and now is one of radio's best liked vocalists. He is popular not only with his hearers but still more so with his old and new associates in the entertainment world. He's a regular showman as well as a regular fellow.

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.

Still Unsettled

THE question whether a station operating under a license from the Federal Radio Commission has a vested right that cannot be taken away from it without compensation, due to the protection of the Fifth of the Amendments to the Federal Constitution, is having a hard time getting settled. In a few instances the question has been before the United States Supreme Court in radio cases, but it has never been answered there. Even in the WGY case, in which Charles Evans Hughes was counsel, the vested right plea was made by him, but the court decided in favor of the station on other grounds, and did not mention anything in its opinion about vested rights, although Mr. Hughes had treated that topic very seriously, likening a station license to a particular frequency to a trademark equivalent. He was the first one to raise the point before that court in a radio case.

Now the Circuit Court of Appeals, Seventh Circuit (Chicago), renders an opinion deciding that the injunction obtained by the Federal Radio Commission against WMBB-WOK, which operated after being denied a license renewal, be sustained, with no comforting qualification to the station's defeat that it is to get remuneration from any source.

Thad H. Brown, the Commission's general counsel, greets the opinion with fervor, saying that the Commission will feel at liberty to go ahead eliminating inferior stations, because the opinion sets forth that there is no vested right to the radio privileges, but the right is only "permissive."

Also the Department of Justice is out with a statement along the same line, and also presumptive.

The question can not be satisfactorily settled, or settled at all, until the Supreme Court has spoken. However, a reading of the opinion in the WMBB-WOK case does not fully justify Mr. Brown's enthusiasm.

The decision of the court pivoted about a technicality of legal procedure. It is a canon of law that you must first exhaust your legal remedies before you can attempt to apply equitable ones. The radio law provides for the appeal from decisions of the Commission to the Court of Appeals of the District of Columbia, but the station, instead of making such appeal, continued broadcasting without a license, claiming that the Commission was attempting to do an unconstitutional act, and also was acting in an arbitrary, unreasonable and unfair manner. The Commission's injunction suit got the station into court.

When an attempt to get the case decided by the Supreme Court on framed questions failed, the case went back to the regular routine of appeals for an injunction suit, and the station rested only on its charge of arbitrary, unreasonable and unfair action, and had to pass up the question of the unconstitutionality of vesting in the Commission power to regulate and limit broadcasting stations. Therefore it proposed that stations not deleted should have to chip in to defray the loss borne by WMBB-WOK, or if WMBB-WOK were continued, fairly enough, it should have to contribute to the property loss suffered by deleted stations. Concerning this contention the court in Chicago, in the opinion hailed by Mr. Brown, said:

"While there seems much of merit in this position, the appellee contends that the appellants are in no position to make this contention in this suit at this time because of their failure to appeal to the Court of Appeals of the District of Columbia."

The Commission had raised the point that there was no vested right, but the court rested its decision on the point that proper legal procedure had not been followed, hence the court was powerless to order any redress even if it saw fit, therefore whatever the court said about vested rights was in connection with a contention improperly before it, and had no legal effect. Such remarks must be mere surplusage or "'dictum," as the legal cant has it, and are merely academic and cannot be decisive.

The court said: "We are well satisfied that there is a vital difference between the rights of one whose property is confiscated by judicial decree and the rights of one to the use of the air, which right is dependent upon a Government permit limited both as to extent and time. The former is vested. The latter is permissive."

But this is of no more legal effect than if a justice of the peace had said it in fining an automobilist for speeding through a village at twenty-five miles an hour.

What the court said about vested rights may be the law, but it doesn't count this time.

A Word for Vallee

RUDY VALLEE has been the target for much jeering, as well as undercover snickers, a lot that this capable radio entertainer ill deserves. He has borne it silently, which must have been an ordeal in itself. His most remarkable success no doubt has occasioned much jealousy, and one can thus explain a great deal of the abuse. He often has to come in contact with a rougher and readier element than he himself represents, which accounts for more of the unsympathetic reactions that slyly or openly result. By nature he is sensitive, and he must feel the affronts all the more keenly.

Vallee got married recently, amid all the worldly advantages that any one could desire in the marriage venture. At 29 he is almost a millionaire. He had a fourteen-room apartment ready for his bride. Fay Webb, brunette moving picture actress, in a choice location overlooking Central Park, in New York City. The general rejoicing attendant upon a marriage, it was to be hoped, would lull even vicious critics into a truce.

He had been married only ten days when his mother died, her famous son at her deathbed in Westbrook, Me. Certainly the prize entertainer is entitled to a respite now. And here's hoping that his critics will develop a habit of giving him a square deal, following being shamed into temporary amnesty.

Forum

Uncommonness of Radio

SOME one said the other day: "Why, that was as common as radio." Like Common Sense, radio is not so common as it appears. Let us render to Caesar the things that are Caesar's.

Theory is necessary for initiating great movements.

Marconi, taking the Leyden jar in his hands and transmitting its electric charge with the aerial through the ether around the world, reminds us of Jupiter Olympus hurling his thunderbolt over the earth.

Hertz had discovered the Hertzian waves around an electrically charged conductor, but it took Marconi to reduce these waves to practice and utilize them. Einstein and others talk about the quantum and the continuum of the ether but Marconi made a bridge through the ether.

What is the quantum of the long wave, the quantum of the short wave? The quantum—a fundamental constant of nature—is in some way connected with the atom and must somehow depend on the properties of the atom, and through this quantum we may soon be able to solve the great secret of the atomic constitution.

Where do the radio electrons originate? Do they exist in a static, neutral, or passive state in the almost infinite space or ether? Do they assemble in the atom by the magnetic pull of the earth? Why and how?

When the radio electrons are accelerated or oscillated they transmit the ether waves around the world, draw near and unite all humanity and may soon bring about a real Fatherhood of God and Brotherhood of Man.

REV. THOMAS J. GLYNN.
St. Peter's Rectory,
704 Market Street, McKeesport, Pa.

* * *

Criticism Taken Kindly

NO DOUBT you have been expecting to receive my subscription renewal, but I have come to the conclusion that your publication is more for the radio technician than for an amateur like myself.

If you could print more radio news, and less of the drawings of various types of circuits, I certainly think you would be giving persons like myself more what they want in a radio magazine.

I am sending sufficient to cover my renewal for six months with the expectation that your publication will improve and that you will try to publish more articles suitable to the ideas and wishes of the amateurs.

I have been a subscriber for your magazine for several years. Your publication is not sufficiently interesting to the average person.

Kindly take this criticism in a friendly way with the sincere wish that you may consider it well, and I hope you may see it the same way as I do myself.

THOS. WINDSOR.
129 Spadina Road, Toronto 5,
Ont., Canada.

Automatic Alarm for Marine Distress

Washington.

An application for a license to test automatic radio distress alarms for use on the seas in both submarine and surface craft has been filed with the Federal Radio Commission by Submarine Signalling Company, of Boston.

In the application, T. R. Madden, president of the company, explained that the 15-watt transmitter sought would be used to test automatic distress radio apparatus under actual operating conditions, which could not be simulated satisfactorily in the laboratory. Four experimental channels, 1664, 2398, 3256 and 4795 kc, were requested.

STATE QUOTAS SHOW A LITTLE IMPROVEMENT

Washington.

During the past four months there has been very little change in the quotas actually provided to the five zones into which the United States is divided for purposes of allocation of broadcasting facilities.

Three zones were very slightly brought nearer their rated quotas of facilities, one zone was stationary and the other zone showed a very small increase in the wrong direction.

The Federal Radio Commission is attempting to carry out a plan of equalization whereby equal units will be assigned to each of the five zones, and the zone units distributed to the States in each zone according to population, which is in line with the requirements of the Davis equalization amendment to the radio law, enacted after the Commission was accused of inequitable distribution.

The First (Eastern) Zone, 6 per cent. under-quota four months ago, is now 5 per cent. under-quota.

The Second (East-Central) Zone was 11 per cent. under, and is 10 per cent. under.

The Third (Southern) Zone is 16 per cent. over, a trifling increase.

The Fourth (Middle Western) Zone was 27 per cent. over, is 25 per cent. over. The most-over-quota zone.

The Fifth (Western) remained virtually constant, 16 per cent. over.

Under the unit system the entire country is entitled to 400 units, and as there are five zones to be given equal facilities, there should be 80 units per zone.

A unit is the equivalent of a 1,000-watt regional station operating full time on a regional channel, with other classes of stations rated in units or fractions thereof accordingly. A station operating on a cleared channel with 5,000 watts power or more, full time, is credited as five units.

While the maximum number of units established for the country is 400, the tabulation discloses that 433.36 units actually are assigned. The objective of the Commission's system eventually is to reduce the number of units to 400 with 80 assigned to each radio zone.

Two New Lynch Resistors for Automobile Radio

Two new Lynch products, the spark plug suppressor for connection to each spark plug, and the distributor suppressor, for connection to common cable to distributor, may now be obtained from Lynch Mfg. Co., Inc., 1775 Broadway, New York City, for auto radio use.

These two new types of Lynch metallized resistors embody outstanding features in design, structural strength and electrical efficiency.

Exacting tests have proved the dependability of these Lynch suppressors for auto radio use where day-in-and-day-out performance is of paramount importance. These units are moisture-proof, rugged and able to withstand heavy mechanical shocks. They have been subjected to exhaustive tests in the laboratories of leading manufacturers and have successfully passed examination under the most critical conditions. Detailed information will be furnished by the manufacturer on request.

Tabulated List of State Quotas

Washington.

Here is the tabulated list of zones, states in each zone, and the quota comparison:

A = total number of units due.
B = total number of units assigned.
C = Net number of units over (+) or under (—) quota.
D = percentage over (+) or under (—) quota.

ZONE 1	A	B	C	D
New York	35.10	39.20	+ 4.10	+ 12
Massachusetts	11.85	9.98	— 1.87	— 16
New Jersey	11.21	11.53	+ .32	+ 3
Maryland	4.56	4.10	— .46	— 10
Connecticut	4.46	3.55	— .91	— 20
Porto Rico	4.32	.40	— 3.92	— 91
Maine	2.22	2.20	— .02	— 1
Rhode Island	1.91	1.40	— .51	— 27
Dist. of Col.	1.33	1.30	— .03	— 2
New Hampshire	1.31	.80	— .51	— 39
Vermont	1.00	.60	— .40	— 40
Delaware	.67	.70	+ .03	+ 4
Virgin Islands	.06	....	— .06	—100
Total	80.00	75.76	— 4.24	— 5
ZONE 2				
Pennsylvania	27.64	20.24	— 7.40	— 27
Ohio	19.05	18.65	— .40	— 2
Michigan	13.88	11.40	— 2.48	— 18
Kentucky	7.54	7.62	+ .08	+ 1
Virginia	6.94	9.50	+ 2.56	+ 37
West Virginia	4.95	4.90	— .05	— 1
Total	80.00	72.31	— 7.69	— 10
Texas	16.22	22.77	+ 6.55	+ 04
ZONE 3				
North Carolina	8.83	7.82	— 1.01	— 11
Georgia	8.09	7.95	— .14	— 2
Alabama	7.39	6.22	— 1.17	— 16
Tennessee	7.29	12.83	+ 5.54	+ 76
Oklahoma	6.67	9.00	+ 2.33	+ 35
Louisiana	5.83	8.50	+ 2.67	+ 46
Mississippi	5.60	3.00	— 2.60	— 46
Arkansas	5.17	4.40	— .77	— 15
South Carolina	4.82	1.70	— 3.12	— 65
Florida	4.09	8.35	+ 4.26	+104
Total	80.00	92.54	+12.54	+ 16
ZONE 4				
Illinois	22.50	33.84	+11.34	+ 50
Missouri	10.72	12.05	+ 1.33	+ 50
Indiana	9.53	7.48	— 2.05	— 21
Wisconsin	8.66	7.95	— .71	— 8
Minnesota	7.59	9.01	+ 1.42	+ 19
Iowa	7.30	11.45	+ 4.15	+ 57
Kansas	5.56	4.71	— .85	— 15
Nebraska	4.08	7.23	+ 3.15	+ 77
South Dakota	2.04	3.01	+ .97	+ 48
North Dakota	2.02	2.99	+ .97	+ 48
Total	80.00	99.72	+19.72	+ 25
ZONE 5				
California	36.85	36.43	— .42	— 1
Washington	10.16	15.80	+ 5.64	+ 56
Colorado	6.74	9.42	+ 2.68	+ 40
Oregon	6.19	9.15	+ 2.96	+ 48
Montana	3.48	3.00	— .48	— 14
Utah	3.27	6.60	+ 3.33	+102
Idaho	2.89	2.60	— .29	— 10
Arizona	2.83	2.60	— .23	— 8
New Mexico	2.77	4.03	+ 1.26	+ 45
Hawaii	2.39	1.40	— .99	— 41
Wyoming	1.46	.20	— 1.26	— 86
Nevada	.59	.80	+ .21	+ 36
Alaska	.38	1.00	+ .62	+163
Total	80.00	93.03	+13.03	+ 16

Seven Stations Get Short-Term Licenses

Washington.

As they are in difficulties with the Federal Radio Commission the following seven stations obtained only temporary license renewals: WPG, Atlantic City, N. J., WLWL, New York City, and WWL, New Orleans, La., for failure to reach time-sharing agreements; KMO, Tacoma, Wash., KFVD, Culver City, Calif., KMPC, Beverly Hills, Calif., and KWJJ, Portland, Ore., for failure to file copies of their regular operating schedules.

The temporary licenses expire August 1st. Meanwhile the stations are designated for a hearing on renewal applications.

WORLD ENJOYS 24-HR. TEST ON 49.48 METERS

Cincinnati.

Fourteen phonograph recordings of selections picked up on a recent W8XAL 24-hour test short-wave international program have just been received by Crosley officials from one of this station's world-wide audience.

The recordings were made by Technical Sergeant E. A. Reading, member of the United States Army Signal Corps, stationed at the Schofield Barracks, Hawaii. They possess excellent volume and tonal fidelity although made at a distance of more than 5,000 miles from the source of the programs in the Crosley broadcasting studios, in Cincinnati.

Studio engineers state the records are of great value in checking over the results of their short-wave broadcasting experimental work.

Report From New Zealand

Excellent reception of the program was had in New Zealand, according to advices just received.

In fact, the reception was so clear as to permit the New Zealand radio station 3ZC to pick up and rebroadcast the Cincinnati program without the use of intermediate amplification such as studio programs receive before being put on the air.

"W8XAL's 24-hour international broadcast was certainly a most successful one, their music and speech being heard at good rebroadcasting strength until 3ZC went off the air. . . . The American station was at excellent strength and clarity and throughout the rebroadcast the 3ZC studio was flooded with congratulatory telephone messages," to quote one of the New Zealand newspapers.

All Quarters Heard From

That the 10,000 watt Crosley short-wave station is being picked up by radio listeners throughout the entire world is indicated from reports being received at the Cincinnati studio from all quarters of the globe.

Letters are being received daily from enthusiastic fans in both Eastern and Western hemispheres voicing high praise of the clarity, strength and fidelity of reception of these W8XAL test programs which, for the most part, are simultaneous broadcasts of WLW programs.

WLW is on 700 kc, 428.3 meters, while W8XAL is on 6060 kc, 49.48 meters. Their schedule is: Sunday, 8:59 a.m. to 12:30 a.m. (Monday); Monday, Tuesday, Wednesday, Thursday, Friday, 6 a.m. to 1 a.m. the following day; Saturday, 6 a.m. to 2 a.m. (Sunday). The time is Eastern Standard Time. Both stations carry the same programs.

WE'RE DELIGHTED—AND ENCOURAGED!

A recent survey of RADIO WORLD's subscription orders for ten weeks from May 2d to July 3d, 1931, proved that the amount paid by new and old subscribers during those ten weeks was 15.9% more than was paid during the corresponding period of 1930.

We're going to try and increase this percentage for the whole year—and know full well that this can be accomplished only by turning out a paper that gives the service expected by a particular and ever-growing public.

THE PUBLISHERS.

CLERK CLAIMS HIS INVENTION STOPS FADING

Stockholm, Sweden.

A clerk in a small radio store, K. E. Ylander, has announced that he has solved the problem of fading. With what he calls a simple and inexpensive device he says that fading can be cured absolutely. He cites six years of experimental work behind his invention.

He says that the device should be ready for the market in a year and that it ought to be universally used almost immediately thereafter.

He does not state what principle is invoked in the operation of the device, but merely remarks that constant strength of output is established regardless of fluctuation of the input.

Modified forms of fading reducers are in wide use now, and are known as automatic volume controls. Their effect is relative, so that fading is less pronounced, but not cured. The principle is that variation of negative grid bias is determined by the signal strength. The higher the signal amplitude, the greater the negative bias on radio frequency or intermediate frequency amplifying tubes, and the less the volume. Thus a relative levelling effect is established.

Combination Receiver For Auto and Home

Keller-Fuller Mfg. Co., Ltd., 1573 West Jefferson Boulevard, Los Angeles, Calif., announces a combination automobile and home set operating without B or C batteries and using an electro-dynamic speaker, the Radiette Troubadour. It operates either on 6 volts d-c or 110 volts a-c.

The set uses the new automobile tubes: Four 236, two 238, with a 171-A as a rectifier. All that is required to change from the automobile to home use is the changing of the plugs and cables, one of which is furnished for the car and one for the house.

DAMARIN REJOINS DUBILIER

Fred L. Damarin has rejoined the Dubilier Condenser Corporation as Western sales manager at 330 South Wells street, Chicago.

Depreciation Rates Settled

Washington.

Difficulties in determining depreciation rates of broadcasting station equipment for income tax purposes have been settled temporarily by a tentative schedule, as follows:

Ten years' useful life: antenna and ground systems; adjusting and testing instruments.

Five years' useful life: amplifier control.

Four years' useful life: listening apparatus.

Three years' useful life: audio equipment; frequency control apparatus.

The agreement was reached between the valuation department of the Bureau of Internal Revenue, and the National Association of Broadcasters. The association emphasized that the agreement is not official but is recommended as a safe guide in the calculation of depreciation rates for income tax payers.

RADIO CITED AS LITERACY AID

Washington.

The enlightening effect of radio has caused a reduction of illiteracy, according to Dr. William John Cooper, United States Commissioner of Education. He bases his remarks on figures compiled by the Bureau of Census.

An illiterate person is defined as any one 10 years of age or more who is unable to read or write.

The Census figures show that 4.3 per cent. were illiterate, in 1930, as against 6 per cent. in 1920. The 1930 total number of illiterates was 4,223,749 or 648,156 fewer than in 1920, when the total was 4,871,905.

The absolute decreases in illiteracy over the period was 13 per cent. since the population over the same period increased 16.1 per cent.

"Experiments conducted by education," said Dr. Cooper, "have shown that unquestionably radio has been an influential factor in reducing the number of illiterates both directly and indirectly. There are many unfortunate folk who know not that they know not, and radio has been a factor in eliminating at least one of those know nots."

AIR HAPHAZARD IN EARLY DAYS, RECORDS SHOW

The comparison between the early days of stations WJZ and WEAF, and the smooth-running machine which is now the National Broadcasting Company, is so great that one can hardly conceive the broadcasting conditions which existed in pioneer days.

In the general library of the National Broadcasting Company there are bound files of the programs of WEAF and WJZ and of WJY, the time-sharing station of WJZ in the early days. They are the original program schedules of these stations, with the marginal comment made by announcers and station directors of those days.

Intermissions Troublesome

Here is one of January, 1925: "A very bad stunt. Let's don't broadcast again where everything is so chopped up. It has no radio value. If more than one intermission is necessary let's don't take the event."

This note was in connection with a program entitled "Singers Glee Club Concert—direct from Aeolian Hall Auditorium."

Another interesting comment is on a soprano who was featured the same month. It reads, "good voice—but inclined to kick transmitter off air."

There are many notes throughout the files on programs saying: "artist did not arrive—had to fill in" or "this is the second time this person has failed to keep appointment, please do not book again."

Signature Song's Reception Then

Another interesting note is, "this orchestra is getting careless in their work and I would like to suggest that the program department request him to discontinue his sign-off, "Aloha Oe" and chimes —this is getting terribly old and sometimes holds us up." This is signed by Keith McLeod, now musical supervisor of NBC. At that time McLeod was an accompanist, studio pianist, filler-in, and jack of all trades about the studios of WJZ and WJY.

In this day and age WJZ or WEAF or a network of over seventy broadcasting stations can go on the air with an event within a half-minute's notice or even less.

Matter of a Few Minutes

In the early days they couldn't as the following notes show: "Do not book an event on WJY before 7:35 P.M.—we cannot have the air until 7:31—and then after going on air technical adjustments require two or three minutes; so with an event booked at 7:30 we are generally three or four minutes before we get our opening announcement out—think it over."

Another quotation was: "Off the air for one hour and 25 minutes. Technical trouble." How different now!

Dividends Declared on RCA Preferred

The Radio Corporation of America declared dividends as follows, payable on October 1st next to stockholders of record September 1st: Class "A" preferred stock, 87½c for third quarter 1931; Class "B" preferred stock, $1.25 per share for same period.

WRIT SUSTAINED OVER SILENCING OF WMBB-WOK

Chicago.

The Circuit Court of Appeals, Seventh Circuit (Federal Court) unanimously affirmed the injunction issued by a lower court to the Federal Radio Commission against the American Bond and Mortgage Company and Trianon, Inc., operators of WMBB-WOK, with studios in Chicago and station at Homewood, Ill., about 25 miles from the city.

The securities corporation and Trianon, Inc., shared the station ownership, half of the time being used by the Trianon Ballroom.

When the reallocation was instituted by the Commission, the station's license was not renewed, on the ground of conservation of radio facilities necessary to reduce interference. But the station continued on the air without a license, the injunction resulted, and the case was taken to the United States Supreme Court on certified questions of law, involving constitutionality, but the Supreme Court stated the questions need not be answered and dismissed the certificate.

Then the regular order of taking an appeal was followed, and the appeal argued here before the Circuit Court of Appeals.

The Circuit Court remarked that the constitutionality of Congress authorizing the Commission to administer the ether was not now raised by the station, which narrowed its argument to be that the action of the Commission was arbitrary, unreasonable and unfair.

Cites Financial Loss

As a basis for this argument the appellant (station) cited it had enjoyed a license, which had been renewed, but that at the expiration of one period, on September 1, 1928, renewal was refused, after a hearing. The Commission's contention was that such action was necessary to promote the public interest and convenience, greatly improving reception conditions in the broadcasting band by eliminating some of the interference.

The financial feature was stressed by the station, which had spent about $100,000 for plant and equipment, of no benefit if the injunction were sustained.

The court's opinion continued:

"Appellants do not now question the necessity of regulation nor the propriety of limiting broadcasting stations in such manner as to give the best service to the possessors and users of radios. Their contention, however, is that the Commission acted arbitrarily when it denied appellants' permit without providing any compensation for the loss of property, which such order of discontinuance necessarily entailed.

"Their position, briefly stated, is that in denying a renewal of license to one broadcasting station, which had not offended against the rules of the Commission, solely to reduce the number of such stations, the Commission should have required the other broadcasting stations to pay a fair sum to appellants to compensate them for their loss.

Compensation Plan

"They contended that if other licensees did not care to continue upon the condition that they pay appellants for their loss, appellants should have been permitted to continue upon the condition that they pay their proportion of the loss which some other licensee suffered through the loss of its license.

"While there seems much of merit in this position, appellee (the Commission) contends that appellants are in no position to make this contention in this suit at this time because of their failure to appeal to the Court of Appeals of the District of Columbia, as provided by section 16 of the Radio Act of 1927, U. S. Code Supplement, title 47, section 81. Appellee (the Commission) also contends that the license under which appellants operated ran for a limited period only; that no vested rights were acquired thereunder, and, therefore, the order of the Commission was valid and appellants were entitled to no compensation for the loss of their property.

A Vital Difference

"We are well satisfied that there is a vital difference between the rights of one whose property (in coal land such as was considered in Pennsylvania Coal Company v. Mahon, 260 U. S. 393) is confiscated by the judicial decree and the rights of one to the use of the air, which right is dependent upon a Government permit limited both as to extent and time. The former is vested. The latter is permissive.

"We are likewise satisfied that appellants are not in a position to attack an order of the Radio Commission which was within its power to make, without first exhausting the remedies given them by the Radio Act, to wit, by appealing to the Court of Appeals of the District of Columbia.

Backed By Supreme Court

"The view of the Supreme Court on this proposition is clearly indicated in White v. Johnson, 282 U. S. 367, a case similar to the one under consideration, in which similar questions were at the same time certified to the Supreme Court, and in which the certificate was likewise dismissed."

Washington.

The Department of Justice, in a statement to the press, said the Chicago decision confirms its stand there is no property right in the ether.

Three Stations To Be Ousted

Washington.

Three stations marked for deletion, but against which the Federal Radio Commission has hesitated to take action, while awaiting court sanction of the deletion powers deemed to be conferred under the radio law, are expected to "get their medicine" when the Commission reconvenes in the Fall. Two of these stations are in Newark, N. J., while the third is in St. Louis, Mo.

Elmer W. Pratt, chief examiner of the Commission, recommended that WMJ and WKBO, at Newark, N. J., be removed from the air, and their time used instead by WHOM, Jersey City, N. J., as better qualified for public service. These three stations, and WMBS, Hackensack, N. J., share time on 1450 kc. WMBS would retain one-quarter time, WHOM obtain three-quarters instead of one-quarter time.

The marked station in St. Louis is KEWF, the idea being to oust it from the air and give to WIL, of St. Louis, the time KEWF shares with it. KEWF is maintained by the St. Louis Truth Center, Inc., according to Pratt, "primarily for the dissemination of the private views of certain religious teachers."

Pratt favors the consolidation of assignments in well-managed, modern, public-serving stations, rather in the devoting of public facilities to private use by inferior stations of limited facilities.

BOARD POSITION AS REGULATOR HELD STRONGER

Washington.

The decision in the case of WMBB-WOK, Chicago, was hailed by Thad H. Brown, general counsel of the Federal Radio Commission, as giving the Commission "a greater sense of security," and as confirming the view held by the Commission's legal department that there is no vested property right in the ether.

"The opinion," he said, "confirms the view held by us with respect to property rights and strengthens the Commission's position in future steps to improve broadcasting by eliminating inferior stations."

Interprets Court Finding

The following additional information was made public at the legal department, according to "The United States Daily":

"The circuit court sustained the judgment of the Federal district court in the case of the American Bond and Mortgage Co., which operated former Station WMBB-WOK, at Chicago. This station had been removed from the air by the Federal Radio Commission in 1928 to reduce congestion, but it challenged the constitutionality of the Commission's action, claiming that its investment in the station had been destroyed.

"In its opinion, the court held that broadcasting stations do not have a vested property right in the channels assigned them by the Federal agency, but that this right is 'permissive.'

"With this decision, the Commission now is enabled to proceed with a firmer hand in bringing about the 'ideal' situation in radio. Overcrowding of stations in the broadcast band has been deplored, and engineering opinion is unanimous that only by a material reduction in the number of stations can broadcasting be substantially improved.

Overcrowded Condition

"There now are slightly more than 600 licensed radio stations assigned to the 90 wavelengths available to the United States. When the Commission assumed control over broadcasting, and radio generally, under the terms of the Radio Act of 1927, there were some 735 stations jammed into the band, and the situation was chaotic. Congress instructed the Commission to take such steps as it believed expedient to alleviate these conditions, and a campaign for the reduction in the number of stations was begun.

"While the number was reduced, by means of consolidations, deletions and financial failures, the Commission felt it was blocked in such future actions, except in clear-cut cases of law violations, when the property rights question was in litigation. Now for the first time, the question is out of litigation; conceivably it may be appealed to the Supreme Court of the United States for final adjudication. The Commission has not been informed as to whether the American Bond and Mortgage case will be appealed.

Will Start on These Stations

"The Commission now is in recess, but when it reconvenes in September it will be confronted almost immediately with the question of deleting at least three stations, and in embarking upon a policy pursuant to this new legal interpretation of the law."

Books

"Principles of Television"

A NEW book is to be added to the growing ranks of television literature. "Principles of Television" ("Radio," San Francisco, $3.75) is intended to serve a three-fold purpose: (1) introduce the layman to the subject; (2) interest the experimenter, and (3) serve as a useful handbook for the engineer. Therefore the book is divided into these three parts.

It is expected that the book will be ready for distribution in September. The subject will be treated in an up-to-date manner, including the projection of large pictures even for home use (one foot square), and also the operation of the scanning tube.

While discs are used at present by experimenters, the scientists working on television feel that a tube will do the scanning when television is ready for the public. Some such tubes have been produced by laboratories, and it is said also that tubes giving a much-desired white light, instead of the familiar pinkish neon glow, have been developed for this purpose. The scanning tube would replace the present neon lamp.

Both transmission and reception are to be considered in the book, with stress being laid on the inexpensiveness and the practicality of the plans outlined. One device illustrated is a talking movie transmitter, using the cathode ray tube. The resultant picture is of the 400-line type, one-foot-square type.

"This book is really a complete course of instruction in television," says the publisher.

* * *

"Key to Radio Law"

ANOTHER pre-publication announcement concerns "Stollenwerck's Key to Radio Law, Regulations and Procedure," intended to be off the press in the early Fall. It contains a cross-index to its self-contained citations to important rules and principles, legal and technical, regarding the Radio Act and amendments, the General Orders and findings of the Federal Radio Commission, and the decisions of Federal and State laws concerning radio matters.

The book will be kept current by a loose-leaf supplementary service. It is being compiled by Frank Stollenwerck, A.B., LL.B., lecturer on radio law at the University of Baltimore, and a member of the bar of Maryland and of Alabama. Mr. Stollenwerck has associated with him in this work Carl H. Butman, radio consultant, formerly Secretary of the Federal Radio Commission, and W. D. Jamieson, LL.B., of the District of Columbia bar, a former Member of Congress from Iowa.

The announcement comes from Carl H. Butman, National Press Building, Washington, D. C.

* * *

"Radio in Advertising"

ORRIN E. DUNLAP, radio editor of the New York "Times," is out with a new book, "Radio in Advertising" (Harper & Brothers). At one point he theorizes on the effect television will have on radio advertising, even though at present advertising programs are barred from television channels, because television is still deemed by the Federal Radio Commission to be in the experimental stage, along with all other short-wave work.

He looks at the advertising possibilities of television largely from the opportunity offered to manufacturers to display their new wares pictorially, rather than by giving a textual description, with the pointing finger resting on particular features the advertiser will want to stress. He feels that pictures will dispense with much of the ballyhoo now heard concerning advertisers' products.

Along with the television outlet will be used the printed word and picture for newspapers and magazines, he believes, so that television advertising will supplement the printed word and picture, not displace them.

The author states:

"Television will permit demonstrations, and the audience will not have to imagine what a product looks like or how it operates. A new model automobile revolving on a turntable in front of a televisor will enable it to be introduced to the entire nation within a few seconds. A silver polish can then be visually demonstrated in a much more effective way than mere words can describe it. For example, hold the tarnished silver knife or kettle in front of the electric eyes. Then use the magic polish and let the housewives of the nation see at a glance how bright and new the old piece of cutlery or utensil looks, after the magic remedy has been applied.

"Great will be the power of television in advertising if for no other reason than the fact that 'one picture is worth more than 1,000 words.'

"Television is likely to bring a revival of advertising characters, and to give those who have been confined to cartons greater scope and renewed life.

"There are so many things that can be done by television that it staggers the imagination. It will open a new era in advertising. Sound broadcasting is the foundation for this progress. The advertisers who learn their lessons well in broadcasting will find countless opportunities in vision programs. Showmen and experts in color effects will be in demand. The radio dramas and concerts in many instances will be broadcast from films prepared in studios in much the same way that the talkies are made. There will be news events flashed by radio cameras on the scene of action, whether it be a presidential inauguration or a prize fight.

"There will be advertising, with the morning and afternoon hours packed with it, directed to the housewife and children.

"At night both sound and sight broadcasting must be more subtle, because that is the time for entertainment. The same general principles that govern sound broadcasts will to a great extent apply to television—the advertiser must not be an unceremonious guest in the home."

The book deals with the general topic of its title. Television is only a side consideration.

New Corporations

Universal Radio and Television Corp.—Atty. H. G. Kosch, 383 Madison ave., New York, N. Y.
Sarrabria Television Corp., Dover, Del.—Sound recording devices—United States Corporation Co.
Fiske Distributing Co., radio sets—Atty. H. Kayesh, 570 7th Ave., New York, N. Y.
Continental Television Corp., Belleville, N. J., broadcast theatrical plays—Registrar and Transfer Co., Dover, Del.
Broadcasting Institute, radio television programs—Atty. S. J. Krinn, 1457 Broadway, New York, N. Y.
Globe Television Corp., Wilmington, Del., television, radio supplies—American Guaranty and Trust Co.
Howard Electric Radio Corp.—Attys. Hyman & Hyman, 103 East 125th St., New York, N. Y.
C. E. F. Recording Systems, sound recording—Atty., J. E. Brill, 36 West 44th St., New York, N. Y.

REPORTS BUSINESS EXCELLENT

Chicago.

U. S. Radio and Television Corporation, manufacturer of Apex and Gloritone sets, announces a present production rate of 1,800 receivers a day, an average of two and a half sets a day per worker, as compared with the usual average of one set. For six months ending January 31st the corporation reports sales 115 per cent. more than for the previous six months.

Sparkles

"STATION KUKU" is the name of a vaudeville act, founded on the radio feature of the same name, especially staged by Raymond Knight, who is guilty of the KUKU silly. The National Broadcasting Company, in announcing the act's presentation at the Flushing Theatre, in New York City's metropolitan outskirts, describes it as "a hilarious burlesque radio revue." Hilarious may be their name for it, but some of us think it is worse than hilarious. But maybe that is what the Mr. Knight intended.

* * *

THE tightness of tie-up that is marking radio is well illustrated in the case of the new Hotel Waldorf-Astoria, New York City, for the National Broadcasting Company will furnish all musicians, dancers and other entertainers for events sponsored by the hotel company, and will have a representative on the premises at all times. Daily the concert and orchestral music will be broadcast from the hotel over networks, and on Sundays organ recitals originating in the Grand Ball Room.

* * *

THERE seems to be little that the King of Siam, our good friend Mr. Prajadhipok, has missed in his journeys in and about New York that started when he came to our shores to have cataracts removed from his eyes. Now that his eyes are in fine condition he has been able to enjoy the sights of a great broadcasting studio.

It is to be noted that members of the receiving party included Manton Davis, lawyer for the Radio Corporation of America, and George S. DeSousa, treasurer of that corporation.

Even a King can not move a foot without legal and financial advice in this country.

* * *

LEE MORSE has left the Columbia Broadcasting System after a successful spell there, and has gone over to the hated rival, the National Broadcasting Company, but Kate Smith has made the journey in the opposite direction.

* * *

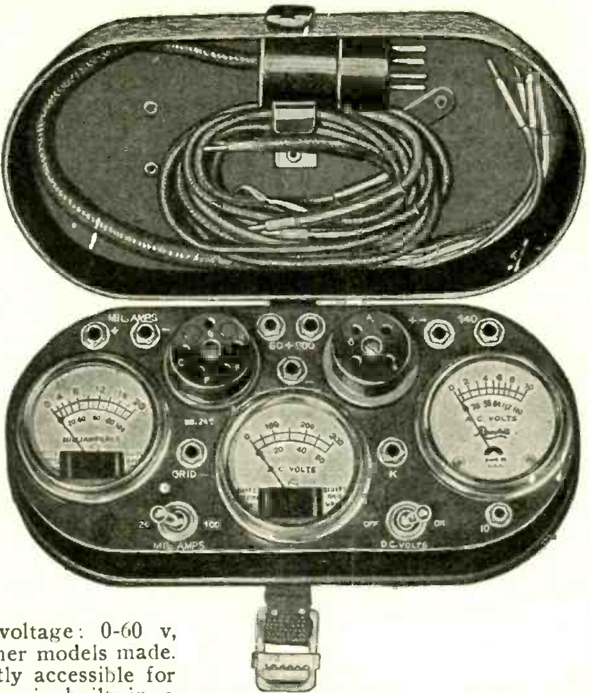
MORTON DOWNEY isn't exactly feeling the effects of the financial depression that we vowed never to mention. He appears every night except Sunday for a sponsor, over the Columbia System, and gets $6,000 a week for his trouble. Besides, when he does a vaudeville turn or otherwise appears on the stage he is good for an extra $6,000 or so. He used to sing with Paul Whiteman's orchestra for much less, say $75 as a starter. He began work as a newspaper and magazine butcher on the New York, New Haven and Hartford Railroad, between, as you might have guessed, New Haven and New York. He attributes his success to the fact that he made New Haven the starting place and New York the stopping place. Besides, he is a deputy sheriff, and that helps. He can easily get by with his fine voice, but if he has a cold the badge will help.

* * *

ERIC PALMER, radio publicity expert, always optimistic, reports the "case" of Dr. Norman C. Crewe, of Detroit, Mich., who put aside the scalpel for the soldering iron, for a brief period, and wired up a short-wave receiver with which he received many foreign stations. Now the doctor, says Palmer, prescribes the thrills of direct reception of European stations as a full antidote for that tired feeling, the blues, ennui and what-have-you.

Send $8.26! Get This Tester!

HERE is your opportunity to get immediate delivery of the Jiffy Tester at $8.26 remittance with order, balance of $3.50 payable in one year. Your credit is good with us. This Tester will read plate current, plate voltage and filament voltage simultaneously, when plug is put into any set socket and tube in the Tester.



Jiffy Tester, Model JT-N, consists of three double-reading meters, with cable plug, 4-prong adapter test cords and screen grid cable. The ranges are filament, heater or other AC or DC 0-10 v, 0-140 v; plate current: 0-20, 0-100 ma; plate voltage: 0-60 v, 0-300 v. It makes all tests former models made. Each meter is also independently accessible for each range. The entire device is built in a chromium-plated case with chromium-plated slip-cover. Instruction sheet will be found inside. Order Cat. JT-N @ $11.76; $8.26 down.

DIRECT RADIO CO.
143 W. 45th St., N. Y. C.

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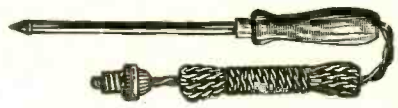

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Full Text of the Langmuir Opinion
in RADIO WORLD of June 13

The United States Supreme Court unanimously decided that Dr. Irving Langmuir's high vacuum for radio tubes did not constitute invention. The final court's 10,000-word opinion contains an exposition of the structure, function and operation of the vacuum tube, as well as a review of the tube's development, all scientifically treated. Be sure to read the opinion in full.

Copy mailed to you for 15c in stamps or coin.
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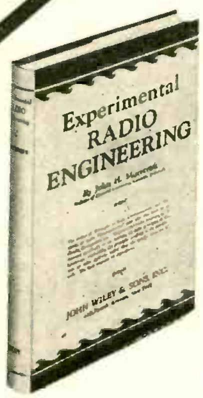

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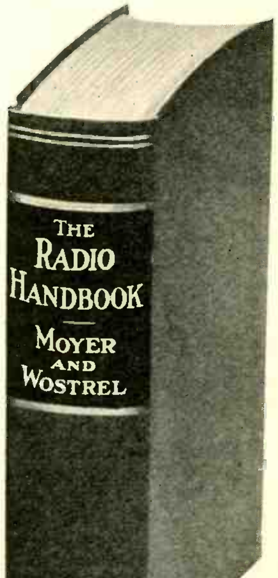

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