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[See Page 8]

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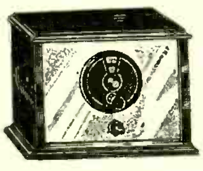

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Radio World 145 West 45th St., New York, N. Y.

COMPLETE TUBE CHARACTERISTICS WITH SOCKET CONNECTIONS

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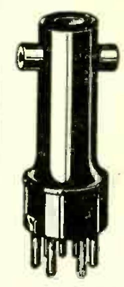
NEW SERVICE EQUIPMENT



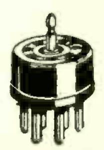
Cat. 907 WLC De Luxe Analyzer Plug, with 5-ft. 8-lead cable attached. Price $3.23

De Luxe Analyzer Plug, with new seven-pin base, with 5-ft. cable (not shown), two alternate grid connector caps and stud socket at bottom that connects to both grid caps. Eight-wire cable assures adaptability to future tube designs, including tubes with 7-pin bases and grid cap soon to be released to the public (2A7, 6B7, 2B7 and 6A7).

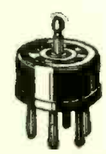
The eighth lead connects to the two grid caps and stud socket which is a latch lock. Standard adapters for the De Luxe Analyzer Plug are 7 top to 6 bottom, 7 top to 5 bottom and 7 top to 4 bottom, thus reducing to required number of pins and enabling testing of circuits using all popular tubes. Special adapters, as for UX-199, UV-199, etc., obtainable.

Latch in Analyzer Plug base grips adapter studs so adapter is always pulled out with Analyzer Plug (adapter can't stick in set socket). Pressing latch lever at bottom of Analyzer plug releases adapter. Analyzer Plug is of smaller diameter than smallest tube and thus fits into tightest places. Made by Alden.

Analyzer Plug, 7 pin, with 8-lead 5-foot cable attached. (adapters extra). Cat. 907-WLC @.....$3.23



Cat. 976-D8 New plug-in adapter, 7-hole top, 6-pin base, with locking stud that fits into 907-WLC latch. Price .... .73



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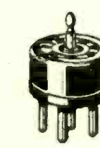
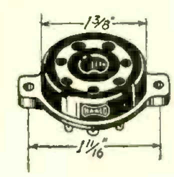
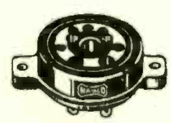


Cat. 974-D8 New plug-in adapter, 7-hole top, 5-pin base, with locking stud that fits into 907-WLC latch. Price .... .73

Above three adapters essential for 907-WLC to test UX, UY and 6-pin tubes, including such tubes with grid caps.



CAT. 456-E
In the Analyzer end, use a 9-hole universal socket, that automatically takes UX, UY and six-pin tubes, with errorless connections. Price....... .35



CAT. 437 E
To accommodate 7-pin tubes, which will not fit into Cat. 456-E universal socket, use Cat. 437 E, a seven-pin companion socket, same size. Price .24

If instead of using two sockets, the universal Cat. 456-E and the Cat. 437, the universal alone may be used, with an adapter that has six-pin bottom and 7-hole top to enable putting 7-pin tubes into the universal socket. A 6-inch lead with phone tip is eyeleted to the side. A pin jack you put on Analyzer, connected to seventh lead of 907-WLC cable, picks up control grid of 7-pin tube through the eyeleted lead. Cat. 976-SL ....$ .73

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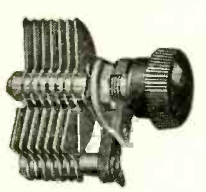

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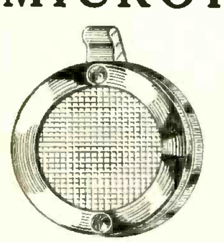

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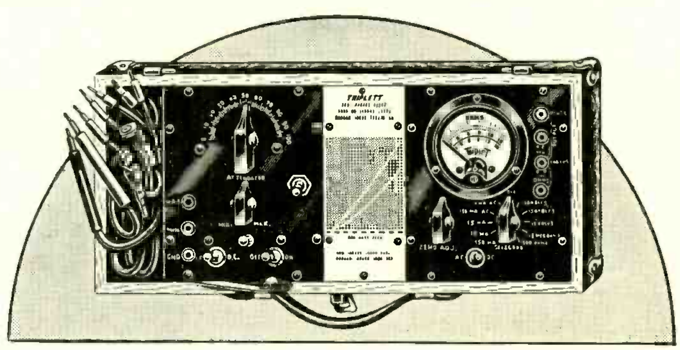
A switch on the oscillator permits its use for generating either a stabilized modulated or unmodulated signal of constant level. Extremely accurate scale divisions cover fractional frequencies on the individually hand made chart from 110 to 1600 KC.



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The First and Only National Radio Weekly
TWELFTH YEAR

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Technical Editor

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THE NEW 84 RECTIFIER

Application Note on 6.3-Volt Heater Type Tube

THE 84 is a full-wave vacuum type rectifier having a 6.3-volt, 0.5-ampere heater. This tube may be operated as a full-wave rectifier, or as a half-wave rectifier if both plates are connected in parallel. Operating conditions for each of these uses are as follows:

As a Full-Wave Rectifier

A-c voltage per plate (rms)..350 max. volts
D-c output current.............50 max. ma.

As a Half-Wave Rectifier

A-c voltage on plates (rms)..350 max. volts
D-c output current.............75 max. ma.

Uses for 84

The 84 finds application as a rectifier in the power units of automobile receivers and in small a-c receivers, whose total current demands are within the limits specified for the 84, say RCA Radiotron Company, Inc., and E. T. Cunningham, Inc.

The curves of Figs. 1 and 2 show regulation characteristics for full and half-wave operation with 4, 8 and 16 mfd. values of capacity input to the filter, and for applied a-c voltages of from 200 to 350 volts on the plates of the tubes. Fig. 1 includes 32 mfd. also.

For full-wave operation with 350 volts a-c., the maximum output of the 84 is 50 milliamperes at 430 volts d-c. For half-wave operation, 50 milliamperes at 420 volts d-c., or 75 milliamperes at 375 volts d-c. may be obtained from this tube.

Heater Aspects

For operation at maximum rating with 350 volts (rms) applied to the plates, the heater voltage should never exceed 7.5 volts.

This heater voltage requirement must be taken into account when the tube is used in automobile receivers; but when the 84 is used in an a-c operated receiver in which there is generally no appreciable change in heater voltages, this requirement does not ordinarily apply. In an automobile receiver the variation in battery voltage may be such that the heater voltage at times exceeds 7.5 volts. In order to avoid damage to the 84 when used in automobile receivers, it is best therefore to operate the tube with the lowest possible a-c voltage applied to the plates commensurate with obtaining the desired d-c input to the filter.

Since the desired rectified voltage at the filter input in automobile service seldom exceeds 300 volts the applied rms voltage will usually be approximately 250 volts. The exact value will of course depend upon the load and may be readily found from the curves of Figs. 1 and 2.

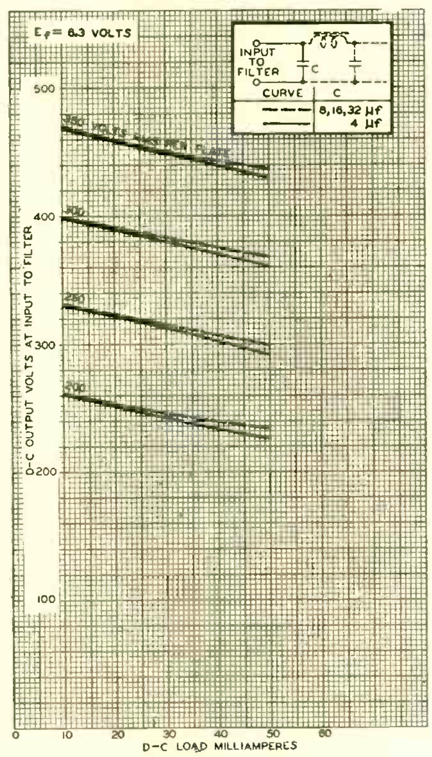


FIG. 1
Regulation curves for the 84 as a full-wave rectifier. This is a 6.3-volt heater type rectifier for auto sets and small a-c receivers, 50 ma at 420 volts being maximum.

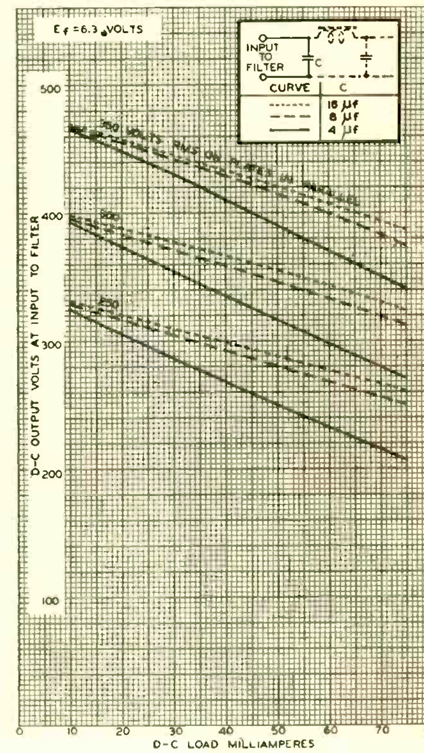


FIG. 2
Curves for half-way rectification, 84 tube. Either 50 ma at 420 volts d.c. or 75 ma at 375 volts d.c. represent maximum. The rms voltages at paralleled plates are given.

THE NEW TUBE CODE

The code number of the 84 tube was assigned before the new system was adopted by Radio Manufacturers Association, Inc. In the new system a letter is used to designate the type of tube. A numeral in front of the letter is used to designate the filament or heater voltage in units of one volt, and a numeral after the letter is used to designate the useful number of elements brought out as terminals.

In amplifier and detector tubes the letters begin at A and run down the alphabet, while in rectifier tubes the letters begin at Z and run up the alphabet. Thus we might have Z, Y, and X rectifier tubes.

A typical designation is 2A5 for an amplifier tube. The "2" means that the filament voltage is between 2.1 and 2.9 volts. A designation for a rectifier tube is 25Z5 (25 volts on the filament).

CAPACITY VALUES

Plotted Against Frequencies for 25 mlh Coil

By Wendell Adams

IN articles in the two previous issues, October 7th and 14th, a simple modified Hartley oscillator and extension of its service were discussed. The General Radio condenser No. 247 was used with two plug-in coils of respective inductances of 25 millihenries and 260 microhenries. The larger inductance was a honeycomb coil of 1,300 turns, tapped at the 500th turn. The smaller inductance was wound on 1-inch diameter tubing, 130 turns of No. 32 enamel wire, tapped at the 20th turn. In each instance the coil was inserted inside a plug-in form.

The curves relating frequency and dial settings for both inductances were printed last week. A special curve detailed the low-frequency settings for the larger inductance, as these are hard to identify in ordinary calibration, using broadcasting stations as standards and beating oscillator harmonics with those standards. Besides, a curve was printed last week relating capacity of the G. R. 247 with dial settings.

Deduct 10 Mmfd.

If a fixed inductance is selected, of course the capacity may be plotted against frequency, and this is done in Fig. 1 herewith, so that any who desire to use other tuning condensers may do so. Any numerical dial may be used on the test oscillator and by ascertaining frequency values, the capacities obtained from the curve herewith can be related to those dial settings, and a capacity dial setting curve drawn.

The curve herewith gives the actual capacity in circuit, but the condenser capacity is less than that by the sum of the other capacities, such as the distributed capacity of the coil and the capacities of the tube, socket, wiring, etc. These extras, in the constructed circuit, proved to equal 10 mmfd., so in calibrating a variable condenser for capacity, deduct 10 mmfd. from each reading obtained from Fig. 1. The deduction will not be exactly right for every construction of every oscillator, but if the constants are followed as prescribed the difference will be slight. The tube is a 56, the honeycomb has very small distributed capacity, and the wiring is so simple that much variation of capacity scarcely is possible so long as leads are, as usual, short.

The curve covers from below 30 mmfd. to 540 mmfd. The capacities below 30 mmfd. are not reliably obtained from a curve, and besides this is the region in which the oscillator does not work at its best. The maximum capacity is high enough to encompass practically all tuning condensers generally used.

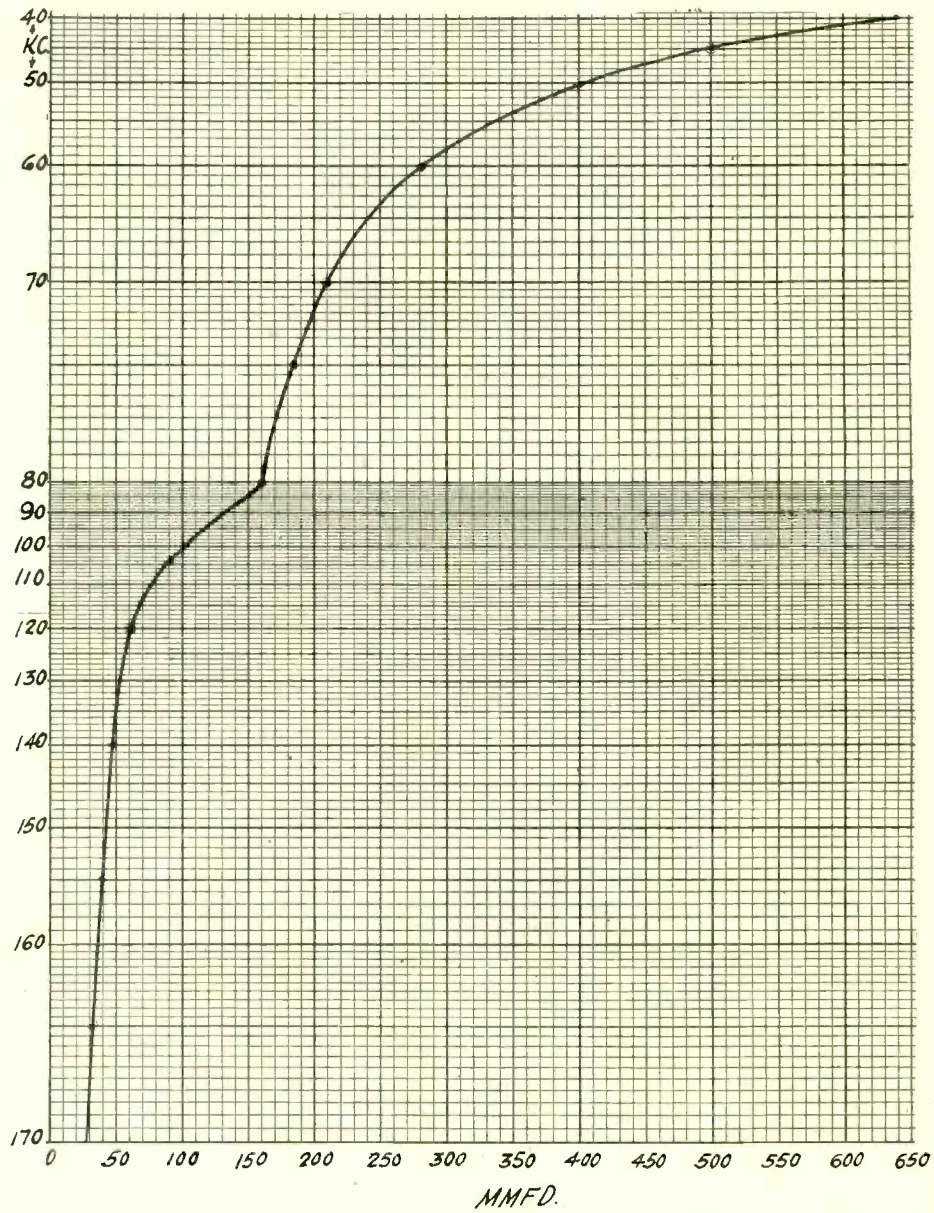


FIG. 1

Curve relating capacities of from 30 to 640 mmfd. with frequencies from 40 to 170 kc, based on an inductance of 25 millihenries. Such a curve is valuable in conjunction with a test oscillator's calibration, as determining the capacity entering into the frequency result. As a general rule, deduct 10 mmfd. from the value of capacity read from the curve, as an allowance for the distributed capacities.

How to Read the Curve

Read the frequencies on the left-hand upright column and the equivalent capacities on the horizontal, the result being at the intersection. The upright gradations are called ordinates, the horizontal ones the abscissas.

While the inductance of 25 millihenries is necessary to effectuate the curve, it scarcely can be wound by the experimenter, but is obtainable commercially at less than 50 cents.

The coil is not to be shielded, if the curve is to apply strictly.

Some ready checks may be made. For instance, 100 mmfd. crosses the frequency gradations at 100 kc. A check for 100 kc may be made if local stations are 50 kc apart. Beat the oscillator with one local station, leave the oscillator fixed, tune past the next local station on the set, 50 kc removed from the other station, no beat being expected here, and then to the next local 50 kc removed from the second one and 100 kc removed from the first one. This time there should be a squeal. It would be due to a harmonic of the test oscillator beating with a station, and the difference in frequency between the two stations causing the beats equals the fundamental of the oscillator. In this instance it would be 100 kc.

Some idea has to exist as to what the dial setting would be. On straight line capacity condensers of the order of 350 mmfd. maximum the dial position may be around 30, assuming dial numbers increase with capacity; for midline condensers or others approximately of that nature the reading would be about 50, and for straight frequency line condensers it would be around 65.

Measuring Unknown Capacities

On the curve it would appear that 640 mmfd. actually was reached, but no condenser of such capacity was used, since the curve is based on computation. In the oscillator discussed, the lowest frequency was not quite 40 kc, and the capacity of the condenser at that setting was 580 mmfd.

Due to the distributed capacities, con-

(Continued on next page)

COMPARISON of TUNERS

Tuned-Grid, Tuned-Plate and Tuned-Grid-Tuned-Plate Contrasted in Respect to Selectivity and Gain

By Einar Andrews

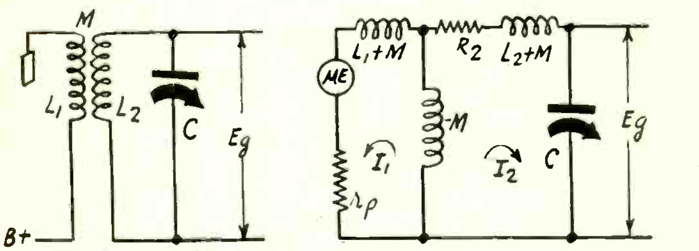


FIG. 1

A tuned-grid coupler with its equivalent circuit. It has one frequency of maximum gain. Selectivity is good and the gain at resonance is high.

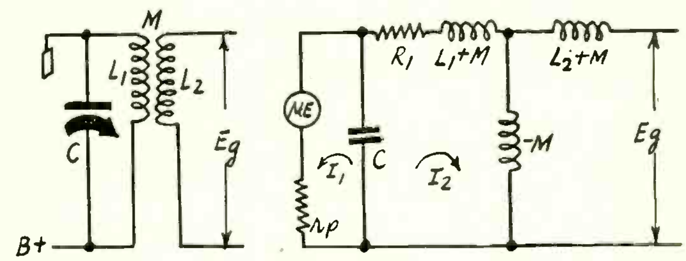


FIG. 2

A tuned-plate coupler with its equivalent circuit. It has one frequency of maximum gain. Neither gain nor selectivity is as good as for the tuned grid coupler.

HOW DO THE THREE tuners, the tuned-grid, the tuned-plate, and the tuned-grid-and-plate, compare in respect to selectivity and gain?

In Fig. 1, at left, is a typical tuned-grid tuner in which L_1 is the primary inductance, M the mutual inductance, L_2 the secondary inductance, C the tuning capacity, and E_g is the voltage across the tuning condenser, which is also the voltage impressed on the grid of the next tube. At right is the equivalent circuit obtained on the assumptions that there is no grid current, either through the tube or through a grid leak, and that the plate to cathode capacity is negligible. In the equivalent circuit rp is the internal plate resistance of the first tube, u is the amplification factor of that tube, I1 is the current in the primary, I2 is the current in the secondary, and R_2 is the resistance in the secondary coil. The voltage gain ratio is E_g/E, in which E is the voltage impressed on the grid of the tube ahead.

Solving the Circuit

The equivalent circuit can easily be solved for E_g in terms of the amplification factor and the various resistances and reactances entering into the circuit. The mathematical work is complex but the solution is relatively simple. It is

$$A = \frac{uM}{r_pR_2C + k^2L_1}$$

in which A is the gain at the resonant frequency and k is the coefficient of coupling between the primary and secondary coils. To arrive at this result it was necessary to neglect a small term affecting the frequency of resonance, but this term is extremely small and no appreciable error is introduced by neglecting it. The frequency of resonance is determined entirely by L2 and C in the approximation.

The equation shows what affects the amplification at resonance and in what manner it is affected. First, the gain is directly proportional to the mutual inductance between the windings, provided that the second term in the denominator is negligible in comparison with the first. In most practical cases it usually is. It is common experience that the gain of a coupler goes up as the mutual inductance between the windings is increased. The equation also shows that the gain is reduced as the internal resistance of the tube is increased, as the resistance of the tuned coil is increased, and also as the tuning capacity is increased. These facts are also common experience.

Values Inserted

Now let us substitute reasonable values in the formula to see what amplification we can expect. Let L1 = 125 microhenries, L2 = 250 microhenries, u = 1,280, rp = 800,000 ohms. These are typical values in a broadcast tuner when the tube is a 58. We may also assume that the coupling is 0.75, making M = 133 microhenries. With these values in the formula it becomes $170{,}000/(0.8R2C + 70.3)$, in which C is expressed in micromicrofarads.

Now at 550 kc we can assume a resistance of 5 ohms for R2, and the capacity will be 335 mmfd. Hence at this frequency the maximum gain will be 120. That is a reasonable value. At 1,500 kc we can assume a resistance of 25 ohms in the resonance coil, and at this frequency the capacity will be 45 mmfd. Hence the maximum gain at this frequency will be 175. This is also reasonable as it is consistent with experience.

Selectivity

The selectivity of the circuit is dependent on the effective value of the resistance in the resonant circuit. In the absence of the primary, or when the mutual inductance is zero, the resistance in the secondary is simply R2. When M has a finite value greater than zero the resistance is augmented by k^2L1/Crp. That is, the increase in the resistance is proportional to the square of the coefficient of coupling and to the primary inductance, but it is inversely proportional to the plate resistance of the tube and to the capacity of the condenser. Remember that this refers to the increase in the effective resistance and not to the total resistance.

Let us substitute the same values as we used in obtaining the maximum amplification. Then we have for the total resistance $R2 + 87.8/C$, in which C again is measured in micromicrofarads. Using the values of R2 and C as before we have for the total resistance at 550 kc 5.262 ohms and at 1,500 kc 26.95 ohms. At 550 kc the total resistance was increased by 5.24 per cent. and at 1,500 kc by 7.8 per cent. Therefore, at neither frequency has the resistance increased greatly, and hence the selectivity has not decreased much.

By expressing the selectivity as the ratio of the inductive reactance to the effective resistance we get 165 at 550 kc and 87.5 at 1,500 kc. These are probably higher than actual values but they are relatively about

Capacity Measurement

(*Continued from preceding page*)

densers rated at 0.00035, 0.000367, 0.00037 mfd., etc., all may be expected to reach or almost reach 50 kc. But since a low-frequency region is covered, a condenser of 0.0005 mfd. rating, which rating actually will be exceeded in the case of the G. R. 247, may be used to advantage.

The service of a test oscillator is extended when capacity information is at hand, because condensers within the correctly measurable range of the tuning condenser may be measured as to capacity by substitution. If the unknown is put across the coil instead of the tuning condenser, and the frequency of response noted, by beating with a broadcast set or with another test oscillator, then the same frequency can be duplicated when the tuning condenser alone is restored, the capacity read from the curve and assigned to the unknown condenser. Of course, by extending the curve, still higher capacities may be measured, until the capacity is almost so high that there would be no oscillation, which is below 20 kc, as determined by tests. While the curve is intended only to cover capacities up to about 600 mmfd. (0.0006 mfd.), the following data are furnished as a guide to tests for larger capacities, using the same 25 mlh coil:

Mfd.	*kc.*
0.00156	25
0.0025	20
0.0035	17
0.005	14
0.007	12
0.01	10

In actual tests with this coil there was not much oscillation below 20 kc, but the 20 kc point can be verified by the squeals obtained at every second channel on a broadcast set, if care is taken to exclude dial regions that yield squeals on 5 kc separation, due to Mexican or other foreign stations. Of course a selective receiver, preferably of the tuned-radio-frequency type, should be used.

right. They will do for comparison with the other tuners.

Tuned Plate Circuit

In Fig. 2, at left, is a typical tuned plate L1 is the tuned coil, M is the mutual inductance, and L2 is the secondary inductance. E_g/E, as before, is the amplification. At right in Fig. 2 is the equivalent circuit. R1 in this case is the resistance in the resonant coil.

This circuit is solved in exactly the same way as the other, and the result is

$$A = \frac{uM}{r_pR_1C + L_1}$$

The maximum gain is therefore directly proportional to the mutual inductance, and in this case it is true in all instances since k does not appear in the denominator. It decreases as each of rp, R1, and C increases, and it also decreases as L1 increases.

If we use the same values as before, except that L1 and L2 are reversed, we get 116 as the gain at 550 kc and 165 at 1,500 kc. Thus the maximum amplification is less for the tuned plate coupler at all frequencies. But it should be remembered that the two coils were reversed, so that in this instance we have a step-down of voltage. If we make the secondary inductance equal to that of the primary and retain the same coefficient of coupling, the two amplification values in this instance become 164 and 233 in place of 116 and 165.

To make a true comparison we should have the same inductances in both cases without a step-down or a step-up of voltage. Suppose we make both L1 and L2 equal to 250 microhenries and retain the 0.75 coefficient of coupling. Then at 550 kc we have a gain of 151 for the tuned plate and a gain of 162 for the tuned grid. At 1,500 kc we have a gain of 208 for the tuned plate and a gain of 230 for the tuned plate. Hence if the gain is to be greater for the tuned plate coupler there must be a step-up ratio.

Resonance Comparison

This gain comparison was all in favor of the tuned grid circuit, although the gain can be increased in the tuned plate circuit readily by using a step-up ratio in the coil system.

New let us investigate the effective resistances of the tuned plate coupler. In the tuned coupler the effective resistance in the resonant primary is $R1 + L1/Crp$. Thus the increase in the resistance is directly proportional to the inductance, inversely proportional to the capacity and also inversely proportional to the resistance of the tube. These proportions apply to the increase only and not to the total resistance.

Since the inductance is fixed at 250 microhenries and the resistance of the plate to 800,000 ohms, in the values we have used for comparison, the effective resistance reduces to $R1 + 312.5/C$, in which C is expressed in micromicrofarads.

At 550 kc our assumed R1 is 5 ohms and C is 335 mmfd. Hence the effective resistance is 5.932 ohms, an increase of 18.64 per cent. At 1,500 kc the effective resistance is 31.94 ohms, an increase of 27.76 per cent. Therefore the percentages of increase in the resistance are much higher for the tuned plate coupler than for the tuned grid coupler.

If we express the selectivity in numbers as we did before, we obtain at 550 kc 147 and at 1,500 only 73.8. At both frequencies the numbers are less than the corresponding values for the tuned grid coupler. We conclude that the tuned-plate coupler is not as good as the tuned-grid either for selectivity or gain. But we can increase the gain, without altering the selectivity, of the tuned-plate coupler by using a step-up ratio in the transformer.

Tuned Grid and Plate

The tuned-grid, tuned-plate is really a band pass filter and is not directly comparable with either of the other two couplers.

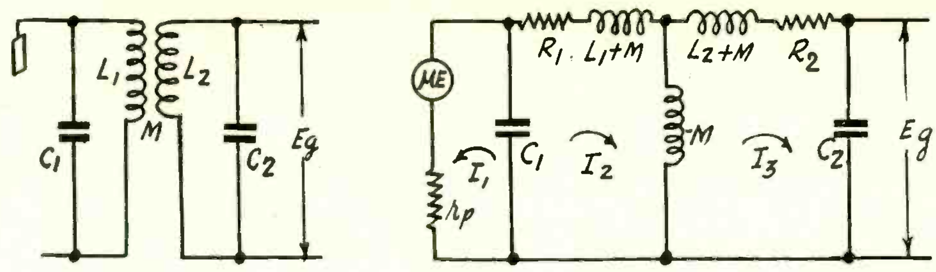


FIG. 3

A tuned-grid, tuned-plate coupler with its equivalent circuit. It has a band pass characteristic as well as high gain in the pass band region.

The circuit is shown in Fig. 3, at left, and at right in the same figure is the equivalent circuit.

For simplicity in solving this circuit we shall assume that the two circuits are identical when standing by themselves, so that $R1 = R2 = R$, $L1 = L2 = L$, and $C1 = C2 = C$.

The solution shows that there are two frequencies at which the gain is maximum. One is determined by $W^2 = 1/C(L - M)$ and the other by $W^2 = 1/C(L + M)$. As in the previous cases these are approximations, but they are entirely justifiable when the resistances of the coils have values ordinarily met in tuners.

Width of Band

It is observed that the two frequencies of maximum response are closer together the smaller the mutual inductance is. If the two frequencies are $F + f/2$ and $F - f/2$, then we have $M = FfL/(F + f^2/4)$ as a relation between the mutual inductance M, the inductance L, the arithmetical mean frequency F, and the frequency difference f between the two maxima. If f is small compared with F we may write the equation $M = fL/F$, and we may take the arithmetical mean frequency of symmetry of the resonance curve, which would be the carrier frequency in the case of a superheterodyne intermediate.

Suppose that the intermediate frequency of a superheterodyne having this type of coupler is 450 kc and that the frequency difference is 10 kc. This will allow for sidebands 5 kc wide. Then $f/F = 0.0222$, and $M = 0.0222L$. Now suppose that the capacity across each L is 100 mmfd. Then the value of L is 1.25 millihenries. Therefore $M = 27.8$ microhenries. That represents very loose coupling. The coefficient of coupling is 0.0222, or the same as the ratio of the frequency difference between the two maxima to the mean frequency F.

Shape of Transmission Curve

Between the two frequencies at which the gain is maximum, or at the carrier frequency F, the gain is a minimum, but at this minimum it is nearly as great as at the two maxima, provided the coupling is loose. If the coupling is tight the gain at the mid-frequency may be quite low, and if the coupling is very loose the two maxima merge into one at the frequency where there was a minimum before. Just how loose the coupling should be so that the two maxima should merge depends on the resistances in the two tuned circuits. The less the resistance, the looser the coupling must be.

Beyond the maxima the gain in the tuned-plate, tuned-grid coupler falls more rapidly than it does in either of the simpler circuits. But between the two frequencies there is comparatively little change in the gain. Herein lies the advantage of the band pass coupler. It has less cutting of the higher side frequencies, yet greater suppression of frequencies beyond the desired range. Therefore it results in better quality and less interference.

Coil to Coil Capacity

When there is capacity between the two windings of a transformer the simple relations do not hold, for the capacity either adds to the coupling or subtracts therefrom, depending on the sign of the mutual. A radio frequency coil can be constructed so that this capacity is negligible even though the coupling is fairly close. In the case of the tuned-plate, tuned-grid coupler, the coils must be placed rather far apart in order to yield the proper low mutual. This also reduces the distributed capacity between the coils so that in most instances it may be neglected. Again, improvement can be effected by proper construction. For example, if the two coils are placed concentrically, or end to end, the low potential ends can be placed toward each other. This will place the high potential ends farther apart and at the same time they will be partly shielded from each other by the two coils. The effect of the capacity will be less. Similar construction can be followed in radio frequency tuners.

66 Frequencies Given To Byrd's Flagship

The first permanent marine unit of a radio network has been granted an operating license with the call letters KJTY. It is located on board the S.S. Jacob Ruppert, flagship of the Byrd Antarctic Expedition. The Federal Radio Commission license grants the station fifteen frequencies for the transmission of voice and fifty-one frequencies for telegraphic communication.

The new sea-going studio will be located on the afterdeck of Byrd's ship. A thousand-watt transmitter, microphones and associated appartus are now being installed on the ship at its Boston drydock.

KJTY will be used for special broadcasts while the Jacob Ruppert is en route to the Antarctic ice barrier. At the barrier the broadcasting equipment will be transferred to the S.S. Bear, which will penetrate the frozen wastes to Byrd's base in Little America. There a new station will be set up to handle the regular weekly programs in which Admiral Byrd and the members of his expedition will report on the progress of their explorations.

John N. Dyer, CBS engineer accompanying the expedition, will direct the technical affairs of KJTY, and a combination production man and announcer, yet to be selected by Columbia, will be the station manager.

The voice frequencies granted the station are 6,650, 6,660, 6,670, 8,820, 8,840, 13,185, 13,200, 13,230, 13,245, 13,260, 17,600, 17,620, 21,515, 21,600 and 21,625 kc.

WBNX GETS FOREIGN SONGS

Edward Ervine, program director of WBNX, New York City, announced that the station has obtained a license from the Society of European Stage Authors and Publishers that gives it access to some 60,000 songs controlled by twenty-six German, Austrian, Italian and Spanish publishers. Among those authors whose music will be available are Franz Lehar, Oscar Strauss, Jean Gilbert, Richard Strauss and Sibelius. There are comparatively few American stations licensed by the Society. Among those who are not are the two national networks, says WBNX, which is associated with the Amalgamated chain, now in regional status.

A CONSTANT-GAIN COUPLER

Adjustment at Frequency Extremes for Flat Characteristic

By J. E. Anderson

METHOD OF EQUALIZATION

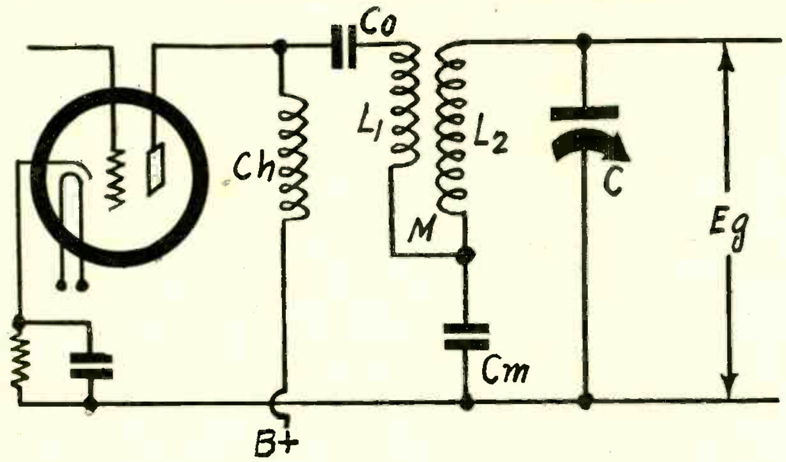


FIG. 1

A constant-gain coupler in which the gain may be made equal at the two end frequencies and only slightly less at the geometric mean frequency.

APPROXIMATELY uniform coupling over the tuning range of a receiver can be effected by combining mutual inductive and capacitive coupling and by proportioning the two so that at any two extreme frequencies the coupling is the same. The arrangement of the circuit is shown in Fig. 1. Here the coupling is the sum of the couplings of the condenser Cm and of the mutual M between the two coils L1 and L2.

Ch is only a radio frequency choke which is supposed to have such a high reactance that it may be neglected when it is in shunt with the other reactances. Co is merely a stopping condenser. Its capacity is supposed to be so large that the reactance can be neglected, considering the condenser is in series.

Sign of Couplings

The sign of the coupling by the condenser is always negative. That of the mutual inductance may be either positive or negative. But if the couplings are to add up, the inductive coupling must be negative as well as that of the condenser.

The total coupling between the primary and the secondary circuits, disregarding sign, is $Mw + 1/C_m w$. Now if the coupling is to be the same at two frequencies w_1 and w_2, we have the equation

$$Mw_1 + 1/C_m w_1 = Mw_2 + 1/C_m w_2$$

whence $MC_m = 1/w_1 w_2$. This gives us a relation between the values of M and C_m and the two frequencies selected to give equal coupling. The mutual and the capacity are to be chosen so that they resonate at the geometric mean frequency of the two selected. Naturally, we would select the highest and the lowest frequencies in the band covered by the tuner. Therefore the two coupling media should resonate at the geometric mean, which in the broadcast band is around 910 kc, or 900 kc if we take the highest broadcast frequency as 1,500 kc and the lowest as 540 kc.

Degree of Coupling

The relation obtained says nothing of the degree of coupling. It is clear that if we increase both the mutual and the capacitive couplings the total coupling at any frequency will be greater, or if we decrease both we decrease the total coupling at any frequency.

Let us assume that the total coupling at either frequency is equal to that afforded by an inductance equal to L at the geometric mean frequency. Then we can write

$$Mw_1 + 1/C_m w_1 = L(w_1 w_2)^{1/2}$$
$$Mw_2 + 1/C_m w_2 = L(w_1 w_2)^{1/2}$$

Solving these equations for M and C_m we obtain

$$M = L(w_1 w_2)^{1/2}/(w_1 + w_2)$$
$$C_m = (w_1 + w_2)/w_1 w_2 L(w_1 w_2)^{1/2}$$

These two give the values of the mutual and the capacity in terms of the two frequencies selected and in terms of the arbitrary L. All we have to do now to determine the degree of coupling is to select a suitable value for L.

L really determines the coupling where this is least, or at the geometric mean frequency. At both w_1 and w_2 the coupling is a little greater, but whatever it is at one frequency it is the same at the other.

Values Selected

Let us take L = 20 microhenries. That is to say, we assume that the coupling at the geometric mean frequency is the same as it would be with a mutual between the coils of 20 microhenries, without any capacity coupling. We shall also assume that the two extreme frequencies are 1,500 and 540 kc. Then the geometric mean is 900 kc. Then M = 8.82 microhenries and C_m = 3,540 micromicrofarads.

With the values of the coupling devices the sum of the two reactances at 1,500 kc is 113 ohms and at 540 kc it is also 113 ohms. But at the geometric mean frequency it is only 99.8 ohms. The coupling due to 20 microhenries at 900 kc is also 113 ohms, which is a check on the computation. The difference between 99.8 and 113, in terms of transmission units, is only about 1 db., being down at the geometric mean frequency by this amount.

If we had used inductance coupling only, say 20 microhenries, the coupling reactance at 540 kc would have been 68 ohms and at 1,500 kc, 188.9 ohms. As compared with the coupling at 1,500 kc it would have been down by 8.86 db. A similar ratio would have resulted had we used capacitive coupling alone, but the gain would have been down at the high frequency. Thus by the use of both inductive and capacitive coupling we have achieved nearly uniform effective coupling throughout the tuning band.

Frequency of Resonance

Since the coupling condenser C_m is in the tuned circuit it will naturally affect the frequency of resonance a little. Indeed, as far as the tuning is concerned the two condensers C_m and C are in series. But if the total coupling is loose, as in the case assumed, the coupling condenser is so large that for practical purposes the tuning condenser C alone determines the frequency. The greatest effect of the coupling condenser occurs when the tuning condenser

(Continued on next page)

Marconi to Listen for Byrd Broadcasts

The proposed broadcasts from the Little American base of the Byrd Antarctic Expedition are entirely feasible, Senatore Guglielmo Marconi informed Edwin K. Cohan, technical director of the Columbia Broadcasting System, representing Admiral Byrd in radio matters, in an interview in New York City. At the same time Senatore Marconi accepted membership on an honorary advisory committee on radio for the expedition.

Marconi, after discussing the frequencies to be used in the broadcasts and the radio equipment to be taken to the Antarctic, told Cohan:

"I think the project is entirely feasible and the manner of carrying it out is very sound."

Learning that the frequencies to be used range from the 8 to the 23 megacycle band, Marconi pointed out that it is possible for signals transmitted in the 23 megacycle end of the spectrum to be heard around the world, and that, therefore, it may be possible some time during the expedition's stay in the Antarctic to transmit voice direct to New York, instead of relaying it through a short wave station at Buenos Aires, as will be done with their weekly broadcasts.

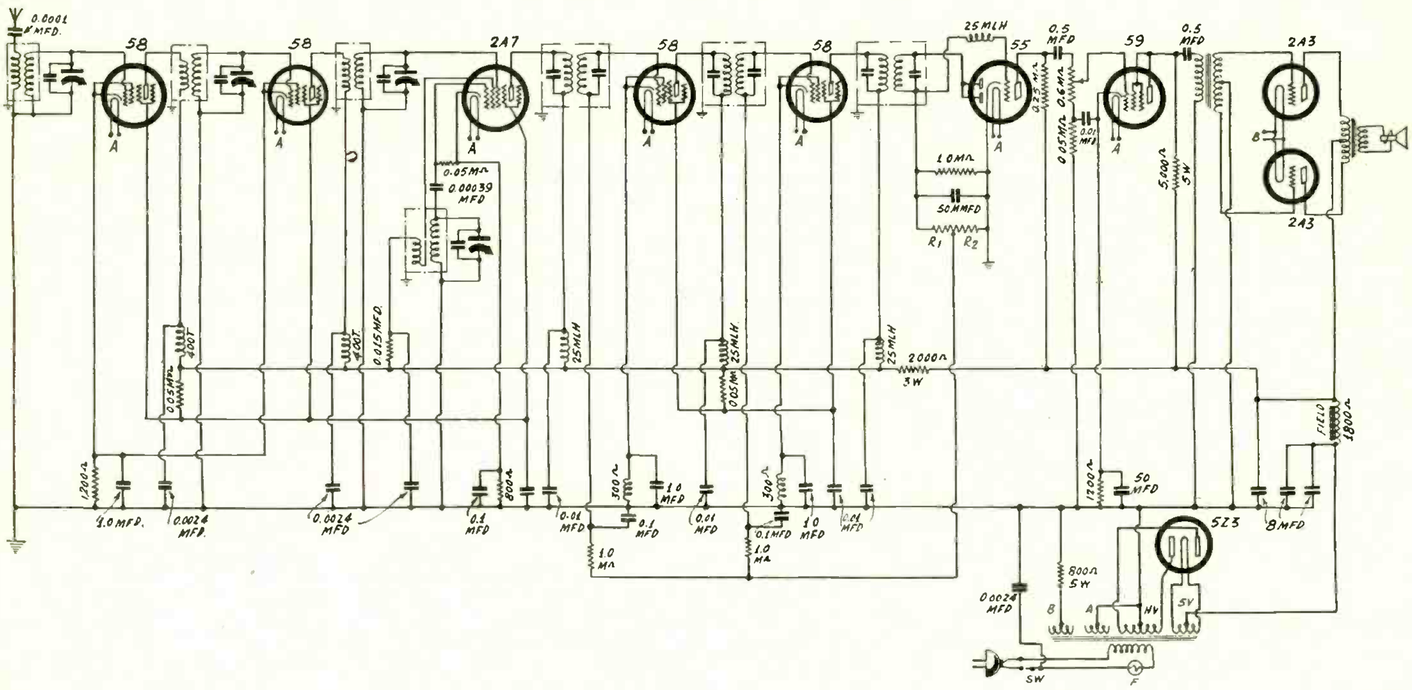
Marconi signified his interest in the outcome of the broadcasts by saying he will establish a listening post either aboard his yacht, "Elettra," or somewhere in Italy to keep in touch with transmission from Little America. Cohan offered to collate all technichal data accumulated during the period of the broadcasts, and Marconi, in turn, said he would be glad to supply Cohan with his findings in connection with the work.

Valuable data are expected.

A 10-TUBE SUPER

With Proper Constants for Undistorted Loading

By Herman Bernard



The problem at the second detector is solved as to giving sufficient swing to the diode even on weak stations by using half-wave rectification and thus creating a large voltage input. The triode of the 55 would not stand the full amount unless automatic volume control were included, and lest there be too much such control, half or less of the diode-rectified voltage is put into the 55. The following tube has to be of the power type, hence a 59 as triode was chosen. This drives the push-pull output tubes.

IN last week's issue a seven-tube superheterodyne was discussed, and this week the same "front end" is shown, but there are two intermediate stages, instead of one, and three stages of audio instead of two, the output being push-pull instead of single-sided. Thus three more tubes are required, 10 in all.

The introduction of the second i-f stage results in a gain of around 200 more, and, as previously intimated, it is easily possible to obtain greater gain than can be used. A check may be put on the gain, so that it will not cause distortion in the triode of the 55, which is the chain's weakest link now, by adjustment of the amount of automatic volume control.

Selection of R1 and R2

If the full amount is used, then local stations in urban centers would develop around 6 volts of rectification at the diode, and since it is practical to double this as 55 triode input, less than the total rectification may be used for a.v.c. If two equal resistors are used for R1 and R2, each say 0.5 meg. or higher, then half the rectified voltage of the diode is used for a.v.c. If R1 is made twice as great as R2, the controlled tubes' grids always returned to the juncture, then one-third of the total rectified voltage is used. Thus if the parallel load resistor is a potentiometer of high resistance, a.v.c. connected to arm, the adjustment may be made once for any location and left thus.

The adjustment is easy enough, as it is made for maximum sensitivity consistent with total absence of double-hump tuning on the powerful locals. If there were a duodiode-triode tube with triode of power tube characteristics this precaution would not be necessary. Of course the same result could be obtained by ignoring the triode in the 55, but since it is there it may as well be used to feed the driver of the output tubes.

59 Drives Push-Pull Pair

The driver in this instance is a 59 used as triode, Class A, grids, other than control grid, connected to plate. Under these circumstances a 5,000-ohm plate load is satisfactory, the bias may be a little under 30 volts and the current then will be somewhat under 30 milliamperes.

Under these conditions the power tubes will be the first to overload, which is desirable, and the full 10 watts power output may be obtained whenever enough is delivered to the output tubes to render this possible, which should be true for practically all local stations.

The volume control has a tone control adjunct, intended to hold up the low-note response, otherwise attenuated at low grid load values. The higher audio frequencies are reduced a great deal more than the lower ones at lower volume settings of the control. The effect can be adjusted by the values of permanent resistance and capacity. If less such effect is desired, a smaller condenser may be used, and if the volume at minimum is too high to suit one's taste, the resistance may be decreased to 0.01 meg.

The 5Z3 will stand 125 ma, and this circuit taxes that rectifier to the fullest.

(Continued on next page)

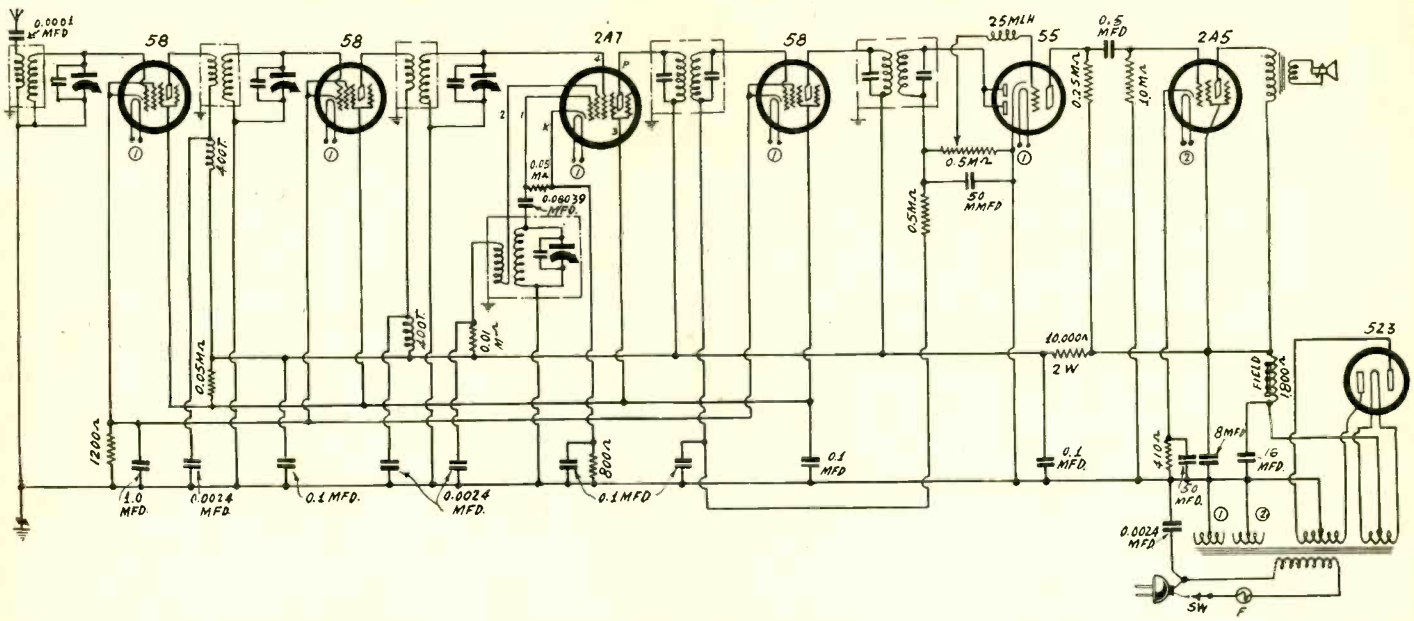
Coupling Redistributed by Compensator-Filter

(Continued from preceding page)

has the largest value, that is, at 540 kc. If the tuning condenser then has a value of 350 mmfd., the total effective capacity in the resonance circuit is 318 mmfd. Thus to tune to 540 kc we would need a tuning inductance of 272.5 microhenries. Therefore, to tune to 1,500 kc we would need a total capacity in the resonant circuit of 41.25 mmfd., when the tuning condenser C would have to be set at 41.7 mmfd. Hence there is no difficulty in covering the tuning band with the arrangement. With a tighter coupling between the two circuits the coupling condenser would be larger, and it would not be quite so easy to cover the band.

The constant gain coupler serves two purposes. First, it increases the coupling at the low frequency end of the tuning range, and second, it decreases it at the high frequency end. Such a coupler is very useful in a radio frequency circuit, but less so in a superheterodyne where most of the amplification is done at a single frequency. But even in a superheterodyne in which several t-r-f stages are used, the coupling might be advantageous. If a tracking condenser is used in the super there might be complications and difficulty in tracking, but if the paddin- method is employed there is no difficulty, for the series condenser could be adjusted to allow for the changed rate of change of capacity in the tuned-radio-frequency circuits.

7-Tube Model of Excellent Super



This is the seven-tube model, discussed in detail last week, and since only the audio is different in the ten-tube model, the tuner discussion of last week may be applied to the circuit shown on preceding page. The only advantages of the larger model are more power output and somewhat increased selectivity, although if careful adjustments are made in constructing the seven-tube model this extra selectivity is not of great importance.

(*Continued from preceding page*)

If r-f chokes of high enough d-c resistance, which also implies very high inductance, are available they may be used also as the biasing resistors at the intermediate level. A seeming inconsistency is present, in that the bias on the intermediate stages is higher than that ahead. But it will be remembered that the requirement ahead is principally selectivity. Higher bias works in that direction. Lower bias for intermediate tubes that handle more voltage is satisfactory, because the signal voltage even so is less than the bias voltage, considerably less. At the intermediate level we are looking for selectivity of course, but there is plenty of that with three coils, two tuned circuits in each.

Seeming Inconsistency

What we are keen about is amplification and we obtain a large amount of it, in fact, more than we can use, and so we include automatic volume control, affecting two stages. Thus a wide swing of the control effect is accomplished. This is true even if only half of the total diode-rectified voltage is used.

The resistance in the plate of the triode-circuited 59 is shown as 5,000 ohms. This is acceptable but not imperative. If one has a resistor of 5 watts or greater power dissipation, two or three times as high as the specified 5,000 ohms, that may be used, but the biasing resistor would have to be increased considerably, until the biasing voltage is around 28 volts or so, anyway, which may be determined by ordinary meters, as the current still will be fairly high.

Bypass Condenser Not Needed

There should be no need for a condenser to bypass the biasing resistor of the push-pull stage. If there is a vast difference in favor of using the condenser then there is lack of symmetry in the circuit and it really isn't truly push-pull. The trouble may lie in the dissimilarity of the characteristics of the tubes, in the off-center tap of the interstage transformer, or similar condition in the primary of the output transformer. A test should be made on a no-signal so that with a meter in one power tube plate circuit and then in the other, the plate current should be the same. This static test is good enough also to serve as a dynamic test for the low frequencies, since the impedances are practically the same as the d-c resistance at 60 cycles or so. Dynamic tests for higher audio frequencies are probably beyond the scope of the instruments in most of the readers' workshops, homes or laboratories.

There is 16 mfd. shown next to the rectifier. Not always does this doubling of the normal capacity do any good. Try 8 mfd. and then another 8 mfd. in parallel with it, and if there is no improvement from the extra 8 mfd., why use only a single 8 mfd., or put the other 8 mfd. after the choke, or, preferably, after the 2,000-ohm 3-watt resistor. If any hum trouble develops, make that change at once, the extra 8 mfd. from B plus 250 volts to ground.

Police Radio 12 Years Old

The fast growth of municipal police radio systems, which sprang up almost everywhere during the past year or two, has given rise to a general belief that police radio is a comparatively new phase of the art. Yet such is far from being the case.

Perhaps the oldest municipal police radio installation is that of the New York police department, which began regular broadcasts of police information in 1921. But concurrently with the installation of this station, amateurs in such cities as Hartford, Conn., Dallas, Texas, and St. Louis, Mo., cooperated with local officials in sending broadcasts of crime information for local and district use.

Of course, the broadcasts of those early days were concerned with the announcement of crimes which had occurred, rather than the nipping in the bud of crimes in the making. Stolen automobiles and escaped convicts provided the most dramatic and important information conveyed. Such was the importance of this work in those early days that every police station in towns near-by the cities thus served was equipped with a radiotelephone receiver for the purpose of picking up the amateur broadcasts.

The pioneer step in this movement was undertaken in Hartford by the American Radio Relay League during the summer of 1920 to transmit immediately to all parts of New England details of stolen automobiles. An editorial in the November, 1920, issue of QST, the League's magazine for amateurs, urged the creation of similar systems in other cities. By the end of 1921 the police departments of many of the principal cities were receiving amateur cooperation along these lines.

The beginnings of police radio, along with all other branches of the radio art, can therefore be seen to lie in the genius and initiative of the radio amateur—and that a full ten years before it was generally accepted as a commercial enterprise.

Amateurs Now 42,000; Up 25,000 Since 1929

Hartford, Conn.—Leaving on his fourteenth semi-annual tour of the principal middle western and Atlantic seaboard cities, David H. Houghton, of the American Radio Relay League, stated that the unprecedented growth in amateur radio in the years of depression has not halted, and that the future of the art looks brighter than at any time during the past two decades.

The League is the national organization of these amateurs, who are to be found in every country of the world to a total of nearly 60,000. In this country alone the Federal Radio Commission has issued nearly 42,000 amateur station licenses. In 1929, when the crash came, there were only 17,000 stations. During the depression years which followed an increase of 250% was achieved over the figure which it had taken twenty-five years to build up.

As indicative of this continued progress, Mr. Houghton stated that for the first time in history no seasonal decline was observed in the distribution of League publications, which include its official organ, QST, and The Radio Amateur Handbook, as well as a number of smaller publications. Some of the latter were introduced during the past summer season, an unprecedented step in the radio field, but one necessitated by insistent demand.

RADIO FORMULAS

Solved with Aid of Slide Rule

By J. E. Anderson

THE PRINCIPLES of the slide rule and a few applications were discussed last week. We shall now pick out a number of formulas that frequently appear in radio and illustrate the application of the slide rule to them.

Perhaps the most common of these formulas is that which connects frequency, inductance, and capacity. It is $F = 1/2\pi(LC)^{1/2}$. The inductance L and the capacity C are supposed to be known. First of all we express both L and C in consistent units. Perhaps the best units to use, all things considered, are the henry and the farad. For illustration let L = 250 microhenries and C = 350 mmfd. To express these in henries and farads we simply express the prefixes "micro" and "micromicro" in powers of 10. "Micro" becomes 10^{-6} and "micromicro" becomes 10^{-12}. That is, the inductance is 250×10^{-6} henries and the capacity is 350×10^{-12} farads. Now we multiply farads and henries together and obtain a number $87{,}500 \times 10^{-18}$. The formula says we should extract the square root of this number. By the rule given for extraction of roots on the slide rule, we use the left cycle on the A-scale, because if we divide the number by 100 twice we get 8.75, which is between 1 and 10. The rule gives 2.96 as the square root. However, we must multiply this by 10 twice, since we divided the original number twice by 100. Hence the square root is 296×10^{-9}. The exponent of the power of 10 is a logarithm and we learned that to extract the square root we divide the logarithm by 2. Hence we get the exponent 9 in the result.

The Reciprocal

The formula also shows that we are to multiply the square root of LC by 2π. Doing this by the rule we get $1{,}862 \times 10^{-9}$. But this is equal to 1.862×10^{-6}, for the minus 9 means that we should divide the number by 10 nine times. Instead of doing it nine times we do it only three times and indicate by a minus 6 that we should do it six times more.

The formula shows also that we get the frequency by taking the reciprocal of the number we have up to this time. The reciprocal is 1 divided by the number. To take the reciprocal on the slide rule we set the number (1.862) on the C-scale on either index of the D-scale and read the result on the D-scale where the index of the C-scale is. The result of this manipulation is 0.5365. But the reciprocal of the power of 10 is the same power with the sign changed. Hence the frequency is 0.5365×10^{6}, or 536,500 cycles per second.

The actual work involved in making this computation, after a little practice, takes only a small fraction of the time it takes to tell how to do it.

As an aid in doing the work it is well to remember that the reciprocal of 2π is 0.159. Hence as soon as we have obtained the square root of LC we can divide 0.159 by this number. That is, we solve 0.159/2.96 by the rules and get the sequence 5365. The decimal point can be located by inspection after a little practice.

Computing a Series

Now it may be that either L or C assumes many values while the other remains constant. In that case it is simpler to reduce the problem so that there is only one constant. For example, let L have the fixed 250 microhenries and let C vary, that is, assume different values. Let it be required to find the frequency corresponding to each value of C. The constant factor reduces to 10.05, and this constant we are to divide by the square root of the various values of C. That is, the formula has been reduced to $F = 10.05/(C)^{1/2}$. It is convenient in this case to divide the square root of C by 10.05 and to take the reciprocal, for that can be done in fewer operations on the rule.

Let the first value of C be 350 mmfd. The square root of C is obtained by setting the runner to 350 on the left cycle of the A-scale and reading at the runner on the D-scale. But we are not interested in the square root of C. Hence we leave the runner where it is and slide 10.05 on the C-scale to it and read the quotient at the index of the C-scale on the D-scale. But we are not interested in this quotient, but rather in its reciprocal, and this we read on the C-scale over the index on the D-scale. Hence to solve the problem we set the runner once and the slider once and then only read the desired result. This operation is done quickly for each value of C. The same constant factor is used each time as long as the inductance has not been changed.

The result of this computation, of course, is 536,500 cycles, as we found previously. Now let the value of C be 250 mmfd. This time the result is 635,000. Next let the capacity be 150 mmfd. The result is 820,000. Next let C be 80 mmfd. Now the question arises as to which 8 shall be used on the A-scale. Well, we ran off the A-scale at the left. We start again on the A-scale at the extreme right and select the first 8 we come to, which is on the right cycle. The result of the setting is 1,122,000. We did not really select the 8 on the right cycle for the reason stated above but because 80 lies between 10 and 100. Had we jumped from 150 mmfd. to 8 mmfd. we would have had to select the left cycle, and then we would have got the frequency 3,550,000.

This series of examples illustrates amply the simplicity of computation when only one factor varies.

Obtaining L or C

Just as the frequency was obtained when the capacity varied and the inductance was constant, so can it be obtained when the capacity is fixed and the inductance varies. But this problem does not occur often.

A problem that does occur frequently is to obtain the inductance in terms of the frequency and the capacity, or the capacity in terms of the frequency and the inductance. This is simple. We rewrite the frequency formula as $L = 1/4\pi^2F^2C$ or as $C = 1/4\pi^2F^2L$, according to whether we want the inductance or the capacity.

As far as the slide rule manipulations are concerned these problems are identical. However, two cases occur. We may, for example, want to find the inductance when the frequency is fixed and the capacity varies, or when the capacity is fixed and the frequency varies. The first thing to do in this case is to find the reciprocal of the numeric. This is 0.0253, a number that always occurs in the problem and therefore should be remembered. It is $1/4\pi^2$.

Let us first suppose that the capacity is to be found and that the inductance has the value 250 microhenries. The simplest way to treat the problem is to reduce the constant term so that the equation can be written $C = (10.06/F)^2$. The constant in this equation is the result of solving for the constant term and then extracting its square root. This is done because it greatly simplifies the solution when F assumes many different values. To find C. 10.06 is divided by F and the square is taken. The slider is set once for all on 10.06 on the D-scale and each value of F on the C-scale is set to the runner. The result is read on the A-scale over the C-scale index. Again a whole series of values can be obtained by simple manipulations. After the runner has it involves only sliding the slider and reading at the proper place.

LC Constant Problem

The other combination under the frequency formula that was mentioned does not occur frequently, although there are tables covering the case in many radio books. To illustrate this let L be found when F is constant and C varies. Suppose F has the value 550 kc. The constant now is $0.0253/550{,}000^2$, or 0.0836×10^{-12}, which is to be divided by the various values of C. Now if C is expressed in micromicrofarads, the formula reduces to $L = 0.0836/C$, L being expressed in henries, or to $L = 83{,}600/C$ if L is expressed in microhenries. For ordinary radio problems this is the simplest form in which to leave. To solve the problem for any value of C, the runner is set to 863 on the D-scale and the C on the C-scale is moved to it. L is read at the index on the C-scale on the D-scale. This is only division by the slide rule.

If C is to be found in place of L, the problem and the constant are the same except that the value of L is set to the runner.

Finding Reactance

The reactance of an inductance coil is equal to $2\pi fL$, f being expressed in cycles per second and L in henries. In this either f may be constant and L vary or L may be constant and f vary. One problem occurs about as often as the other. On the slide rule the two are identical.

Suppose that L is constant at 250 microhenries and that f varies from 550 kc to 1,500 kc. To find the reactance X in ohms. We have $X = 2\pi \times 250 \times 10^{-6}f$, or if f is expressed in megacycles, $X = 2\pi 250f$. The constant factor in this case is 157.08. Hence $X = 157.08f$, where f is in megacycles and X in ohms. It is simple multiplication by the slide rule. The index of the C-scale is set to 157.08 on the D-scale and then the reactance is read under f of the C-scale on the D-scale. It may be necessary to interchange the indexes once if f assumes many different values.

Capacitive Reactance

Capacitive reactance may be obtained in exactly the same way, except that instead of reading the product, the reciprocal is read. But there is a simpler way, namely, finding the reciprocal of the constant and then dividing this by the frequency. Suppose that the capacity is 350 mmfd. Then we have $X = 455/f$, where f is in megacycles. Thus we set the runner on 455 on the D-scale and slide the number f to it. It is ordinary division on the slide rule. Only the slider need be moved to the different values of f.

Power Computations

Power is computed by one of the following formulas: $P = IV$, $P = RI^2$, and $P = V^2/R$. The first of these is used when the current and the voltage are known. It involves simple multiplication on the slide rule. One, say the voltage, may be constant and the current may vary. In that case the runner alone need be moved after the first setting in order to get the different products.

The second power formula is used when the resistance and the current are known. If the current is constant and the resistance varies, the formula is solved by simple multiplication in the same way as the previous example, but first the constant current square is found for setting the index.

PUSH-PULL RESISTAN
TUBES DRIVE

By Bruns

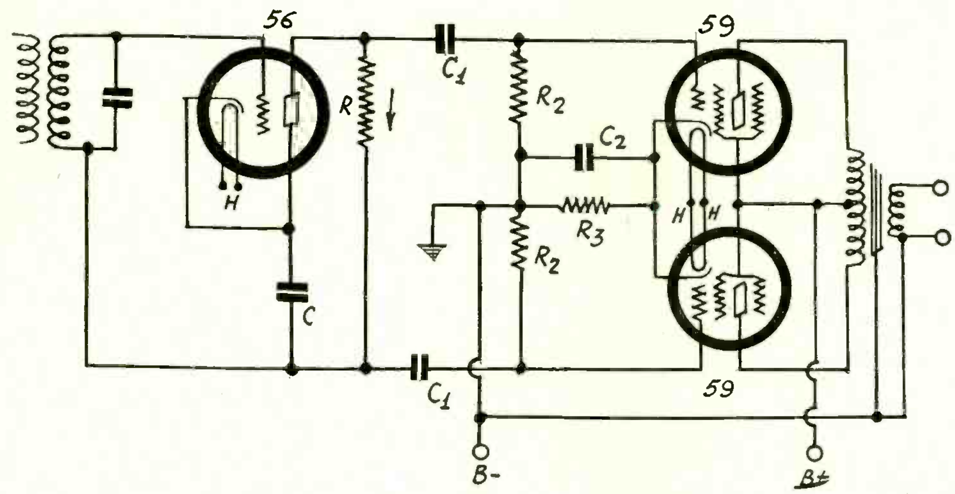


FIG. 1

A push-pull amplifier, using 59 output tubes, coupled to the diode detector by resistances. High quality is possible if the stopping condensers are made of the order of 0.04 mfd. or larger.

THE PROBLEM of coupling a detector to a resistance push-pull amplifier is ever with us. It has been solved in one way which does not offer many objections, and that is by the use of a diode detector immediately in front of the push-pull circuit. It is not entirely free from objections, of course, but they are minor in character.

In Fig. 1 we have a circuit in which a stage of two 59's is coupled to a diode detector, this tube being the 56. While the 55 or any other diode detector could be used here, there is no particular advantage in using one of the more complex tubes, for to use one of the others would merely require leaving a number of extra elements to dispose of, or to leave undisposed.

In this circuit the 56 is used only as a diode by connecting the plate to the cathode and by utilizing the grid as the anode of the rectifier. The load resistance on the diode is R, a high resistance, 0.5 meg. and up. This is hunted by the usual filter condenser C, which should not be more than 50 mmfd. Now if we do not ground any portion of the detector circuit, we can divide the signal voltage generated in R equally between any two tubes, such as the two 59's following. However, to do this without unbalancing the bias values of the 59's by the d-c component in R, we have to resort to the stopping condensers C1. These should be equal, although it is not absolutely necessary that they are equal if no part of the diode is grounded. Indeed, it is not absolutely necessary to use more than one of them for all we are interested in is that there shall be no d.c. flowing in either of resistors R2. But they might as well be equal.

Voltage Division

It is absolutely necessary that the two resistors R2 be equal, for they divide the signal voltage between the two output tubes, and if the resistors are not equal the voltages impressed on the 59's will not be equal. One condition for push-pull operations is that the voltages impressed on the output tubes be out of phase by 180 degrees. This condition will be satisfied by the grounding of the junction of the two R2 resistors, or rather by connecting the common cathode of the 59's to the junctions through the necessary grid bias resistor.

The 59 tube takes a bias of 18 volts so that across the two grid leaks we can stand a voltage of 34 volts. Since R is in shunt with the grid leaks and since the condensers C1 are so large that there is a negligible voltage drop in them. the signal voltage drop in R should also be 34 volts. It is an easy matter to get this drop from a strong signal on the input side of the diode detector. Indeed, we could get an even higher voltage if ecessary.

Since the diode circuit cannot be grounded at any point, we are limited in the choice of input circuit on the radio frequency side. The input that is shown assumes an intermediate frequency transformer. But we are not limited to that provided we do not put the tuning condenser on the diode side of the transformer. If we tune the primary we can also use the arrangement for a radio frequency circuit.

Objections to Circuit

The main objection to this type of coupler is that the voltage division will not be right at the high frequencies. The reason for this is not apparent, but it lies in the fact that the distributed capacities are not the same on the two sides of the circuit. Between that side which contains (a) the cathode and the plate and (b) ground the stray capacity is higher than it is between the grid side and ground. This will upset the balance on the higher frequencies. An easy remedy of this unbalance lies in putting a small condenser between the grid of the lower 59 and ground and in adjusting its value so that the capacity to ground is the same regardless of which side of the circuit is measured.

The other objection is that the coupling is not quite non-reactive. The signal must go through the two C1 condensers. Hence the gain will be less on the very lowest audio frequencies than on the medium frequencies. This defect can be partly remedied by using only one of the condensers, since only one is needed, or by making the condensers very large so that the reduction in the gain on all audible frequencies will be negligible. This approximation may be said to have been achieved when the product of the capacity of either condenser by the resistance of either resistor is 0.02 second, or larger. If we select 0.02 second as the smallest time constant that should be used, and if we use a grid leak of 0.5 megohm, the capacity of the condenser should be 0.04 mfd. That is not a large condenser and may be a leak-proof mica type condenser.

Use of Other Tubes

It is not necessary to use the 59 tubes in the output stage, for any other high-mu tubes would work equally well. They should be high-mu tubes so that they can be loaded up to the limit by a relatively small signal voltage. If low-mu tubes are used in the output stage, it would be necessary in nearly all sets to put in an intermediate radio stage. But there are now so many high-mu output tubes that seems no reason why a couple of them should not be used and thus avoid aonther stage of push-pull.

In case the output tubes are 59's, the grid bias should be 18 volts, for a plate voltage of 250 volts. The screen and plate current of each tube will be 44 milliamperes so the total current will be 88 milliamperes. Hence the grid bias resistor R3 should be a little over 200 ohms. As the stage is push-pull, the bias may safely be a little higher than 18 volts so that a bias resistance of 250 ohms would be all right.

Using Newer Tubes

The 2A5 is a splendid tube for a circuit of this type. In Fig. 2 is a circuit similar to that of that in Fig. 1 but using a pair of 2A5's in the output stage and a 55 as diode rectifier. Here both the control grid and the plate are connected to the cathode, and the two anode plates are joined together to form the anode in the rectifier circuit. As was stated before, no special advantage results from the use of a 55 over a 56. It is used in this circuit only to illustrate the connections.

As in the preceding circuit, R is the load resistor on the rectifier and C is the filter condenser across it. Each should have the same value as it had in the other circuit.

In Fig. 2 one of the stopping condensers has been omitted so that only one C1 is used in the cathode side of the circuit. It will be observed that, although only one condenser is used for stopping, no direct current from the rectifier can enter the push-pull input circuit and therefore no disturbance of the grid bias can occur from this cause. The omission of one condenser has this advantage that for the same values of the two R2 resistances and the same value for C1, the reproduction on the lowest audio frequencies will be twice as good, approxi-

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en Brunn

mately. For R2 we can use 0.5 megohm and for C1 0.04 mfd. However, if we use a 0.02 mfd. condenser the reproduction will be as good on the low notes as it was when two 0.04 mfd. condensers were used as in Fig. 1.

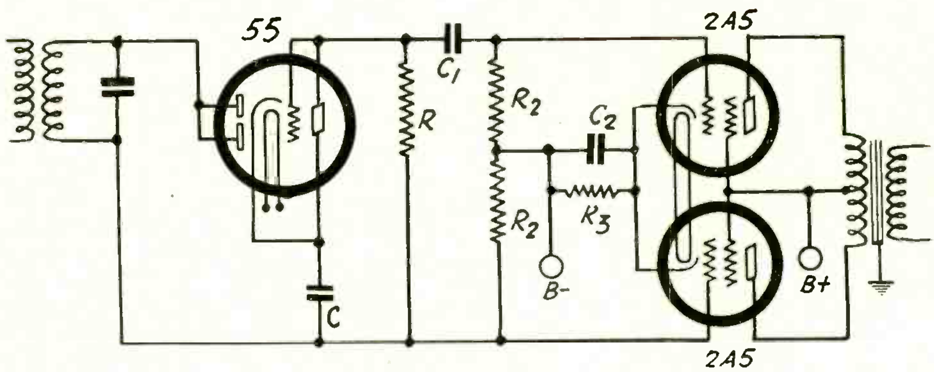


FIG. 2

This is the same circuit as that in Fig. 1 except that it employs two 2A5 tubes instead of 59s. The 55 detector here used may be used also in the other circuit. The 2A5 circuit is preferable.

Bias Adjustments

The amplification factor of the 2A5 is higher than that of the 59, and for that reason full output will result from less signal input. The maximum peak voltage that may be applied to the 2A5 is 16.6 volts, for that is the required bias. The screen current will be 6.5 milliamperes and the plate current 34 milliamperes. Hence the total current in the bias resistor R3 will be 81 milliamperes. Therefore the bias resistor should be a little over 200 ohms, or about the same as it was in the case of two 59's, and for the same reason the resistance used may be 250 ohms.

The unbalance at the high audio frequencies will be about the same as it was in the preceding case, and it may be compensated for in exactly the same manner.

Circuits of the type illustrated in Figs. 1 and 2 are not what might be called standard because they are not used in any commercial receivers, as far as the writer is aware. But they are commended to those who wish to try something a little out of the ordinary when the promise is good quality. It should be realized that the results depend on the adjustments made. The circuits in theory are balanced, but they will not balance themselves. It is necessary to select equal values for the resistances R2 and a large value for C1. As to C and R, the same considerations as for any other diode detector should be observed. It is of prime importance not to ground any part of the rectifier circuit. If the tuning condenser must be grounded, it should be placed in the primary of the transformer so that the secondary can be left ungrounded. Balance of the self capacity is also important if symmetry is to obtain at all frequencies in the audio range.

Method of Balancing Capacity

Balancing the capacity can be done in several ways, and it may be done accurately enough while the circuit is cold. Perhaps the simplest is by the use of an oscillator. Suppose a radio frequency oscillator is set up and made to beat with another oscillator, which may be a broadcast station. The condenser of this radio frequency oscillator is grounded, as is also the B minus of the amplifier. Now connect first one grid and then the other of the power stage to the stator of the condenser of the oscillator. Different capacities will be added to the oscillator by the two grids. One of them will be greater, as will appear by a lower frequency of the oscillator. While this grid is connected to the oscillator tune to zero beat with the standard oscillator or with the broadcast station, and use for this purpose the variable condenser. Now switch to the other grid and without touching the variable condenser, add capacity to the circuit, by means of a small trimmer condenser, until the zero beat is obtained. Then we know that the capacity from either grid to ground is the same. Hence when we remove the oscillator condenser the equality remains, since we remove the same thing from the two sides. The circuit is then balanced in respect to distributed capacity.

This balancing can also be done while the tubes are in working condition, provided no signal is coming in. A slightly different adjustment may result, for the capacities are not quite the same while the tubes are hot as while they are cold.

By-passing Bias

Condenser C2 across the bias resistor is not critical in a push-pull circuit. In many good push-pull amplifiers it is omitted entirely. In others it is made very large. If the push-pull stage were truly balanced, no condenser should be required because no current would flow in it at the signal frequency. It is on that theory the condenser is omitted. However, in nearly all circuits there is a slight unbalance due to differences, not only on the input side, but also on the output side. No two tubes are exactly alike. Even if this unbalance could be eliminated, there is still a reason why a condenser should be used. The power tubes are not free from harmonic distortion. The push-pull, or balanced feature, eliminates the even order harmonics as far as the speaker is concerned, but not as far as the bias resistor is concerned. The even harmonics add up in the bias resistor, and thus change the bias with the strength of the signal. This would not cause any damage to the signal for the resulting even order fluctuations could not get to the speaker, but they do shift the operating point and increase all distortion. Hence the odd order harmonics are increased, and these get to the speaker. Hence it is advantageous to use a large condenser across the bias resistor. A suitable value for C2 in this case is 10 mfd. It may be larger, but if it is much less it might as well not be used.

Output of Amplifiers

The 59 tube is rated at 3 watts output when the load resistance is 6,000 ohms. Thus the push-pull stage can be expected to put out 6 watts of undistorted power. Ordinarily, a push-pull stage could be made to put out more than this by allowing the grid to go a little positive. In this instance, however, it will not do because of the high values of grid leaks. The grid current would quickly limit the output. By overbiasing the tubes a little, as has been suggested, the power can be increased without danger of grid current distortion.

The 2A5 tube is also rated at 3 watts, but when the load resistance is 7,000 ohms. Therefore when two tubes are used in push-pull, the output will be 6 watts. This may be increased a little by increasing the bias resistance, as was suggested. But the increase can only be effected by increasing the input signal voltage.

The 59 and the 2A5 tubes are so nearly alike that they are interchangeable, except that they require different sockets. The 59 takes a medium 7-pin socket and the 2A5 a small 6-pin. The load requirements are such that if the transformer has been designed for a 2A5 it will work nearly as well with a 59, but if it has been designed for a 59 it will not work quite as well with a 2A5. The difference in the load resistances is only that between 6,000 and 7,000 ohms.

Plate and Heater Characteristics

The plate and screen voltages taken by these two tubes are the same, namely, 250 volts. The filament voltages are also the same, namely, 2.5 volts. But the currents are different. The 59 requires a current of 2 amperes while the 2A5 requires only 1.75 amperes. Therefore the 2A5 is slightly more economical, but only to the extent of 0.63 watts. One advantage that the 2A5 has over the other is that it is considerably smaller and therefore calls for less room in the receiver.

Both tubes are of the heater type and for that reason are comparatively free from hum.

Other tubes can be used in similar circuits. For example, we might want to use automobile type tubes, in which case the 85 should be substituted for the 55 and the 89 for the 2A5. The only change in the detector circuit would be the higher heater voltage. This same voltage, of course, would be used for the 89s. The plate and screen voltage on these tubes would be made less and the grid bias would be altered a little.

Radio University

A QUESTION and Answer Department. Only questions from Radio University members are answered. Such membership is obtained by sending subscription order direct to RADIO WORLD for one year (52 issues) at $6, without any other premium.

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

Loudspeaker at Fault

I HAVE AN OLD receiver using four t-r-f stages, a 27 detector, a 26 first audio, and a 71A output tube. This tube feeds a magnetic speaker through a specially built-in filter. Transformer coupling is used. On low volume the quality is good, but there is a tendency for the high notes to be emphasized. Would a couple of 2A6s as triodes and resistance coupling make a worth while improvement?—H. E. H.

The high mu tubes would undoubtedly make the amplifier unstable and would cause it to motorboat. Also, the high gain on the low notes which would result would probably cause a great deal of hum. A better speaker, one that is capable of handling the low notes, would be a better solution. Then, also, the output filter might be improved so that the low notes could come through better. A tone control could be used, without any other change, to lower the gain on the high notes. Of course, this would cut the gain, but since you have four t-r-f stages you ought to have enough gain in the circuit to permit a little loss in the interest of good quality.

* * *

Current Rating

THE RATING of the 2.5-volt winding of a power transformer I have it 10 amperes. I want to use this for tubes drawing one ampere at 2.5 volts, but all these tubes do not draw more than 4 amperes. Now, my problem is to determine the resistor necessary to cut the current down from 10 to 4 amperes as I do not wish to burn out the tubes by excessive current. Please give me the right value and also explain how it is obtained.—G. W. B.

No resistance is necessary. There is no relation between the current rating of a transformer and the current you draw from it. What determines the current that you draw from the transformer is the voltage and the resistance. Assuming the internal resistance of the transformer winding is negligible, the voltage across the terminals does not change as you add tubes. If you connect one 58 tube across the winding the voltage remains 2.5 volts and you draw one ampere, for the resistance of the heater of the 58 is such that one ampere will flow when the voltage across the terminals is 2.5 volts. If you add another tube having an equal heater, you double the current but you do not change the voltage. If you connect four tubes of the same type, as far as the heaters go, you draw 4 amperes. You can connect any number of these tubes up to 10, since 10 amperes is the rating of the winding. As you add tubes the voltage will drop a little due to the fact that the 2.5-volt winding is not entirely free from resistance. But the drop will be small.

* * *

D-C Short-Wave Set

WILL YOU kindly publish the circuit of a short-wave regenerative set in which battery type tubes are used? Three tubes should be sufficient but I can use more or less as required by the circuit you give. I prefer to use tapped coils or individual coils picked up by switches.—T. M.

We show a three-tube regenerative circuit employing two -30s and one -33. Switches are used for picking up the various coils, of which there are six. There is only one primary for all of them, which means that all the secondaries, and hence the ticklers, are wound on one form in such a manner that the single primary is coupled to all of them. If there is to be a separate primary for each coil, another switch must be used, but in that case the several coils may be entirely separate. No ground is shown on the secondary windings. Of course, there should be one to complete the tuned circuits. The common side of all the secondaries can be connected to the grounded side of the primary.

* * *

Tracking Condenser

IF A TRACKING condenser has been designed for an intermediate frequency of 456 kc and the broadcast band of signal frequencies, can it also be used for receiving short-wave signals provided that the intermediate frequency remains the same? I have a superheterodyne of this type that works very well and now I want to take advantage of the excellent tracking for receiving short wave signals.—R. K.

No, you cannot track with this condenser on any frequencies except the broadcast band if you keep the intermediate frequency the same. If you change the intermediate frequency in the same ratio as you change the signal frequencies, and retain the same frequency ratio of the short-wave tuner, then you can make it track. For example, the broadcast band now covers a range 2.78, or 1,500/540. Any other frequency span having the same ratio can be covered with the condenser, provided that the intermediate frequency is changed in the correct ratio. To illustrate, if the lowest frequency in the new range is 1,620 kc the intermediate frequency will have to be 1,370 kc, because 540/1,620 = 456/1,370. The intermediate frequency has been multiplied by 3 because every signal frequency has been multiplied by 3. The same principles hold for padding if the padding adjustments are to be fixed.

* * *

Effect of "Wobbulation"

WHEN THE OSCILLATOR of a broadcast station wobbles with modulation, that is, when its frequency changes with the modulating frequency, are receivers tuned to this signal broader? In other words, is the wave from such a station of itself broad? —B. A.

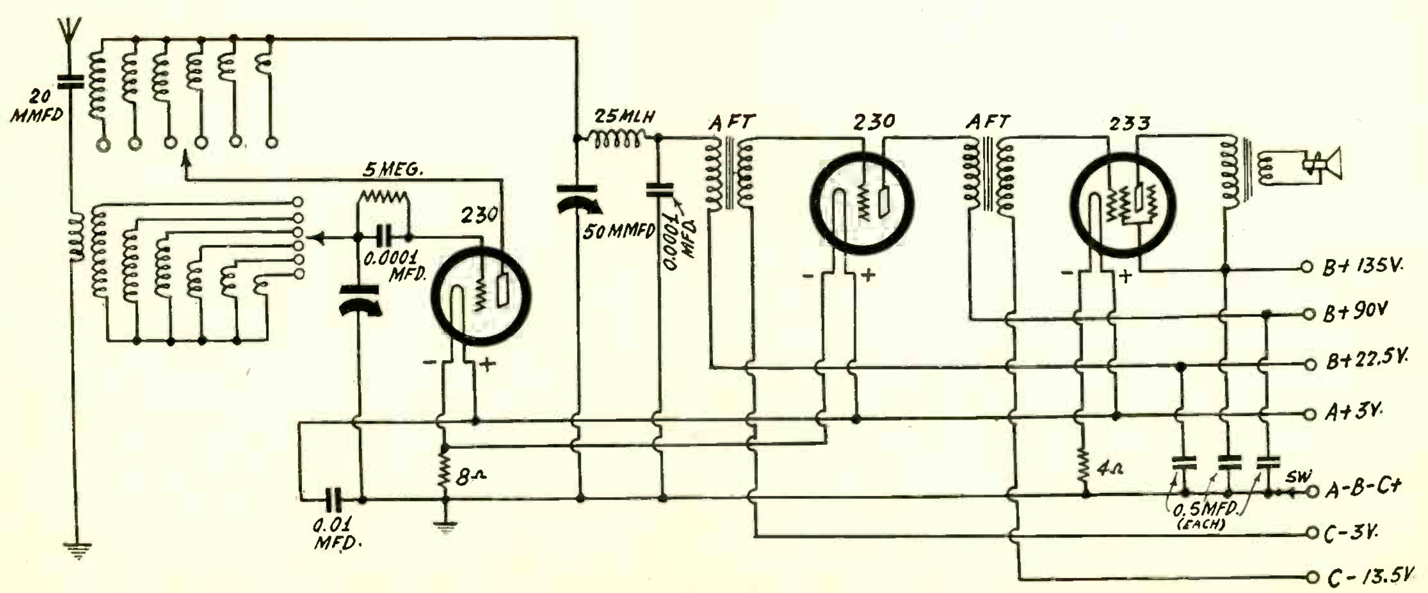
This is the effect "wobbulation" has for the station does not send out a constant carrier wave but one that varies over a certain range of frequencies. A station equipped with crystal control, or with a good master oscillator, or with a thoroughly stabilized oscillator, such frequency variation does not occur. Now a days very few stations wobble enough to make it noticeable at the receiver. In fact, most of them don't wobble at all. They are compelled to remain within 50 cycles of the assigned frequency, and there are many that stay within one.

* * *

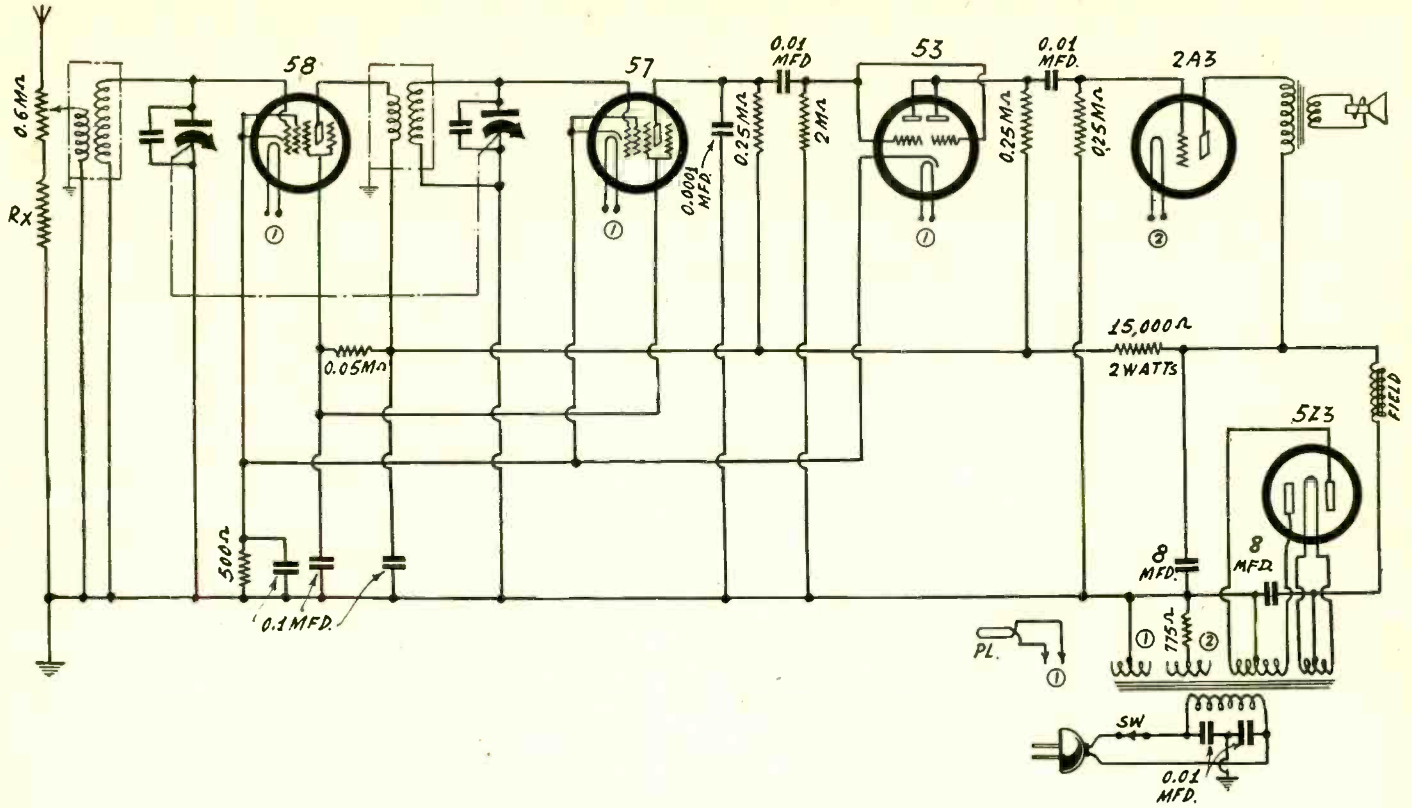
Grid Circuit Power

IS POWER expended in the grid circuit of a radio frequency amplifier or grid bias detector when a grid leak is used? If so, how can it be figured in watts? If power is expended, does this reduce the selectivity and the sensitivity of the circuit.—T. H. S.

If there is a resistance across the tuned circuit there is current through this resistance and power is expended. Even if the winding in the grid circuit is not tuned and there is a resistance across it, there will be



When batteries must be used for powering a short-wave set, a receiver of this type is economical and at the same time capable of a good loudspeaker output. Quietness of operation is in favor of battery operation even where a.c. is available.



For experimenting with the 53 tube as an audio frequency amplifier in a resistance setting, this is suitable. The 53 is a high mu tube designed especially for Class B operation and it is very critical in respect to grid bias voltage.

a current through the resistance and power will be expended. To figure the power we must know the resistance and the current, or the resistance and the voltage across the resistance, or the current and the voltage. The power is RI^2, or VI, or V^2/R. The effective values of the voltage and the current should be used. If the peak values are known they can be used but then products above should be divided by two. Suppose, for example, that the resistance is 1.0 meg. and that the peak of the signal is equal to the bias, which is 3 volts. What is the power expended in the grid leak? Here we know the voltage and the resistance, and therefore we use the last of the three expressions. The power is ½ $(3)^2/1{,}000{,}000$, or 4.5 microwatts. This is lost power and it decreases both the sensitivity and the selectivity.

* * *

An Experimental Circuit

I SHOULD LIKE to experiment with the new 53 tube as an audio frequency amplifier. If you have such a circuit will you kindly publish it? A tuned radio frequency circuit will do as I do not wish to construct a complex set for this experiment.—R. L. B.

We publish a five-tube receiver consisting of a 58 r-f amplifier, a 57 detector working into a resistance, a 53, also working into a resistance, and finally a 2A3 working into the loudspeaker. For rectifier a 5Z3 is used. It will be noticed that the 53 is used as a single tube, the two plates being tied together and also the two grids. It is essential that the grids be negatively biased for if any grid current flows the distortion will be great due to the high grid leak resistance. Part of your experiment should be to find out what the best grid bias is. It may not be the same as the bias required by the 58 and 57, as in the diagram. Remember that the 53 is a high mu tube and that it will not take a strong signal without overloading. But it will put out a strong signal voltage because of the high mu and of the high plate voltage.

* * *

Sympathetic Resonance

THERE IS a disagreeable rattle in the output of my set, the source of which I have been unable to locate. It occurs on certain notes only. If I move the receiver to another room I do not notice it. What do you think could be the matter?—T. N.

The trouble is undoubtedly sympathetic resonance of some object in the room. It may be a table top, a thin board, a piece of bric a bric, or anything that will vibrate at a certain frequency when struck. The vibration is started by the note from the speaker which happens to coincide with the natural frequency of the vibrating object. If you had an audio frequency oscillator the frequency of which could be changed to that at which the disturbance takes place, you could set the object in violent vibration and in that way it would reveal itself. You should also suspect room resonance as the cause, or as a contributory cause. It may be that the natural frequency of the room coincides with that of some object. Again, the room resonance may cause the speaker to vibrate so violently that the armature strikes the pole pieces.

* * *

Choice of Oscillator Circuits

IF YOU WERE to select between the Colpitts and the Hartley oscillators when a high constancy of frequency is essential, which would you choose? Please explain the reason for your answer.—E. W. W.

We would choose the symmetrical Colpitts oscillator in preference to the symmetrical Hartley. The reason for this is that in the Hartley the shunt elements of the coupler between the grid and plate are inductances, while in the Colpitts they are capacities. Since coils have much higher resistances than condensers, there will be a much higher resistance coupling in the Hartley. While this resistance is extremely low, it is sufficiently high to cause a certain lack of stability of the frequency, or it would require a slight readjustment of the reactances to overcome this. The construction of the Hartley may be simpler, but if we are to take account of the adjustments necessary to make the two equally stable, there is no comparison and the Colpitts wins out.

* * *

Beat Oscillator

IS IT NECESSARY to use two frequency-stabilized oscillators in the construction of a beat frequency generator if the frequency of the beat is to be constant, or is there a way of making such an oscillator so that the errors will cancel each other?—R. W. H.

It would be best to use two stabilized oscillators and to make them as nearly equal as practicable, but it is not necessary if the two circuits are made as nearly equal as possible, making allowance for the fact that they must differ in frequency. The object for making the circuits equal is that any variations due to voltage changes will be in the same direction in the two and therefore the difference frequency will not vary nearly as much as if variations were in opposite directions. When they are equal the variation in the beat frequency will be of the same order as the variation in either circuit. Otherwise the variations in the beat frequency might be ten or twenty times as great as the variations in the component circuits. Even when the two oscillators are stabilized it is best to make them of the same type because stabilization is never perfect, and when a beat frequency is involved a high order of stability is essential if a tolerable stability is to be obtained in the beat frequency.

* * *

Effect of L/C Ratio

HOW IS IT that the response of a circuit will be greater the higher the L/C ratio? I know that this is a fact for I have often tested it and I have also read statements that it is so.—S. W. B.

If we have a tuned circuit in which a voltage E is induced, then at resonance the voltage across the tuning condenser, which may be taken as the output voltage, since it will be impressed on the grid of the tube following, is Er/R, in which r is the square root of the L/C ratio and R is the resistance in the tuned coil. Thus the voltage across the condenser, for a given voltage in the circuit, is directly proportional to the square root of the L/C ratio. This is the only explanation there is. That this ratio increases rapidly as the capacity of the condenser decreases is clear. If the inductance of the coil is 245 microhenries, the capacity is 341 mmfd. when the circuit is tuned to 550 kc. Hence the square root of the L/C ratio is 846. At 1,500 kc the capacity is 46 mmfd. Hence the root of L/C is 2,310. Thus the ratio changes by a factor of 2.73. This is also the frequency

(Continued on next page)

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ratio, so that if there were no other variable the response would be directly proportional to the frequency. The resistance in the circuit, however, does not remain constant, but increases as the frequency goes up. At 550 kc it might be 5 ohms and at 1,500 kc 25 ohms. If this were the case and if there were no other factor, the amplification would be less at the higher frequency, which is obviously a wrong conclusion. However, the voltage is usually introduced by a mutual inductance, and this is directly proportional to the frequency. Making this allowance we arrive at the result that the gain at the higher frequency is approximately 50 per cent. greater than that at 550 kc. Sometimes it is much more, which means that the resistance does not increase quite so rapidly as we assumed.

* * *

Phototube Legerdemain

AT A RECENT RADIO show I saw a device incorporating a phototube in which a light would go on or off by waving a hand in a certain way. This was not simply a question of interrupting a beam of light but there was something else back of it. Interrupting the same beam would either turn on the lights or turn them off, or nothing would happen, depending on how it was done. Do you know the principle of the device?—R. S.

No, we do not know the details of the device, but we do know how it might be done. A time lock works on about the same principle. First it depends on when the beam is interrupted and then how it is done. The time element enters into it. It is easily conceivable that the light was turned on when the beam was interrupted for a definite length of time and not if the interruption was shorter or longer. Such details could be worked in any number of ways.

* * *

Use of Band Pass Filters

THE TUNED intermediate frequency transformers employed in modern receivers are supposed to be band pass filters, but they are not terminated properly to give true band pass effects. Do you think that in the future real band pass filters will be used in intermediate tuners? Why do you not design such filters and published in your paper?—W. H. C.

Well, they are not terminated exactly in the right way but they are band pass filters nevertheless. If you wish to construct a filter that is terminated more nearly correctly you might add a couple of inductance coils equal to the two coils now in the circuit. Connect one in the plate circuit of the first tube and one in the grid circuit of the second tube, in series next to the plate and the grid. Also connect a resistance in the grid circuit, from the coil that is connected to the grid and to ground. Make this resistance equal to the plate resistance of the tube ahead. This makes a type of symmetrical filter in which there are four tuned circuits. The first is the coil in the plate lead and the first shunt condenser. The second is the primary circuit, including the first condenser. The third is the secondary circuit, including the secondary condenser. The fourth is the coil in the grid circuit and the second condenser. The end circuits resonate to the carrier frequency and the two interior to two other frequencies, one on either side of the carrier.

* * *

Sense Finder

WHAT IS THE meaning of sense finder, a term which I have seen used in connection with direction finders? Is it another term for direction finder or does it refer to some detail of that instrument?—S. E.

When a loop is used for determining the direction in which a station is located an ambiguity arises because the loop does not tell directly whether the signals come from one direction or from exactly the opposite direction. The sense finder is a detail of the direction finder which removes this amgibuity. It consists of a regular antenna, small though it may be, by which a signal is picked up and combined with the signal picked up by the loop. With this added signal the sense of the signal, or the sign of it, is determined because signals coming from one direction are received and those from the opposite are not received or else they are received feebly. As a rule the adjustment of the loop is such that the signal is feeblest. When this adjustment has been made, if the loop is turned around the signal is again feeblest. But if the sense finder is working there is only one position of the loop in which the signal is absent or extremely feeble.

* * *

Getting Most Out of Tube

IS THERE ANY way in which the voltage amplification from a tube and coupler could be made equal to the amplification factor of the tube without using a step-up transformer? If there is such a possibility I should like to know about it.—S. E. L.

The only way that high gain could be achieved would be to have a load impedance that is infinite in value. That is not possible. Of course, in theoretical work on electrical circuits infinite impedances are often used, but they are used only because of simplicity in computations. Nobody really believes in the possibility of getting such impedances and still do something with them. In all such cases, after the work has been done on an imaginary circuit without resistance, modifications are made to fit practical cases. It is possible by reducing resistance in resonant circuits to get extremely high effective values of resistance. When the resistance in a series circuit is zero the parallel circuit offers an infinite resistance. The resistance of a parallel circuit has been made practically infinite by the use of the an oscillator —a special type of feedback—but if an extra tube must be used to increase the impedance that tube might as well be used in a standard hook-up as an amplifier. The gain that way might be a hundred times greater.

* * *

Resonance Wave Coils

A FEW YEARS ago there was much talk about resonance wave coils and much was claimed for them. I recall that some official of the U. S. government, either of the Bureau of Standards or the Naval Laboratory, did some work on them. What is the reason that these coils never came into wide use? Do you think that they will be taken up again in the future? There must have been some reason why they were not adopted in the radio industry, but that reason, as I recall it, was not lack of performance, judging performance by selectivity and sensitivity.—W. P.

Dr. Louis Cohen worked out the mathematics of the resonance wave coil and showed that it had many advantages. He also suggested circuits for taking advantage of the properties of the coil. The reason it was not adopted for radio receivers was that it was cumbersome and not easily tuned to different frequencies. It is quite possible that the principle of these coils will be applied to future circuits, especially where the frequency does not change. Perhaps there is a possibility of using system in the intermediate amplifier of a superheterodyne. As far as we know, the resonance wave coil principle has not been used for this purpose. The clumsiness of the coil is a deterrent.

* * *

Constant Coupling

SOME YEARS ago a circuit in which the coupling was constant for all frequencies was popular, but I have not seen it lately. It was a combination of inductive and capacitive coupling. Will you kindly give the details?—T. L.

This circuit was popularized by Messrs. Loftin and White and it did approximately what is was said to do, yield uniform coupling. It is not used much now because simpler circuits have won out. It is not practicable to give the details here, but you will find a brief description of it elsewhere in this issue.

* * *

Choke as Biasing Resistor

I NOTE IN September 30th issue of your magazine that someone has conceived the brilliant idea of killing two birds with one stone by making an r-f choke do double duty as a choke and a cathode resistor. This would be laughable to a radio engineer but to a plain screwdriver electrician like me it's a little aggravating, for I look upon RADIO WORLD as my guide, and how can I trust anything in your magazine if you condone such ridiculous schemes as this? I'll give you the benefit of the doubt and suppose that your entire staff went to sleep. But just in case you don't see the joke—how can an r-f choke, which is supposed to bypass the r-f signal around the resistor do so when it is made the resistor itself? Incidentally an r-f choke for removing r-f signal current from a low resistance cathode resistor must be of considerable less resistance than the cathode resistor to be effective, as the r-f voltage drop in the choke will always be there to couple the plate and grid circuits together. Of course, the condenser will still bypass the r-f signal around the choke-resistor combination, but winding the resistor in the form of a choke is a waste of wire. There are several other matters I've had in mind to question you rather severely on—first your constant reiteration that the 55 and 85 tubes don't amplify at zero bias. I haven't noticed it. If such was the case the tube would be a frightful distorter, and anyway noise itself is a signal and can put plenty of bias on the tube. Well, that will be enough for the present. Let's see more articles on distortion and their cures; and, by the way, in a recent article on push-pull resistance coupling why wasn't the scheme put forward by me in your April 1st issue mentioned? I have been using the 25Z5 as push-pull diode detector for six or eight months. It's OK.—O. C. LaF.

If an r-f choke of very small d-c resistance is used as a filter adjunct in the cathode leg, and a biasing resistor is used in series, the bypass condenser across the total, the resistance may as well be in the choke. It will be noted that a very large bypass condenser was recommended, one of almost audio-frequency capacity (1.0 mfd.). A commercial choke of 25 mlh has a d-c resistance of 100 ohms, and any high-inductance r-f choke of compact size will have a relatively high d-c resistance. Besides, the method has been carefully tested and approved. The r-f choke is used for its inductance. You yourself point out the effect of the bypass condenser on the carrier-voltage drop in the d-c resistance of the choke. The 55 and 85 triodes draw grid current at zero bias and even at 0.7-volt negative bias. This is a detecting rather than an amplifying condition. It does not mean nothing is or can be heard, but very little. The set noise is something, of course, but the signal always should be large in comparison, for enjoyable reception. Noise as a program is "out." Therefore, we recommend that any station in the audibility range should give the diode a decent swing. The main thing about the triode is not to put too much in, as saturation produces double-hump tuning. Adjustments for the proper condition were detailed last week.

* * *

Effect of Shunting Coil

IN A CIRCUIT where a radio frequency coil is so connected that it is in effect in shunt with the tuning coil, what should be the inductance of the choke to insure that the effect on the tuning inductance is negligible?—W. E.

That depends on many factors. First, the accuracy required, second, the frequency involved, third, to what degree it is in parallel, that is, what resistances and condensers are associated with the coil and in what manner. If it is only a question of a large coil being in parallel with a small one, the effective inductance of the combination can be computed in the same manner as the effective resistance of a large resistor in shunt with a small one, assuming that the large coil is placed so that there is no mutual inductance between the two coils. Suppose that the large coil has an inductance Lo and that the small coil has an inductance of L, microhenries in both cases, or millihenries, or henries. That is, Lo and L are expressed in the same units. Then the inductance of the combination is $LoL/(Lo+L)$. This is the same formula as is used for combining two parallel resistors or two series condensers. Now suppose that L is 250 microhenries and that the reduction in the combined inductance should not be more than one per cent. of L. Then what should the value of Lo be? We have then that $LoL/(Lo+L)=0.99L$, a reduction of one per cent. We conclude that Lo would be 99 times as large as L. Hence $Lo=24.75$ mh. Whether this reduction is negligible depends on the accuracy. It may be that it is necessary to maintain the inductance in the resonance circuit to one part in a thousand. In that case it would be necessary to make the large shunt inductance 999 times as large as the tuning inductance, or simply 1,000 times as great. Thus a 250 millihenry coil would do. This does not take any account of the capacity of the coil, which is also put in shunt with the smaller coil, and in most cases also across the tuning condenser. This capacity works in the opposite direction from the inductance, in regards to the frequency of resonance. Hence it may be that there will be no change in the frequency of resonance when the large coil is put across the other.

W1XAU OUSTED; BOARD SCANNED VISION STOCKS

Washington.

Claims made in its prospectuses of stock it was trying to sell in the new parent company, General Electronics Corporations, caused the Short Wave & Television Corporation, of Boston, to lose its two television licenses. The revocation was made by the Federal Radio Commission as a step consistent with the policies of the recently-enacted national law regarding how far the seller may go in making statements intended to facilitate the sale of stock.

The formal applications of the company were for permission to operate WIXG and for a renewal of the license for W1XAU. Action had been held up for quite a while. As long as a year ago the Commission started making inquiries into the stock-selling side of the company's activities, especially claims made in conjunction with the issue of new and extended licenses.

All television licenses are in the "experimental" classification, as the present state of the art is not deemed officially to warrant commercial licenses. Short Wave & Television Corporation did considerable research work and sent out pictures that were picked up in various parts of the country and in Canada. It was one of the first companies to send out a sound track, using a different frequency at first, and thousands who had not the equipment to bring in the pictures did pick up the sound on short-wave sets.

No criticism was voiced concerning the company's research and experimental work, as it had recognized engineers and performed some interesting and important experiments. But the legal division of the Commission became convinced that the principal activities of the company had to do with sale of stock to the public.

The Commission has been very slow to revoke licenses or refuse renewals, in any branch of radio, and has taken such action only a few times in regard to broadcasting stations. This is the first time that any such action has been taken concerning a television transmitter.

Our Ambassador in London Introduces Good-Will Feature Here

With official backing an Englishman is here to look us over in his wide travels and broadcast to England about what he sees and thinks. A chain carries the program here.

The idea is to bring England and the United States closer together than they've been since 1775.

The fellow is S. P. B. Mais, and he's well-built and handsome. He's supposed to be rediscovering America for British listeners.

However, at first he was quite conventional. He spoke well about our weather and skylines.

"Why have we in England never heard of your American weather?" he asked. "One day like this in London would be cause for celebration, and here you seem to have one after another in an unbroken succession of glorious days."

In his first talk to listeners back in England, which also was heard in this country over National Broadcasting Company networks, Mr. Mais said little about the weather, which at this time of the year is beginning to fog up in London.

Mr. Mais will be heard each Friday at 4:30 p.m. EST, over an NBC-WEAF network in the United States and over a British Broadcasting Corporation network in England.

The first broadcast was from Lexington, Ky., while others will originate in Florida, Louisiana, Texas, Arizona, California, Washington, Minnesota, Illinois, Pennsylvania, Massachusetts and New York.

The first program was introduced by Robert W. Bingham, American Ambassador to the Court of St. James, from London.

The Review

Questions and Answers Based on Articles Printed in Last Week's Issue

Questions

1. What is one of the prime requisites to prevent heterodyne squeals in a superheterodyne?

2. Does the argument hold that the antenna input should be high in a superheterodyne, especially in congested areas, to keep down the noise ratio?

3. What are two simple ways to reduce the antenna pickup?

4. In a sensitive receiver, does it become important to shield leads to overhead grids, tubes, plate leads, etc., and, if so, why?

5. What is overloading of the second detector, and what is the general effect? Name two particular effects.

6. Compare the voltage-handling capabilities of the amplifiers of the 55 and 2B7 and state what effect this consideration should have on design of the preceding part of the receiver circuit.

7. Is enough amplification obtainable from a one-stage intermediate-frequency amplifier when there are some r-f amplification, and two audio stages, the last or power stage a pentode tube? If not, why not? If so, why so?

8. How high may the grid resistor be in a resistance-coupled audio amplifier, any stage, including power output tube? What is the effect of high resistance in this circuit, compared to low, and how would you test for how high the resistance may be?

9. What is one of the advantages of using a tracking condenser in a superheterodyne? Can the coincidence be much greater than by the padding method?

10. Since there is only one frequency at which the adjustment may be made, with the tracking system, state why this is, and where in the tuning band the adjustment should be made, and why.

11. If one has a frequency-calibrated dial, and the proper inductance for a given maximum and minimum capacity tuning condenser, may the condenser be used with safe reliance on coincidence of rotor positions with dial-frequency readings?

12. How does a thermo-couple galvanometer differ from a standard ammeter?

13. How may a thermo-couple be made at home or in the shop? With what sort of an instrument may it then be used and for what purpose, and how may the readings yield absolute values?

14. Is it advisable to have a reversing switch on a thermo-couple instrument, if so, why? State the fundamental procedure for measurement.

15. In a set that has automatic volume control, and multi tubes, is it to be expected that the loud locals will come in much louder than on a tuned-radio-frequency or superheterodyne receiver of fewer tubes but having no a.v.c.? Should weak, distant stations come in louder on the set that has fewer tubes?

16. State one limit to the amount of amplification that can be developed in a system.

17. What is the best-quality type of detector so far developed for practical use? What is the general nature of the response curve, assuming proper load?

18. What is a slide rule? What is its purpose? State the procedure necessary to add or subtract fundamental numbers, using a slide rule.

19. Does a honeycomb coil of a large number of turns have a greater or a smaller distributed capacity than a honeycomb coil of fewer number of turns? In general, is the distributed capacity in a solenoid greater or less than in a honeycomb? Why?

20. Concerning General Radio Company's condenser No. 247, rated at 500 mmfd., is the maximum capacity actually nearer 500 or nearer 600 mmfd.? How may this be confirmed?

21. If the calibration of a tuning condenser is known, how may unknown capacities be measured, and what is the limitation on scope of capacities?

22. In diode detector, so-called linear detectors, is the tube itself linear, and, if not, what is, or how is linearity accomplished?

23. Are all frequencies detected with equal effect in a linear detector? If so, why so; if not, why not?

24. Define voltage amplification factor. Can this be obtained from certain families of curves of a tube? What families, for instance? How?

25. Does a radio-frequency transformer with a tuned secondary present a high or a low impedance to a tube? How does the d-c resistance in the grid circuit or tuned circuit affect the impedance? Does the impedance increase as the capacity of the tuning condenser is increased, always assuming non-reactive secondary?

Answers

1. One of the prime requisites to prevent heterodyne squeals in a superheterodyne is sufficient selectivity ahead of the modulator (first detector).

2. No, the argument does not quite hold, that the antenna input should be high to keep down the noise-to-signal ratio, as this advice applies rather to tuned radio frequency receivers and to such superheterodynes as already have abundant selectivity ahead of the modulator. Particularly in congested areas, where there would be several powerful locals, the selectivity ahead of the modulator has to be great and loose coupling to aerial or short aerial, aids this.

3. Two ways of reducing the antenna pickup are (a) use a physically shorter aerial and (b), leaving the physical size and height of the aerial as it is, insert a small-capacity series condenser between aerial and antenna primary connection on the first coil.

4. Shielding of leads at "hot" potentials becomes imperative in a sensitive receiver because of the magnetic and electric fields about these conductors which, unless suppressed by grounded shielding, will introduce feedback and will also act as aerials and reduce selectivity whenever the pickup is subsequent to a prior tuned stage because without benefit of that prior tuning.

5. Overloading of the second detector, or anything else, consists of putting more into it than it will stand without misbehavior. In this instance it would refer to signal voltage. More than the second detector could stand would define a condition of serious distortion. Therefore distortion is the general effect. Two particular subdivisions of the distortion classification are (a) double-hump tuning and (b) choking or blasting on loud passages.

6. The amplifier of the 55 is a triode and at rated d-c voltages will stand an input of 12 to 15 volts or so under conditions of excellent amplification. The amplifier of the 2B7 is a pentode and will stand only 3 or 4 volts or so input, but amplifies a great deal more. The practical gain from the 55 amplifier may be 4, that from the other 20 or more. The effect these facts should have on the tuner design is that no more than the maximum voltages that the amplifier of either tube will well stand should be put into it, the values taken from above.

7. Yes. Enough voltage is readily obtained to load up the output tube.

8. The resistance in the grid circuit of an audio amplifier may be as high as practical, consistent with absence of motorboating and of bias-loss of the tube in the grid circuit of which it is connected. High resistance well supports the low notes, and raises the practical gain generally. Low resistance impairs the low notes more seriously, and also reduces the practical gain generally. A test for how high the resistance may be includes steadiness of plate milliammeter needle position under all conditions of maximum steady input. When the input is increased so that the plate current shoots 'way up, the tube is losing bias and the grid resistance has to be reduced to the point where this bias loss is not serious.

9. A tracking condenser in a superheterodyne has specially cut plates for the oscillator, and therefore the mechanical infirmities of a padding condenser are not added to the other exactions in the oscillator circuit. That is, there is no padding condenser the capacity of which may change from time to time, under differing meteorological and jarring or vibrational conditions. The coincidence can not be much better by the tracking than by section than by the padding method. A maximum deviation of 5 kc in the broadcast band would be pretty close work for either.

10. The reason there is only one frequency at which adjustment may be made with the tracking-section system is that the oscillator circuit, like the others, has only a parallel trimmer that can be adjusted, while in the padding method the oscillator capacity may be adjusted both in series and in parallel. For the tracking-section method the adjustment should be made at or near the geometric mean of the broadcast band, because there the difference may be greatest and because any divergence will be distributed among the two extremes, and thus will be minimized, especially at the low-frequency end, where the small capacity differences are not so serious.

11. No, the frequency-calibrated dial can not be expected to coincide with a condenser the minimum and maximum capacities of which are correct, in relation to the required accurate inductance, because these two extremes determine only two frequency points, and there are almost a hundred more frequency points, all of which may be considerably off. The dial coincides with only the condenser for which it was calibrated, with the specified inductance.

12. The thermo-couple galvanometer differs from the usual ammeter principally in that it is more sensitive and has a scale in numerical comparative (not absolute) values.

13. A thermo-couple may be made at home or in the shop by crossing two wires of different material (say, copper for one, iron for the other), to form the junction. Current heating this junction causes needle deflection on the meter. Thus the junction may be used with a d-c meter to measure a.c. The readings will yield absolute values after the thermo-couple instrument has been calibrated.

14. It is advisable to have a reversing switch, or at least, to take readings in two directions, due to the juncture passing more current in one direction than in the other. The average of the two readings is taken. Naturally, this applies strictly even if the two readings are exactly the same.

15. If a multi-tube set has automatic volume control, it need not be expected to produce a greater quantity of sound on strong locals than a set with fewer tubes that has no a.v.c. Weak stations would come in much louder on the larger set, in fact, many stations would be heard plainly that the other set could not raise to the audibility level at all.

16. The noise level is the principal limit to the amount of amplification that can be developed by any system.

17. The best type of practical detector is the vacuum tube diode. The general nature of the response curve is linear when the tube is properly loaded.

18. A slide rule is an instrument with fixed and sliding scales which have logarithmically-separated divisions, thus enabling rapid multiplication (by adding logarithms) and division (by subtracting logarithms),

and other operations, but not those of adding or subtracting fundamental numbers, as these can not be performed on the logarithmic rules.

19. The greater the number of turns on a honeycomb coil, the smaller the distributed capacity, because the effect of the turns is that of capacities in series. The distributed capacity of a solenoid is, in general, greater, because it relates to the diameter of the coil.

20. The maximum capacity is nearer 600 mmfd. This may be confirmed by using the maximum capacity in an oscillator, with a coil of known inductance, and determining the frequency response by measurement. Then the capacity can be computed. The condenser capacity is the difference between that computation at the sum of the distributed capacities. These may be taken as 10 mmfd. as an approximation, and the maximum capacity in micro-microfarads is then X—10.

21. Unknown capacities may be measured by substitution, by determining the generated frequency and noting, after removal of the unknown, how much capacity has to be supplied by the variable condenser to establish the same frequency. The limitation in scope is the range of the tuning condenser itself, as expressed in the calibration.

22. No, the tube itself is not linear, but its resistance is small compared to the load (normally 0.5 meg. or more), and therefore it is the load that is linear. Since the tube resistance is very small compared to the load, the ensemble is linear.

23. Not all frequencies are equally detected in any detector, as the filtration, to get rid of radio frequencies at the output where only audio frequencies are desired, necessarily has a reactive effect. So, parallel condensers to bypass large resistors should be small, and chokes not of any greater inductance than required.

24. Mu factor is the ratio of the change of plate voltage to the change of grid voltage that produced the plate voltage change, the plate current held constant. From plate-voltage, plate-current curve families you can get the desired values of plate and grid voltage changes at constant current and determine the mu-factor by division.

25. A radio-frequency transformer with tuned secondary presents a high impedance to a tube, the lower the d-c resistance in the tuned circuit, and also the less capacity in circuit, the higher the impedance. (The secondary is assumed non-reactive as a definition of resonance.)

Dial As on 'Phones Used on Executives' Sets in Radio City

All executive offices in the new National Broadcasting Company headquarters in Radio City are equipped with receiving sets which operate on the "dial" system, like telephones.

By dialing the proper number it will be possible to connect the sets with any one of a large number of broadcasting stations, with either NBC network, with short-wave transmitters, or with any one of the numerous studios in which programs, rehearsals or auditions are taking place.

The dial switching is handled through the main control room.

AL WILLIAMS AN ATHLETE

Capt. Al Williams, speed flyer, who is heard over an NBC network each Saturday in a resume of the week's highspots in aviation, was the original "Fordham Flash." After graduating from Fordham University in New York, Capt. Williams pitched for two years for the New York Giants, and left to go into flying before Frankie Frisch, who now bears the "Fordham Flash" title, joined the club.

Radio Leadership Puts U. S. First in Music, Says Rolfe

By BIDE DUDLEY

B. A. Rolfe, band master, has just examined the director's sheets to be used at his next broadcast.

"It isn't generally realized," he said, "but the United States is now the greatest music-loving nation in the world."

"How do you figure that out?" I asked.

"On the mail broadcasting stations receive from listeners. Musical appreciation has advanced by leaps and bounds in recent years in America. And the credit for the tremendous increase in the number of music conscious people is due first to radio.

Music's Widening Sphere

"Where can you find a person today who hasn't heard a tune in twenty-four hours? Fifteen years ago where could you have found one who had? Let's take some workman, or storekeeper, for instance. In years gone by he probably had no access to music and gave it little or no thought. Then radio came and he put a receiving set in his shop and began going home at the end of the day with a tune in his mind. He had been made music-conscious.

"What did he hear first? A jazz tune, most likely—a composition that was mostly rhythm. He learned to like jazz. It wasn't long until jazz began to hatch out what is now known as popular music, a form given over to melody rather than to rhythm.

"The storekeeper had been in the kindergarten of musical appreciation and had learned much. What was at first a mere diversion for him produced a real desire for music and, as the styles in composition changed, so did his tastes.

"The storekeeper I mention as a representative of the masses. Think of the millions of Americans in all walks of life who have been made music-conscious as was he. Before the advent of radio, hundreds of thousands of people on farms and ranches heard practically no music at all. Now the rural family of any standing that doesn't own a radio set is the exception and music has become a big factor in their lives."

"But," I expostulated, "what about classical composers here?" I inquired.

No Market for New "Old Masters"

"People often ask where America's Wagners, Verdis and others of that type are. We haven't got them and, frankly, we can't use them. Styles change in everything, including music. We may have composers who could turn out works like those of the old masters, but there would be no market for their music. So they follow the styles of today. Many of our authors could write in the style of John Bunyan if they tried, but who wants to? The style has changed.

"In support of my argument that the mass of American citizenry wants mass production of music that is easily absorbed and pregnant with entertainment, let me ask—where are the concert tours of other days? And where are all the symphony orchestras? Oh, there are still some, but the loss in favor of classical music has made its presentation almost futile. Many people who profess to enjoy classics are like the woman who vows she just loves a good cry.

"We may get back to the classical form in future years, but first the musical inclination must be instilled in the people at large, as it is being done by radio through the offering of light, ingratiating compositions.

"Another thing," Rolfe continued, "it is my opinion that crooning, which has long been made the butt of jokes and jibes, is a commendable form of vocal music. It is natural and soothing. The baby hears its mother croon and it slumbers.

"Some day," concluded Mr. Rolfe, "I intend to develop a crooning choir of 200 voices and give a concert devoted entirely to this form of music. What a tidal wave of satisfying harmony 200 crooners could send forth!"

COPYRIGHT HITS BRITISH "PUBS" IN A TEST CASE

The Court of Appeals, in London, Eng., has decided that a restaurant owner who reproduces a broadcast program for the benefit of his customers is liable for payment of a copyright fee to the copyright owners of the broadcast piece. The court held that the payment of one fee by the broadcasting station to the Performing Rights Society did not excuse the restaurant owner from liability, as his was in legal technique "a separate performance."

This is the same attitude as was taken by United States appellate courts in a case brought by the American Society of Composers, Authors and Publishers, where a hotel was held responsible for the reproduction of a program on which copyright music was included by a station that had no authority from the copyright owner.

Appeal Dismissed

The case in England is regarded as significant, for unless upset on appeal it will result in collection of fees from nearly 50,000 public houses, restaurants and refreshment places. It was at one of these refreshment places, part of a brewery-operated chain, that the litigated reproduction by radio took place.

Justice W. J. C. Maugham heard the case originally and decided against the refreshment chain, on a question of law. The facts were not in dispute. He held that the reproduction was a "performance" within the meaning of the copyright law, such as to constitute a violation of the legal right possessed by the copyright owner. The appellate court held that the case raised an important point but that the point had been properly decided by the lower court, so dismissed the appeal.

The case will be pressed farther, for, although not generally so stated, it is a test case in which both the restaurateurs, hotels, etc., on one side, and the copyright owners, on the other, desire to ascertain just where they stand legally.

Brewers' Funds Relied On

The Brewers' Society is therefore expected to appeal to the House of Lords, since nearly 50,000 public houses in England and Scotland make a practice of entertaining guests with radio programs.

The same complications exist here as existed in the United States prior to the decision in its hotel music case, including the fact that the Performing Rights Society does not own the copyright to even nearly all the music broadcast. In fact, the hold is not nearly so extensive as is that of the Society in the United States.

The assertion that the Society here could charge what it liked if its legal contention is upheld is the same as that which has been heard in the United States in all quarrels stations, restaurants, hotels, etc., have had with the Society. An agreement, however, was reached in all instances. The tentative outlook in England and Scotland is for fees amounting to \$5 to \$125 a week for the whole group affected, from the smallest refreshment place to the largest hotels, the fee depending partly on the amount of business done.

A THOUGHT FOR THE WEEK

THE flesh stage continues its raps at radio. It has devoted its cynicism and rough-and-tumble humor to motion pictures for so many years that authors and producers get a new kick out of their lambasting of microphone folk and radio officialdom. For instance, the Sam H. Harris presentation of "As Thousands Cheer," current at the Music Box in New York City, has a scene in which John D. Rockefeller, Jr., offers Radio City as a birthday present to his venerable father and—here is where the shrewd comedy is supposed to materialize—the younger Rockefeller runs away before the gift can be refused. The audience seems to enjoy the episode, even though most of those present don't quite know where the humor comes in. Thus does the stage continue its onslaught on the world's newest type of entertainment, which is supposed to have made the footlights something that no longer glow.

RADIO WORLD

The First and Only National Radio Weekly

Twelfth 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.; Herman Bernard, secretary, 145 West 45th Street, New York, N. Y.

Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager; J. B. Anderson, technical editor; J. Murray Barron, advertising manager.

LEGAL ACTIVITY

THE legal side of radio is constantly busy, abroad as well as here. The British have just been treated to an appellate decision that a refreshment place reproducing broadcast music is responsible to the copyright owner. The plea that the station's satisfaction of the copyright owner's desire for recompense covered all reception and reproduction of the program was overruled by the court.

And there is a Society in England and Scotland, as well as here, only it is the Performing Rights Society. Ours is the Society of Composers, Authors and Publishers. The further parallel and conventional cousinship are illustrated by the same outraged determination not to be at the dictatorial mercy (or is it cruelty?) of the Society. But in the end probably the fees will be agreed upon and paid, that is, if the patrons of the public houses really want to listen to the programs. American visitors can not conceive that it is possible, but English visitors to our own immaculate shores, if intimate enough with their hosts, will openly wonder that it is possible such programs as we put on can conceivably interest anybody. Oh, where are the interesting ten-minute intermissions?

Another legal question looming is whether a station can be punished if a few shots extra from a pistol are added by an enthusiastic broadcast director during the clinical detailing of the hunt for ten escaped convicts who at the moment may not have been in the same State. At least, the head of the highway police in a mid-Western State has complained to the Federal Radio Commission. Indeed, the escaped convicts themselves might have a case, for was not the broadcast an invasion of their personal privacy? There should be a Recovery Code for escaped convicts. Broadcasters should be compelled to respect it.

And then the old allegation that money has its way in this fair land of ours needs some more investigating. A group of millionaires' sons took over the operation of a New York City station, but not the license itself, and the Commission's eyes were focused on the possible trafficking in a license, strictly against the rules. The chairman of the new board in charge of the station's business policies is Alfred E. Smith, so perhaps a word to the right man might help. That right man might be Curtis B. Dall, son-in-law of President Roosevelt, but Mr. Dall is chairman of the board of a new and rival regional chain. So the question may be settled either strictly on a legal basis or not officially treated at all, as something that, though possibly actionable if involving obscure identities, is not worth dragging into the foreground where national political rivalries may be exhibited.

Again the law is invoked when a manufacturer has prepared some toys for Christmas sale, so that children may be made happy, and parents still prouder, by young voices broadcasting within the home. This has been definitely prevented because the pretended limited area of transmission is not within ready control, and operation would constitute interference with stations' waves, particularly waves wafted by stations from other States, and thus clearly in violation of the protections of inter-State commerce laws, of which the Radio Law is one.

At least that project is off, without even a court order. But so soon as these legal matters formally reach the Commission and the courts there are at once that lasting play of legal activity and that overburdened occupation of the tribunals that postpone the final determination so far into the future that we must have great vitality to survive the problem and an impossible memory to retain interest in it.

MARCONI

GUGLIELMO MARCONI is circumspect. He will not say for a certainty that radiated power by radio is impossible. Yet he is not afraid to be confident. He foresees a great future for short waves, particularly that spectrum now classed as ultra waves. He himself hopes to accomplish more, as soon as he gets back to his yacht Elettra, now the most famous yacht in the world, although it has won no races. What is more important, it is his floating laboratory, and it supports the high aerials he uses for his 45- and 60-centimeter work.

Marconi has carried on two-way communication for distances around 170 miles, using these high frequencies. He has succeeded, although hills intervened. He is not quite sure just how waves got by the hills. One might expect the usual obstruction that light waves encounter. He inclines to the opinion that the waves got around the hills, rather than going through them, but would like more opportunity to test before he really commits himself.

A great fondness for Marconi exists in the United States, not only because of his early experiments that included the use of our shores, and the other visits he has paid us, but because American leadership in radio naturally causes America to look with admiration, if not awe, upon a man who himself represents leadership in that field. Marconi is the outstanding radio scientist today, and so recognized in radio scientific circles, although of course not regarded as "the inventor of radio." It was nice to conjure that title for him from the ink and matrix of the printing room, but he has other and authentic titles.

Radio as it is today is the result of a step-by-step development, even though the steps were rapidly taken. The contributors were numerous, ranging from pensive mathematical scientists and resourceful devotees of laboratories to tinkerers who by chance hit on valuable contributions to the art without half knowing why. If any individual alone came close to being the "inventor of radio" he was Thomas A. Edison, who discovered the Edison effect and who made and broke a circuit in a coil at one end of the room and gained response in a similar coil at the other end of the room. But Edison was busy with other things, passed by this invitation to open radio to the world, and it was left to numerous others to pry out the secret. Marconi was one of them. A lofty score of men and a trailing miscellany were the others.

STUMPED BY EDUCATION

EDUCATION by radio is proving a difficult problem. Possibly one of the greatest difficulties connected with the problem is scarcely ever mentioned, and that is that radio is popularly regarded as a medium of entertainment, and a flashier and racier program will be preferred to an educational one. It would help if the educational program were dramatized.

In the narrower aspects, education by radio can be more readily accomplished by having teachers broadcast to classes assembled in schools, but this concerns teaching youngsters. The larger aim is to establish broad adult education by radio. Now, it is legendary that youngsters are not naturally keen for school. Maybe it is even truer that adults are not keen for education. Maybe that's where children inherit their tendency. There are hormones, you know.

Another problem is to get those most learned in their appointed subjects to give their talks in the manner best calculated to attract, hold and influence even the adult mind. This is difficult. One has to educate some of the educators how to do this. A few of the noted scientists, for instance, characteristically talk as if to scientists. This upsets every one, except the educator.

Then there is the economic problem. Some wealthy men must contribute to a fund if time on the air is to be assured, or even the expenses of the venture defrayed if the time is given by the stations without cost, as is often done. Or sponsors may adopt educational features, in the hope that finally sales will be obtained through these efforts. A conventional dance orchestra, male crooner and female torch singer as a choice would show less program courage, but probably greater sales.

On the borderline of education is information. If a person is sufficiently well informed he is educated. Information dissemination by radio is growing. The news-item broadcasts by an increasing group, and the editorial comments by similar groups, prove this. The current-events forum is a fixture. Dramatization of the news, with actors impersonating the characters, is successful. The study of history always has been a part of education. Events of world-wide significance are history, even if the events are current, even if only one day ahead of the broadcast.

It should be possible actually to obtain an education through radio. The pace of modern developments in science and government is swift, but as the history of the development is revealed, the past is once more exposed to view. The slower pace of learning foreign languages may never become popular as a radio educational project, nor of learning accounting, law, mathematics and the like. But the attempt of recording in listeners' minds the whole march of modern progress should be made. It might be presented as information, but it would endure as education.

WORLD SERIES AIDED RADIO

Radio receivers came into their own for the World's Series games. The city public places in New York City did not display signs and give the AC because of the tie-up in traffic, but there were plenty of places where the returns came over the radio. Wall Street brokers and others rented radio receivers for the returns, and in many instances with option to purchase the receiver, the renting payment applying on the purchase price. This idea was so successful that already others are planning to follow out the same idea of renting for the football games.

SIDNEY DIXON APPOINTED

Sidney Dixon, formerly production manager at KYA, has been appointed manager in charge of local sales in NBC's Pacific Division.

Station Sparks

By Alice Remsen

NOT SO UNLUCKY

October started with a rush of new programs over at the National Broadcasting Company. The unlucky number thirteen, (or is it lucky?) is the total of commercial accounts to make their debut over NBC networks this month; very encouraging news. Many other advertisers are hanging back until the NRA gets going a little better, and many others are not radio-ing at all because all the choice air-spots are either sold or optioned; Standard Oil is one of the latter. . . . Francis X. Bushman, pioneer movie matinee idol, is now on the air with the new Rin-Tin-Tin Thrillers series over WABC, each Sunday at 7:45 EST; Bushman spins yarns about the dogs belonging to movie stars; the program is sponsored by Chappell Brothers, Inc. . . .

A STRANGE STUDIO

The world's strangest studio soon will answer to the Columbia Broadcasting cue, "Okay, Little America!" This studio is KJTY, the newly licensed marine unit of the Columbia Broadcasting System aboard the S. S. Jacob Ruppert, flagship of Admiral Byrd's Antarctic Expedition; KJTY is equipped not only with technical equipment, but also has sleeping quarters for four men; the studio occupies the working and living quarters of the ship's radio telegraph operators; the former radio room has been transformed into a control room, and the bunk room is now the studio, with its original complement of two bunks and two more added to take care of the CBS men accompanying the expedition; a plate glass window has been built into the wall between the upper and lower bunks which run along the wall; the microphone will be set up on a table at one end of the cabin, and for broadcasts in which a large number of persons will participate a line will be run out on deck to a "standing" mike; Station KJTY will be used for several special programs to be transmitted from the ship on its way to the Antarctic; John N. Dyer, of the CBS field engineering staff, is in charge of the station's technical affairs. . . . Carson Robison's "Crazy Buckaroos," offering original and traditional music of the hill and prairie folk, may now be heard over a WABC-Columbia network every Sunday, Tuesday, Thursday and Friday at 10:30 a.m.; the program is sponsored by the Crazy Water Company of Mineral Wells, Texas. . . . You heard the redoubtable Bing Crosby as his own master of ceremonies when he started on his new series of broadcasts on October 16th; Lennie Hayton's band and a chorus support him; time is 8:30 p.m. EST, and station—oh, of course, WABC and the Columbia network. . . . The Philharmonic-Symphony Orchestra of New York is to be heard over both the Columbia and Canadian networks during its weekly Sunday afternoon broadcasts; from 3:00 to 5:00 p.m. EST. . . . Jack Mitchell, formerly of Mitchell and Dove, vaudeville act with which I had the pleasure of working many times, is back again on the street called broad. after quitting for over three years to peddle insurance in Buffalo; Jack will be heard in radio very shortly, with Bill Brown, golf expert, who was heard on the Richfield Oil program. . . .

FRANK PARKER'S REALIZATION

Frank Parker will realize a great ambition when he takes Jimmy Melton's place with the Revelers Quartet, as the latter leaves that famous organization to sing in light opera with Jeritza; Frank deserves his good luck, for the lad has worked very hard to improve his voice; when I first knew him it was a light lyric tenor; now it has a strong robust quality and his diction has improved one hundred per cent. Good luck, Frank! Stick to your last, boy, and there's no stopping you! . . . NBC has lost that swell orchestra of Wayne King's, and the Lady Esther Serenade to CBS; this series may now be heard over WABC and the Columbia network each Monday from 10:00 to 10:30 p.m. EST. . . . Ed Wynn is supposed to be back on air October 30th with Texaco. . . . Milton Biow, who has long produced radio programs for his own advertising agency, is now operating his own station; he has merged WODA, Paterson, and WAAM, Newark, into a single outlet and plans a still more ambitious combination of stations in New York, Pennsylvania, Maryland and Virginia. Good for you, Milton Biow! Competition is always the life of good old trade. . . . WOR has sold plenty of its time commercially this season. . . . Moran and Mack are under a four-week contract with Fred Waring's sponsors, with an option for a few more weeks if they make good; the boys, who are tried and true comedians, with an ace air-delivery, should more than make good. . . . Vera Van, the personable CBS warbler, will make some records for Victor. . . . Georgie Price and Phil Spitalny's Band are now at the Hotel Paramount Grill, on West 46th St., New York. . . .

A WARM TRIO

And now rumor has it that Bing Crosby and Burns and Allen will play one-nighters together this winter, under the William Morris banner. . . . And Elsie Hitz with Nick Dawson will go NBC this season in a script act titled "Dangerous Paradise," for Woodbury; Elsie made a name for herself last season as the Magic Voice in script act of that name over WABC for Ex-Lax, and also on the Evening in Paris mystery series. . . . General Foods has renewed the "Cape Diamond Light" sketches over WJZ for another thirteen weeks; and "Death Valley Days" commences its third year this month, for the Pacific Coast Borax Company, also NBC blue network. . . . Ridgely Hudson, tenor, who formerly sang with the New York and St. Louis Symphony Orchestras, now has his own period on WMCA, New York; Mr. Hudson, who comes of a family prominent in musical and political history, writes and directs the program, which he calls "The Dream Ship"; he is also the tenor and narrator; with him are Sue Hicks, soprano, of musical comedy and radio fame, and a string orchestra; each Friday evening at 10:45. . . . It's good news that Alex Gray, the romantic baritone of stage and screen, has decided to enter the radio lists once more. . . . Fred Waring discovered Rosemary and Priscilla Lane in a music publisher's place, where the two girls were rehearsing a number; the girls were born in the town of Indianola, Iowa, and their right name is Mullican. . . . Another orchestra, familiar for years on NBC, will be heard over WABC and the Columbia network this winter—Vincent Lopez from the Chez Paree in Chicago; Sundays at 11:30 p.m. and Tuesdays at midnight, EST. . . . "Roses and Drums," that popular dramatic series, will be heard on a new time schedule after October 15th, from 5:00 to 5:30 p.m., EST, each Sunday; WABC and Columbia network. . . . Kate Smith is limping again, because of a bruised right knee due to a fall. . . . There are two new network announcers at CBS; both come from below the Mason and Dixon line; Davison Taylor, 26 years old, was once a Baptist minister, from WHAS, Louisville, Ky.; and Bert Parks, 20 years old, once was an amateur mimic of Charles Chaplin and lately of Station WGST, Atlanta, Ga.; both now are broadcasting from the New York studios, having been chosen from a group of twelve competitors, ten of them veteran radio announcers. . . . The Will Osborne-Pedro de Cordoba period has been renewed; this tri-weekly series is sponsored by the Corn Products Refining Co. and may be heard each Monday, Wednesday and Friday from 10:45 to 11:00 a.m., EST, via WABC and the Columbia network. . . .

GOLDENROD CHANGES TIME

The Goldenrod Revue, featuring Phil Spitalny's Orchestra with Ethel Pastor, soprano, and Nicolini Cosentino, tenor, has moved to a new time period on WABC; they are now heard each Saturday evening at 8:30 p.m., EST. . . . "Gems of Melody" will be the title of two new programs on NBC; the first, which will feature Muriel Wilson and Fred Hufsmith, with Harold Sanford's orchestra, may be heard on Sunday afternoon at 2:45 p.m. EST over an NBC-WEAF network; the second will feature John Herrick, young Boston baritone, and the Sanford orchestra, and will be on Wednesday evenings at 7:15 p.m., EST, over an NBC-WJZ network, both programs sponsored by the Carleton & Hovey Company. . . . Irene Beasley, formerly with Columbia for several seasons, has signed with NBC and has been sent out to their Chicago studios for a series of sustaining programs; Irene is a very clever girl with a distinctive style of her own; you can hear her on Mondays and Fridays over WEAF and network at 6:30 p.m., and on Wednesdays at the same time over an NBC-WJZ network. . . . And now it appears that Benny Kreuger, the leader of WMCA's dance orchestra, is nursing a secret ambition; Benny is yearning to be a great symphonic conductor; instead of tapping a mean jazz tempo, he longs to wave his arms in the throes of Tchaikowsky. Go to it, Benny; may you out-toss Toscanini! . . . WSM, Nashville, Tennessee, boasts of a real honest-to-goodness songwriter on its staff pay-roll; Freddie Rose, who appears five times weekly over this enterprising station with his Radio Song Shoppe, has already three hundred compositions to his credit, and has just tossed off two more—"I Live a Song" and "Suppose We Make a Business Out of Love." Which after all isn't a bad idea—and I think it's a good idea for me to say so long, until next week.

German Station's Aerial To Tower 624 Feet High

A wooden radio tower, the highest ever attempted, 624 feet high, is at present under construction for government accounts at Koblenz, Germany, according to information received by Axel H. Oxholm, Chief of the Lumber and Paper Division of the Department of Commerce, in Washington, D. C.

The German Government after diligent investigation decided to use American southern pine in this structure and in this manner a new outlet for American lumber is found in Europe.

According to Oxholm, who has made a special study of the European wood construction methods, these radio towers are built under the new European system of "modern connectors for timber construction." These connectors consist of disks, plates or rings, inserted between the members to be joined and held together with a bolt. This distribution of the load results in strengthening the joints from four to eight times. An appreciable economy in wood construction costs and obtaining the maximum efficiency from the construction material used are the main advantages. More than fifty wooden towers from 200 to 500 feet have already been erected in Europe, chiefly built of American woods, according to Oxholm. Earlier this year a handbook on this construction system and its application to American conditions for a multitude of purposes was published.

FAKE CHARGED IN BROADCAST OF A MAN-HUNT

A broadcast over WIND, Gary, Ind., and other stations, by the Columbia Broadcasting System News Service, of a police hunt for ten escaped convicts, was accompanied by shots purporting to be those exchanged by hunters and quarry, and caused so much excitement and anger that a complaint has been filed with the Federal Radio Commission in Washington, D. C., that the broadcast was a fake.

The escaped convicts were supposed to be in hiding in a patch of Indiana woods, and the Columbia News editors decided it would be a distinct service to their listeners if a clinical news broadcast of the hunt were executed. The attitude of those who arranged for the broadcast on Columbia's behalf is that arrangements were agreeably made with the State Highway Police.

Hours' Delay Alleged

However, the head of the police, Capt. Matthew Leach, listening in, heard what he said were described by the announcer as shots, and hurried to the scene, only to learn from some of his own men that the police had fired no shots and the convicts never had been sighted. Moreover, he complained, the police telephone was tied up for a few hours by persons seeking information or even, because near the supposed site of the "battle," seeking assurance of personal safety. The chief asserts that the hunt for the fugitives was hampered for hours as a direct result of the broadcast.

WIND itself did not originate the broadcast, but was one of the stations sending out the news service, so officials of Columbia were asked about the matter. Leslie Atlass, vice-president, denied the charge that the broadcast was a fake or that it was malicious or ridiculous, but said he had been reliably informed that the police actually did shoot their revolvers, though not necessarily as a part of the man-hunt, but rather as a mark of enthusiasm during the broadcast.

"We made every effort to broadcast exactly what happened," said Mr. Atlass, who is in full charge of Columbia's mid-West activities.

One Columbia Man Discharged

The Columbia Broadcasting System headquarters in New York City asserted that the broadcast, far from being a misrepresentation, "was substantially correct," adding that the broadcast was made "with the approval and assistance of the authorities." The statement then went on:

"Our investigation does show, however, that a responsible and experienced Columbia man who was in charge at this broadcast, in spite of general instructions as well as specific cautions with regard to this particular broadcast, did connive at increasing the number of shots, although there were shots of spontaneous origin. Because this man was thoroughly aware of Columbia's rigid policy of accuracy and its unswerving rules against sensationalism maintained throughout the company's history, his connection with this organization has beeen terminated."

Police Head Wires Complaint

Capt. Leach wired the Federal Radio Commission the following:

"I desire to file formal complaint in regard to the almost entirely false and fake broadcast by the Columbia Broadcasting Company news service over WIND and other stations. This broadcast seriously interfered with the work of the sixty-five State police under my command and a considerable number of other enforcement officers stationed in the neighborhood of where we thought some escaped convicts might be hiding.

"No shots have been fired to this date by any authorized officer in the pursuance of his duties searching for the ten prisoners who escaped from the Michigan City prison.

Rushes to the Scene

"We wasted several hours of what at that time seemed too precious time in, first, determining there was no truth to substantiate the broadcast and, second, in making an inquiry into the hoax.

"The telephone wires of the State police at their barracks at Chesterton were tied up for several hours by persons who apparently had heard the broadcast and were calling for information. Many of the callers expressed their fright, many of them being residents of the immediate vicinity. I heard part of the broadcast myself, and as soon as I could reach the scene where the broadcast was being put on the air I questioned those in charge and held in custody one of their number for some time until I was convinced there is no law under which I could hold him legally.

"I desire the Federal Radio Commission to make a complete investigation of this broadcast, and I offer the services of myself and men in furthering this inquiry."

Chairman Eugene O. Sykes, of the Commission, refused to comment on the complaint, except to say that the requested investigation would be made. Neither the Commissioner nor any one else connected with that body would say whether there was any ground for action even if the broadcast was not strictly true. A station license is held under the law that provides that operation shall be guided by public interest, convenience and necessity.

TRADIOGRAMS

By J. Murray Barron

One of the features of the National Electrical Exposition just brought to a close at Madison Square Garden, New York City, was the actual operation of a short-wave amateur station, under the auspices of the American Radio Relay League. Through the co-operation of Walt Jablon, factory representative of the Hammarlund Mfg. Co., the Hammarlund "Pro" receiver with quartz crystal filter was in constant operation, signals being received from hundreds of distance stations using a temporary antenna system. In attendance at the A. R. R. L. booth in addition to Walt himself were M. B. Kahn, E. Baunsch, Dave Talley, F. W. Couget C. C. Nuremberg and W. W. Braden.

* * *

To the short-wave enthusiast or fan or experimenter the question of an efficient receiver is so often a problem. That is, to have a set that will perform consistently and bring in the hard-to-get European and other foreign stations. Many who have received a number of these stations have had what might be termed freak reception and it is no way dependable as the performance of recognized short-wave receiver. This does not mean that nobody but those owning laboratory receivers get foreign stations. The goal is to establish a short-wave receiver on a dependable day-and-night basis and not have it in the "occasional" class.

United American Bosch Corporation, of Springfield, Mass., announces a new six-tube automobile radio receiver. This will make three automobile radio models, the latest being the De Luxe Model 160.

* * *

Information furnished as to increased radio costs show labor gets 64% more. The additional increases for a few of the materials that enter into the industry are copper (for wire) 29½%, steel 15%, iron 10%, tin 83%, zinc 72%, lead 48%, silk 55%, and hardwood lumber 65%. All these items enter into the making of a radio receiver and as raw material must stand the extra cost.

* * *

H. A. Hutchins, general sales manager of National Union Radio Corporation, announced the appointment of F. J. Wessner as his second in command of sales. Mr. Wessner has been engaged in sales promotional work with National Union since the formation of the company. He had been Eastern sales manager of Ypsilanti Reed Furniture Company and assistant general sales manager of a cotton goods house. He is now National Union's assistant general sales manager.

LITERATURE WANTED

W. V. Boush, 1107 Camden Ave., Portsmouth, Va.
Edgar R. Jones, 45 LeMarchant St., Halifax, Nova Scotia.
R. Q. Downey, 81 Cuthbert St., Scotia, N. Y.
John S. Becher, 433 Elm St., Holyoke, Mass.
Heim Radio & Electric Shop, 5970 N. 30th St., Omaha, Nebr.
E. L. Horne, Batesburg, S. C.
Ferdinand Owenia, 77 Main St., White Plains, N.Y.
Wm. Parker, 1921 Mona Avenue, Muskegon Hgts., Mich.
Albert Wilson, 2790 Green Street, San Francisco, Cal.

Ultra Violet Tanning Lamps Are Announced

A new ultra violet lamp announced by National Vita Lite Corporation, affiliate of the National Union Radio Corporation, is the result of research and experimentation of two scientists, father and son, over a period of thirty-five years.

Dr. Anton Lederer, Viennese scientist, father of National Union's chief engineer, started on research work involving rare gases, rare metals, and ultra violet sources in 1898. He worked continuously to produce a source of vital ultra violet, which would be safe, easy to handle and economical. He achieved, shortly before his death, his goal of a practical ultra violet source.

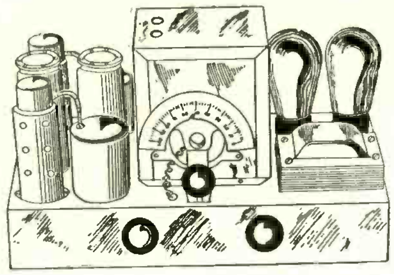
It remained for his son, Dr. Ernest Anton Lederer, to arrange this work for commercial application. The son picked up the threads of his father's work and improved upon them with the fine basic material and improved manufacturing processes which radio has produced. After extensive studies and tests, the Lederer Lamp was declared a commercial practicality and is brought to market by National Vita Lite Corporation.

Two types of lamps are being manufactured. Both lamps are the same in basic construction, the difference being in the kind of glass used in the bulbs. They are designated as the Lederer D-30 for medium fast tanning, and X-30 for fast tanning. They operate at low voltage and therefore, require the Lederer type T-30 transformer for use on 110-120 volts 60 cycle alternating house current.

'Phone Reception Without Requiring Solder or Wiring

By SOL. PERLMAN, E.E.

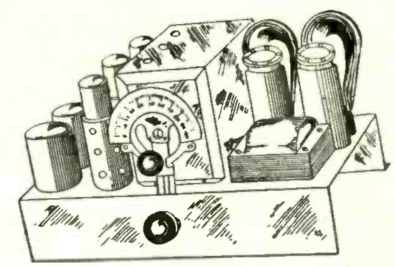
Many shortwave enthusiasts and DX fans are handicapped late in the evening with the cries of disapproval from folk when they have their loudspeaker on. Here is a gadget that will solve the fan's trouble. All that is necessary is to plug it into the receiver and the speaker is automatically stopped. You can listen to your heart's content on this 'Phone Receptor without annoying anyone. No doubt many will find this phone gadget a lifesaver. DX is once again a big interesting pastime. The device may be adapted to the short-wave receivers. In fact any type receiver can use this Phone Receptor with surprising results.



BLUEPRINTS, COILS and CHASSIS

FOR THE TUNED R-F

DIAMOND OF THE AIR



FOUR-TUBE DIAMOND

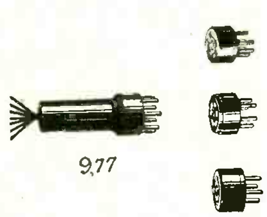
Extremely fine performance, including fetching tone quality, marks the Four-Tube A-C 1933 Diamond of the Air, blueprint of which is now available (half-scale). Many have been surprised that so much can be accomplished on a t-r-f set that costs so little to build. The circuit uses a two-gang 0.00035 mfd.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

Send $3.00 for six months subscription (26 issues) and get the blueprint, two official shielded coils and the drilled metal chassis free. Order PRE-D-4-COMB.

FIVE-TUBE DIAMOND

The Five-Tube A-C 1933 Diamond of the Air provides greater sensitivity than the four-tube model, also somewhat more selectivity, as a three-gang condenser is used. An infallible method of permanently suppressing oscillation is introduced, so that besides having a sensitive and selective set one will have a stable receiver. The tone is most excellent. Send $4.00 for 34 weeks subscription (34 issues) and get the blueprint, three shielded coils and drilled metal chassis free. Chassis is 13.75 x 9 x 3 inches. Order Cat. PRE-D-5-COMB.

Analyzer Plug and Adapters



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

0-10,000-Ohm Resistance Meter

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

We do not pay postage on resistance meter. Average postage 17c.

RADIO WORLD and RADIO NEWS } $7.00

Get both of these mazagines for one year for $7.00, although the regular subscription price of RADIO WORLD alone is $6.00 a year and that of "Radio News" alone is $2.50 a year. Instead of paying $8.50 you pay $7 and you get 52 issues of RADIO WORLD (one a week) and 12 issues of "Radio News" (one a month). "Radio News" recently bought "Citizens Radio Call Book," and "Technical Review" and consolidated them with "Radio News." This offer at this combination price applies only to United States and possessions. Send $7.00 and order Cat. PRE-RWRN.

To Canadian and other Foreign subscribers the combination price offer is at $8.50 for these two magazines. Order Cat. PRE-FOR-RWRN.

RIDER'S MANUAL

The standby of the service man is John F. Rider's "Perpetual Trouble Shooter's Manual."

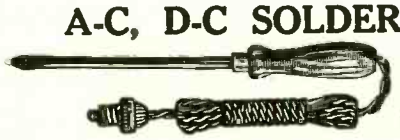
Vol. 2 contains additional diagrams on the same basis as above, but in Vol. 2 there is no duplication of any of the diagrams printed in Vol. 1.

To get Vol. 2 free, send $9.00 for 1½-year subscription (78 weeks) and order Cat. PRE-RM-2.

PHONOGRAPH MOTOR

Allen-Hough synchronous phonograph motor, 78 revolutions per minute; takes up to 12-inch records. Works from a-c line, 50-60 cycles, 105-120 volts. Equipped with felt-covered turntable. To start the motor give it a slight impetus. Fits into 3-inch depth, hence handy for compact installations. Given free with 34-weeks subscription at $4.00. Order Cat. PRE-PHOMO.

A-C, D-C SOLDERING IRON



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

DOLLAR SPECIALS

R-F CHOKE COILS

These coils have 50, 100, 200, 400 and 800 turns, diameter 1 inch, and are suitable for detector plate filtering, screen filtering, grid and plate loads, etc. The 50 is for short waves, 100 for television band, 200 for broadcast band, 400 for high intermediate frequencies (450 to 300) and 800 for lower intermediate frequencies. Any four, or four of a kind, or combinations not exceeding total of four, sent free on receipt of $1.00 for 8 weeks trial subscription. Order Cat. PRE-4-CH and state chokes desired, by quantity and number of turns.

TWO BOOKS BY ANDERSON AND BERNARD

"The Superheterodyne," by J. E. Anderson and Herman Bernard. A treatise on the theory and practice of the outstanding circuit of the day. Special problems of superheterodynes treated authoritatively.

"Foothold on Radio." A simple and elementary exposition of how broadcasting is conducted, with some receiver circuits and an explanation of their functioning. Both books sent free on receipt of $1.00 for 8 weeks trial subscription. Order Cats. PRE-SH-FH.

CHOICE OF PANEL TYPE METERS

One meter sent free with each $1.00 trial subscription (8 weeks). Order Cat. PRE-MTR and add the number of the meter to the catalogue number. Any number of meters may be ordered on the equivalent extended subscription basis.

0-6 Voltmeter D.C.	No. 326
0-50 Voltmeter D.C.	No. 337
6-Volt Charge Tester D.C.	No. 23
0-10 Amperes D.C.	No. 338
0-25 Milliamperes D.C.	No. 325
0-50 Milliamperes D.C.	No. 350
0-100 Milliamperes D.C.	No. 390
0-300 Milliamperes D.C.	No. 399
0-400 Milliamperes D.C.	No. 394

HANDY PACKAGE OF PARTS

One grid condenser of 0.00025 mfd., with clips; one 5-to-7 meg. fixed grid leak; one knob with ¼-inch shaft; one a-c cable and plug. All sent on receipt of $1.00 for 8-weeks trial subscription. Order Cat. PRE-HANPKG.

SHIELDS FOR 57, 58 TUBES

Aluminium shields of the type specified by the tube manufacturers for sensitive circuits, so that the shield top fits snugly about the tube dome, are obtainable, six free on receipt of $1.00 for 8 weeks trial subscription. Order Cat. PRE-TUBSH.

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(WE PAY POSTAGE ON ALL PRODUCTS LISTED ON THIS PAGE, EXCEPT OHMMETER).

NEW MODEL SHIELDED TEST OSCILLATOR!

Either 50-150 kc Fundamental Model, a-c or battery; or 500 to 1,500 kc Fundamental Model, (broadcast band) a-c or battery, available.

Either model FREE with two-year subscription for Radio World (104 issues) $12.00

AN improved modulated test oscillator, fundamental frequencies, 50 to 150 kc, enabling lining up of intermediate frequency amplifiers, t-r-f and oscillator circuits, is now ready. It is shielded in a metal box 9⅛" wide x 6¼" deep x 4⅛" high, with beautiful Japanese finish. The test oscillator is obtainable in two models, one for a-c operation, the other for battery operation. The same cabinet is used for both.

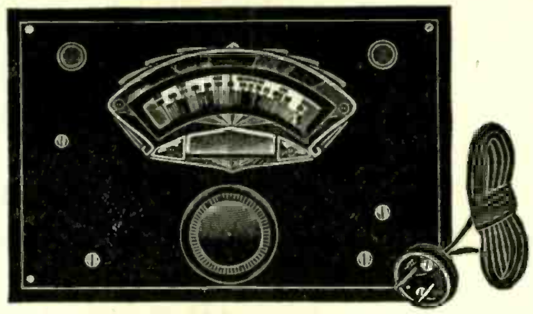
The a-c model not only is shielded but has the line blocked, that is, radio frequencies generated by the oscillator cannot be communicated to the tested set by way of the a-c line. This is a necessary counterpart to shielding, and a special circuit had to be devised to solve the problem.

The modulation in the a-c model is the a-c line frequency, 60 cycles, effected by using the line voltage on the plate of the tube. In the cabinet there is a very high resistance between the shield cabinet and the a-c, a double preventive of line-shorting and application of a-c line voltage to the user.

The oscillator is equipped with an output post. No ground connection need be used, as the circuit is sufficiently grounded through the power transformer capacity to prevent body capacity effects in tuning.

The frequencies are more accurately read than normal use requires, being never more than 2% off, and usually not more than 1% off, many readings being right on the dot (no discernible difference). The frequency stability is of a high order from 100 to 50 kc, and somewhat less from 100 to 150 kc. Zero beats are guaranteed at all frequencies.

The oscillator was designed by Herman Bernard and is manufactured under the supervision of graduates of the Massachusetts Institute of Technology.



The test oscillator has a frequency-calibrated dial, 150 to 50 kc, with 1 kc separation between 50 and 80 kc and 2 kc separation between 80 and 150 kc. Intermediate frequencies are imprinted on the upper tier. Broadcast frequencies are obtainable on tenth harmonics (500 to 1,500 kc).

RADIO WORLD
145 West 45th St., New York, N. Y.

THE a-c model is completely self-operated and requires a 56 tube. The battery model requires external 22.5-volt small B battery and 1.5-volt dry cell, besides a 230 tube. The use of 1.5 volts instead of 2 volts on the filament increases the plate impedance and the operating stability.

The battery model is modulated by a high-pitched note. Zero beats are not obtainable with the battery model.

Directions for Use

Remove the four screws and the slip cover, insert the 56 tube in its socket, restore the cover and screws, connect the a-c attachment plug to the wall socket, and the a-c test oscillator is ready for service.

For testing some particular set, follow the directions given by the designer or manufacturer. In the absence of such directions, use the following method.

Mentally affix a cipher to the registered frequencies on the lower tier (so 50 is read as 500, and 150 as 1,500), and set the dial for any desired broadcast frequency. Connect a wire from output post of test oscillator to antenna post of set. Leave aerial on for zero beats, off otherwise. At resonance the hum will be heard. Off resonance it will not be heard. For testing intermediate frequencies, connect the wire to plate of the first detector socket. The first detector tube may be left in place and bared wire pushed into the plate spring. The intermediates then are tuned for strongest hum response. If an output meter is used, tune for greatest needle deflection.

The battery model is connected to voltage sources as marked on oscillator outleads and is used the same way.

Vol. III of RIDER'S MANUAL (A New Book)

Just out. John F. Rider's Vol. III Manual weighs nearly 11 lbs. and has 1,100 pages, all diagrams of commercial receivers, etc. (no text). Sets announced up to May 1st, 1933, are included—and complete information on every one, including resistance values. The volume is original and necessary and does not repeat data that are in Vols. I and II.

A Chronological Catalog and Index of all nationally-advertised radio receivers manufactured and sold in the United States between January, 1921 and January, 1933 are contained in Volume III. This list will be of tremendous aid in the identification of receivers for which the model number is not known.

Complete data include schematic wiring diagrams; chassis wiring diagrams; parts layouts; photographic views of chassis; socket layouts; voltage data; resistor values; condenser values; location of alignment and trimmer condensers; alignment and trimmer adjustment frequencies; intermediate-frequency amplifier peaks; alignment and intermediate-frequency adjustment instructions; color coding; transformer connections; point-to-point data; continuity test data; parts list with prices; special notes.

Complete tabulation of tube data showing electrical characteristics and constants for all of the tubes employed in radio receivers and amplifiers since 1921. Also a table of interchangeable types.

A complete table of I-F. peak frequencies as used in radio receivers. This list augments the information of this type shown upon the diagram pages. Intermediate-frequency amplifier peak information is very important because quite a few of the manufacturers employ more than one figure in their year's production. A wrong guess on your part means trouble.

Order Cat. RM-3 @ $7.50. Remit with order and we pay postage. Order C.O.D. and you pay postage.

Volume II—Order Cat. RM-2 @ $6.50

Volume III of Rider's Manual has a page sequence in accordance with Vols. I and II, and is not cumulative, or repetitive of the earlier volumes. However, it contains an index for all three volumes.

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SPECIAL SMALL POWER TRANSFORMER

Filament-plate transformer, for oscillators, 1 or 2-tube sets, etc.
Primary, 110 volts a-c.
Secondary A, 2.5 volts, center-tapped; stands up to 3 amperes.
Secondary B, 110 volts, not center-tapped.
Excellent for test oscillators with a-c in plate.

Price, $1.10

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NEW RADIO AMATEUR'S HANDBOOK, 180,000 words, 207 illustrations, 218 pages (10th edition, issued 1933). Issued by the American Radio Relay League. Price, $1.00 per copy. Radio World, 145 West 45th Street, New York, N. Y.

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"The Inductance Authority"

By EDWARD M. SHIEPE, B.S., M.E.E.

Coil Winding for All Radio Frequencies Without Any Computation Whatever!

THE ONLY BOOK OF ITS KIND IN THE WORLD, "The Inductance Authority" entirely dispenses with any and all computation for the construction of solenoid coils for tuning with variable or fixed condensers of any capacity, covering from ultra frequencies to the borderline of audio frequencies. All one has to do is to read the charts. Accuracy to 1 per cent. may be attained. It is the first time that any system dispensing with computation has achieved such very high accuracy and at the same time covered such a wide band of frequencies.

A condensed chart in the book itself gives the relationship between frequency, capacity and inductance, while a much larger chart, issued as a supplement with the book, at no extra charge, gives the same information, although covering a wider range, and the "curves" are straight lines. The condensed chart is in the book so that when one has the book with him away from home or laboratory he still has sufficient information for everyday work, while the supplement, 18 x 20 inches, is preferable for the most exacting demands of accuracy and wide frequency coverage.

From the tri-relationship chart (either one), the required inductance value is read, since frequency and capacity are known by the consultant. The size and insulation of wire, as well as the diameter of the tubing on which the coil is to be wound, are selected by the user, and by referring to turns charts for such wires the number of turns on a particular diameter for the desired inductance is ascertained.

There are thirty-eight charts, of which thirty-six cover the numbers of turns and inductive results for the various wire sizes used in commercial practice (Nos. 14 to 32), as well as the different types of covering (single silk, double silk, single cotton, double cotton and enamel) and diameters of ¾, ⅞, 1, 1⅛, 1¼, 1⅜, 1½, 1¾, 2, 2¼, 2½, 2¾ and 3 inches.

EACH turns chart for a given wire has a separate curve for each of the thirteen form diameters.

The two other charts are the tri-relationship one and a frequency-ratio chart, which gives the frequency ratio of tuning with any inductance, when using any condenser the maximum and minimum capacities of which are known.

The book contains all the necessary information to give the final word on coil construction to service men engaged in replacement work, home experimenters, short-wave enthusiasts, amateurs, engineers, teachers, students, etc.

There are ten pages of textual discussion by Mr. Shiepe, graduate of the Massachusetts Institute of Technology and of the Polytechnic Institute of Brooklyn, in which the considerations for accuracy in attaining inductive values are set forth. These include original methods.

The curves are for close-wound inductances, but the text includes information on correction factors for use of spaced winding, as well as for inclusion of the coils in shields. The book therefore covers the field fully and surpasses in its accuracy any and all mechanical aids to obtaining inductance values.

The publisher considers this the most useful and practical book so far published in the radio field, in that it dispenses with the great amount of computation otherwise necessary for obtaining inductance values, and disposes of the problem with speed that sacrifices no accuracy.

The book has a flexible fiber black cover, the page size is 9 x 12 inches and the legibility of all curves (black lines on white field) is excellent.

Order Cat. IA @ $2.00 (book and supplement). Remit with order and these will be sent postpaid to any destination. Order C.O.D. and you pay the postage.

Accuracy of 1% or Better, Hence Fulfilling Requirements Even of Engineering Practice

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