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RADIO WORLD

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The First and Only National Radio Weekly

603d Consecutive Issue Twelfth Year

Dollars for Ideas

(SEE PAGE 3)

A-C Measurements

How to Use Slide Rule

7-Tube A-C Super of Remarkable Performance

Increase in air advertising is one of the most encouraging signs of a clear, if possibly somewhat rough, road ahead, says M. H. Aylesworth (above). See page 20.

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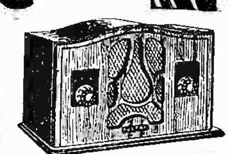
31 FAIR WARNING



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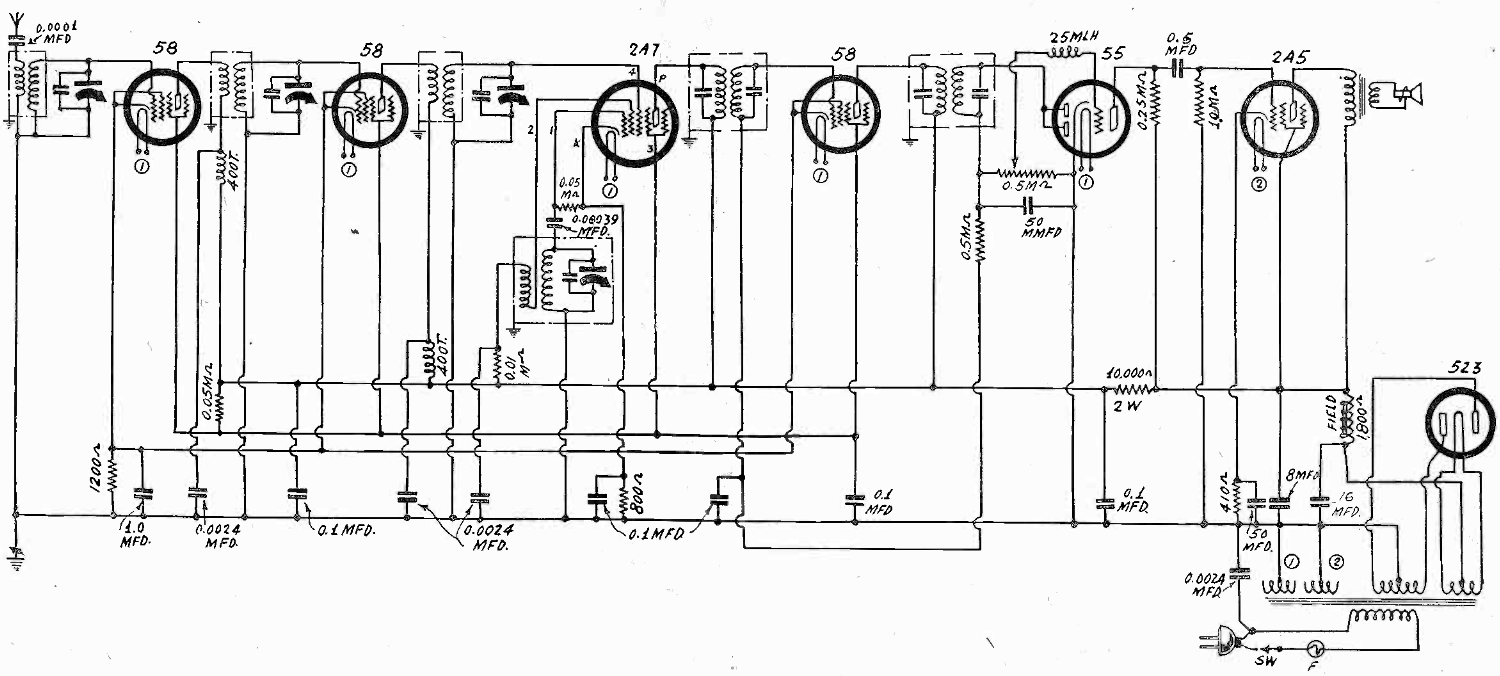
REAL RESULTS FROM 7 TUBES

Tracking Condenser Used in Receiver That Brings in Distant Stations 10 kc Removed from Locals

By Herman Bernard



A seven-tube circuit that produced exceptionally fine results and met the author's test of tuning out the strongest local in the metropolitan area, and bringing in a distant station 10 kc removed from that local. A tracking condenser was used. The r-f and oscillator secondary inductances have to be held to 1 per cent. for use of such a condenser.

SUPPOSE one desires to build a seven-tube a.c. superheterodyne. What requirements must be fulfilled before the performance will be satisfactory? In the light of increasing experience with the superheterodyne it is possible to press the results considerably beyond even those of last year, a tribute to the fact that the science is advancing.

Certain fundamental requirements for the receiver may be set forth:

(1) There should be sufficient selectivity ahead of the modulator to prevent squeals due to heterodyning of selected frequencies with insufficiently-rejected frequencies.

(2) The first detector should be able to stand any likely amplitude impressed on it due to combination of signal amplitude with oscillator amplitude, the chief point referring to the oscillator not overloading the modulator.

(3) No part of the audio system should be subject to manifold overload.

(4) The r-f and i-f levels should be stable. (Due to two-stage resistance-coupled audio the a.f. will be stable.)

The Local Interference

Now let us look into these requirements a little more fully.

As for the first, sufficient r-f selectivity, any one who has used a test oscillator at station frequencies in conjunction with a superheterodyne knows that with a test oscillator several response points (not due to harmonics) will result as one device is changed in frequency and the other remains fixed. This is why t-r-f systems are recommended for calibration of oscillators, using station frequencies as standards. The extra responses often can be traced directly to frequencies equalling those of local stations. The off-resonance local stations are getting by a bit, and the rejection of them can be improved only by improving the selectivity. Reducing the sensitivity of the set merely begs the question.

There will be adequate pre-selection if there are two stages of t-r-f, tuned input to the modulator, and of course tuned oscillator, with an extra provision. In other words, a four-gang condenser may be used. The extra provision is a series condenser in the aerial circuit, unless a very short aerial is used, because the looser the coupl-

(Continued on next page)

(*Continued from preceding page*)

ing at that critical point, the greater the actual selectivity. In fact, even in poorly-designed superheterodynes it is possible to eliminate heterodyne squeals by reducing the aerial height or length, or using a series condenser as diagramed, although the receiver may not be designed to give adequate quantity of sound on the basis of the diminished sensitivity. The present set is well designed. The argument that antenna input should be high so noise will be low compared to it does not hold for superheterodynes as has been proved for congested centers.

A Custom Installation

In or near large centers of population the series condenser or short aerial is necessary. In other localities the series condenser may be omitted or the aerial may be longer, or higher, or both longer and higher, which is one point in favor of knowing something about radio, so that a receiver can be accommodated quite simply to the exigencies of the location.

The plate leads underneath the chassis should be shielded at the r-f level and the shield grounded, so shielded wire may be used; and also the wire from antenna post of set to antenna terminal of coil should be shielded. So, too, should be the leads to overhead grids (control grids of 58's and 55 triode), and the tubes should be in grounded shields. Connection of tube shield to cathode, accomplished in the new form-fitting tube shields, is satisfactory. Leads from condenser stator to grid connection of r-f coils should be similarly shielded.

The shielding is introduced in these wiring directions so that the pickup due to these leads will be killed off, since any such pickup subsequent to the antenna stage will be without benefit of any selectivity derived from the preceding tuned stage or stages.

The r-f level is of the high-gain type, and the coils usually provided for such a circuit may have around 25 primary turns wound over 130 secondary turns, for 0.00035 mfd. r-f tuning, form diameter 1 inch. aluminum 2 in. diameter shield assumed, and secondary wire No. 32 enamel, primary wire size not important.

Conversion Conductance

As for the second requirement, that the second detector should be able to stand what's put into it, this usually takes the form of recommending a negative bias for the modulator equal to 1 volt more than the maximum peak voltage obtainable from the oscillator under specified coupling conditions. The value of the station carrier component need not be considered, as the extra volt takes care of that small quantity.

The circuit shown was built, and with a 12-turn tickler wound over an 80-turn secondary, wire, form and shield as previously, the highest amplitude of oscillation was near the high frequency end, equalling 5 volts. So the negative bias provided for the modulator (pentode control grid) of the 2A7 was fixed at 6 volts. The resistor to accomplish this, when the screen voltage was 80 volts and the plate feed was 230 volts, was 800 ohms.

The tickler therefore was smaller than normally recommended, for looser coupling results in a reduction of intensity of harmonics from the oscillator, although at lower conversion conductance. In small sets it may be important to keep the conversion conductance as high as possible, but in larger sets there are more serious requirements, since heterodyne squeals are not to be tolerated. R-f gain sacrificed for greater selectivity may be compensated for subsequently.

Second Detector Protected

The second detector is important because harmonics can be generated there by overload as well as anywhere else, due particularly to association of the triode amplifier with the diode detector. The second detector, considered alone, is two parallel diodes, both duo-diode units tied together, which doubles the current-handling capacity, or, assuming some certain load resistance value, doubles the amount of voltage that may be put in. The subject may be dismissed with the statement that the second detector, gaited this way, is practically removed from possibility of overload, so far as the diodes are concerned, and these are in fact the detecting agency. But the triode is associated with the second detector as first audio amplifier, diode-biased, and should be considered under the third classification, that no part of the audio system should be subject to manifold overload.

Now, it is possible to overload any audio system, but the point stressed here is that the receiver, in its actual operating condition, should not be a constant source of harmonic distortion. If so much voltage were put into the second detector that the triode associated with it would be called upon to handle a signal of 30 volts or so (not hard to do), then all strong local stations would be difficult to tune in properly. There would be double-hump tuning, that is, local stations would come in, with best clarity under the circumstances, one side of true resonance, and equally well on the other side of true resonance, the quality condition not signifying reception with absence of distortion on either side, but local reception under these conditions of some distortion at best, the benefit of resonance being sacrificed, and operation confined to some productive portion of the triode's characteristics, which part of the curve, being so near cutoff, can not be free from distortion.

Second Detector Stands 17 Volts

Therefore considerable experimenting with duo-diode triodes and duo-diode pentodes was necessary before a satisfactory condition could be achieved. This experimenting has been done by the author, who has spent many hours testing the receiver performance, using the 55 and 2B7, and the results with the 55 will be found to conform to reproducable practice, though constants are somewhat at variance with data supplied by tube manufacturers. The tube manufacturers are not wrong, but they are not the ones who have to answer immediately for unexpected troubles that arise in the use of rather new tubes.

Only one stage of intermediate amplification is used, as the sensitivity developed was keen enough indeed, though two stages could be used, with filtration then needed in that channel, but no changes in the second detector and audio systems would be required. However, the present discussion is confined to the circuit as shown, for this is the one that was built, and from which results were obtained that met all preliminary requirements of selectivity, sensitivity and tone.

Output Tubes

The second detector could stand 17 volts or so, particularly as the high voltage is fed to the plate load resistor of 0.25 meg. (a value preferred to lower resistances previously suggested in tube data sheets, the 0.25 meg. now being adopted by the tube manufacturers as standard). The voltage at this point in the constructed set was 350 volts. No tube data show the use of this tube at such high voltage, but the one object of the high voltage is to permit distortionless operation of the triode of the 55 at the momentarily high rectified voltage developed in the second detector during strong passages of speech or music. That is, instead of working well at 12 volts negative bias, but not much beyond, the tube is good for 17 volts, but not much beyond. These extra 5 volts make quite a difference. The triode does not choke up on those strong passages, nor is there double-hump tuning, which would be another evidence of the same trouble. Here the trouble is avoided. Certainly this is a better way to use the 55 in such a sensitive circuit than the method normally shown.

Manifold overload refers to repeated circuit points at which distortion may be experienced. If the output tube is a 2A5, biased around 20 volts or so, due to the higher plate voltage, not only is the power output raised, but also up to 5 volts or so of rectified diode-rectified voltage may be fed to the triode of the 55 without any extra distortion from the output tube. There will be some overload on strong passages, but this is infrequent, not so serious, does not introduce double-hump tuning, and is a possibility in any receiver. This is merely repetition of the statement that any system may be overloaded.

The use of the 2A5 is gratifyingly consistent with the feed from the 55, as in the region where the 55 works best are found output voltages less than the negative bias on the output tube. The sensitivity of the 2A5 (or the 47, if that tube is to be used), is a requisite to satisfactory quantity of sound, where the 55 tube drives the output tube. If the 45 or 2A3 is to be used an extra stage of audio would be necessary, and the driver would have to be a 45, 2A3 or 2A5 or other power tube, as the normal drivers will not stand the high signal voltage. For instance, the 53 certainly will not, with its meagre 3 volts negative bias, nor will even the 56, with its 10-volt bias at 250 plate volts, or 13-volt bias at 350 volts. It can be seen that the audio becomes a bit complicated when an extra stage is introduced, just as would the i-f level if an extra stage were put there.

Oscillation

R-f oscillation is prevented by the use of choke-condenser filtered plate circuits. The negative bias, higher than usual, augments this correction. Since selectivity, not amplification, is the prime requirement, the bias will be around 5 volts, or nearly twice as great as fixed bias normally recommended for these tubes at 250 volts, though here the B voltage is 230 volts.

The intermediate level offered no difficulties as to curing oscillation, so long as the same precautions were taken as to use of shielded wire as at the r-f level, but choke-condenser filtration was not found necessary in the plate circuits, hence is omitted from the diagram of the i-f stages.

The resistor in series with the oscillator Grid No. 2 (really its plate) is not there especially for filtration, though with the condenser it provides some of that too, but is mainly to insure the B voltage always being less than 200 volts. Such is the standard recommendation for voltaging Grid No. 2 this tube.

The leak in the last audio stage may be as high as is consistent with a plate current drain of not more than 40 ma under strongest signal conditions. Hence the measurement should be made on the basis of a strong signal input, a test oscillator with its constant modulation being preferable. If the current runs around 50 ma or more it is a sure sign that there is grid current and that its effect (due to no stopping condenser between grid and leak) is to make the tube lose bias.

Values Considered

Values up to 1.0 meg. are standard recommendations, but much more than 1.0 meg. would be necessary for full support of the low notes, so raise the value of this resistor to multiple megohms, but not beyond the point where the bias loss is introduced. The meter should be in the plate circuit only, when the measurement is made. The screen alone will draw 10 ma, approximately, so making both screen and plate currents flow through the meter might lead to wring conclusions.

Tracking Condenser

There is no padding condenser shown in the oscillator tuning, for a tracking condenser was used. It is possible to obtain good results either way, but in favor of the tracking section it can be said that the dial set-

A THOUGHT FOR THE WEEK

THOSE "Two Black Crows" (Moran and Mack) are coming into their radio own again. These blackface comedians start again on October 25 with Waring's Pennsylvanians over the Columbia Broadcasting System after a lapse of five years since they appeared originally over the same network. Moran and Mack won much fame and considerable fortune when, at the end of the Great War, they teamed up and played from coast to coast; their negroisms of the drawling southern rather than the hot Harlem type, made the whole country laugh immoderately. It is said that nearly 4,000,000 of their records were sold in 1927. They have been the greatest blackface favorites since the days of McIntyre and Heath and Williams and Walker. Radio listeners will undoubtedly get a big kick out of these original murderers of college English.

tings hold more closely in the long run, as a series padding condenser, with its mechanical aspects subject to temperature effects, as well as its dielectric subject of jar and moisture consequences, will change capacity a bit. And the change is in a circuit where small changes make large resultant differences.

It is not so important that air-dielectric condensers be used in intermediates as that they be used in padding. So a tracking condenser may be viewed as an air-dielectric tuning condenser with the effect of air-dielectric padding condenser.

The usual padding condenser type circuit has a regular gang section's capacity reduced by a series condenser. A tracking section has specially cut plates, based on minimum circuit capacities and inductances being held close. The r-f secondary inductance for the condenser used is 242 microhenries and the oscillator inductance is 135 microhenries.

No other intermediate frequency than 456 kc may be used for this tracking condenser, but the 465 kc and equivalent transformers all may be tuned to 456 kc, and besides all the large condenser manufacturers have tracking condensers for 456 kc i-f, though the inductance requirements (which they will furnish) may be somewhat different than those given.

The problem is where to line up a system that includes a tracking section. The capacities can be set only in one way, where by padding, in the oscillator at least, capacity may be adjusted both by series and parallel methods.

Trimming in Middle of Band

It was found by experience that the best point at which to line up is at or near the second harmonic of the intermediate frequency. This would be 912 kc as literal second harmonic, but if a station has to be used as test, one at or near 900 kc would be satisfactory.

One reason for selecting what is approximately the geometric mean of the broadcast band is that any disparities are reconciled midway as to the two extremes. It must not be expected that the tracking will be utterly perfect, as at some points in all systems it will be 5 kc off, and that is considered close work.

Test of Receiver

Squeals that may appear around the 900 kc position will denote the right point for adjustment, and if there are such squeals, the trimmer condenser adjustments may be made on the basis of eliminating them, which is consistent also with peaking, for when the setting is correct there will be no more squeal trouble, except possibly around 1,400 or 1,500 kc, which would be due to insufficient shielding of r-f tubes, leads, etc., including possibly the omission of a shield over the extreme top of the first or second r-f tube. Such seemingly small things do make a difference in a sensitive receiver like this.

The set was built by the author, the diagram showing the result of several changes. The effort was one to create a simple, inexpensive but dependable receiver, using not many tubes, but giving abundant results.

The test usually made of receivers by the author, that they must tune out WOR, Newark, N. J., the strongest local, and tune in WLW, Cincinnati, 10 kc lower than WOR's 710 kc frequency, proved successful.

It is excellent practice, in lining up intermediates, and as a concession to the impracticability of doing a finely-balanced job of it with a test oscillator and even an output meter, to make the final readjustment on the basis of the i-f (slightest imaginable change in setting of the set-screw governing the condenser) when a distant station 10 kc away from the local is tuned in. The adjustment is made for getting rid of any trace of interference from the distant station, if such trace exists at all. And while it has been said that the i.f. must be 456 kc, this is true if all constants are held as prescribed, which they might not be in a complete sense, and the tiny change in i. f. (perhaps a fraction of 1 kc) may be made, and in the right direction, by the method just outlined, although the test frequency at the carrier level should not be much more than 200 kc removed either side of the 900 kc point.

Since WOR can be tuned out, WLW tuned in, of course stations 10 kc removed from other local stations (since these other locals are weaker) also are brought in. Many who live in or near large cities set up this separation as a requirement to their enjoyment of a radio receiver, and as for those living farther from large centers, certainly since there is no sideband cutting, they have use for this excellent selectivity too.

The 2B7 Discussed

The fundamental design offers about the optimum obtainable. There would be no advantage, for instance, in using a 2B7, which is like the 55, but the amplifier is a pentode. The reason is that this tube is intended for far less sensitive receivers, for it will stand only 3 or 4 volts input and cuts off very quickly. Double-hump tuning would result, and the gain established at audio frequencies would be beyond capitalization, as not all the voltage developed across the diode load resistor could be put into the amplifier pentode. We have been discussing 17 volts, and now we consider a tube that stands, say, 4 volts, so we could amplify only about one-quarter of what is there, which provides an excellent reason for not using the tube in this circuit. As a general proposition, the 2B7 may be used in a less sensitive tuner to feed a Class A driver which feeds a power output, but that gets us into a different circuit then the one we are discussing.

However, for the benefit of those having trouble with the 2B7, it can be said that the load resistor may be 0.5 meg. safely, if the return is to around 350 volts, for the plate side, whereupon the screen may be tied to an r-f bias, say, 4 to 7 volts. Zero voltage on the screen gives virtually no signal result at all, but 1 volt begins to make the tube show signs of life, and somewhere between 4 and 7 volts (not critical) the results are good, but, as stated, little can be put into the pentode.

Substitutions

The standard recommendation is for around 25 or 30 volts on the screen, but then the plate voltage is 250 volts, the plate resistor 0.25 meg. This works well also, but the sensitivity is not nearly so great as that obtained by the method previously discussed.

The circuit may be built by even a novice without fear of "no results." Of course some departures are permissible, and if one feels fully able to do so he may make the substitutions, although the author stands ready to offer assistance to any who desire to inquire about the construction, lining up and operation of this receiver.

Moreover, the results were good enough to warrant the preparation of some special material for encompassing compactness in construction as well as accuracy of coils for the tracking condenser used. Also, the frequencies have been calibrated carefully and it is hoped that a frequency-calibrated dial, so dear to the heart of all seekers of accuracy, with a 10 kc separation all over the scale, will be prepared.

As stated, for such a dial to be of much consequence the constants in the circuit must not shift much under varying conditions of humidity, temperature, pressure and the like. Previous experience with padded circuits led to the abandonment of hopes of such stability over long periods, but in early tests the tracking method has stood up well, and if this continues for a few weeks it is hoped the frequency-calibrated dial will be prepared and constructional data on the circuit supplied.

One thing must be borne in mind regarding such a dial, and it is a fact that results in some humorous inquiries at times (though intended to be serious): when a frequency calibrated dial is used, the condensers and coils must be exactly as specified, and no substitution of these two constants can be made with any hope of a coinciding the tuning with the calibration.

DOLLARS FOR IDEAS

Readers are invited to send in letters, with diagram when illustration is helpful, revealing any idea originated by them for simplifying procedure, widening the application of various parts or circuits, improving accuracy, or doing anything else helpful in radio technique.

Each week an award of $10 will be made for the letter regarded as best, and $5 for the one regarded as next best, the judges being the Editor, the Managing Editor and the Technical Editor of RADIO WORLD. *In the event two of a tie the full award for each such tie will be given to all so tied. The decisions of the judges are final in all respects.*

Besides the letters receiving the two awards, other letters printed will be paid for at $1 each.

All letters should be addressed to "My Idea Editor, care RADIO WORLD, 145 *West 45th Street, New York, N. Y." We can not undertake to return any of these letters.*

NEW CATALOGUES ISSUING

Radio fans and home experimenters who are ready to purchase should watch the radio feld pretty closely, for the catalogs are commencing to make their appearance. If one is to avoid regrets and dissatisfaction, he should be extremely careful thoroughly to understand everything so that there can be no question as to what the price includes. If there is any question in his mind he had better write the mail order house and get a complete understanding. Any reliable organization wants to give satisfaction. The buyer, too must be careful and take nothing for granted. There are enough reliable organizations with real ethics without bothering with the questionable or gyp house.

ASSIGNMENTS

London Radio Stores, Inc., 130 W. 17th St., New York, N. Y., assigned to Darcy V. Wonders, 220 East 42nd St., New York, N. Y.

Steinway Radio Corp., 130 West 17th St., New York, N. Y., assigned to Darcy V. Wonders, 220 East 42nd St., New York, N. Y.

PETITION IN BANKRUPTCY

Filed By

Cavalier Radio Corp., involuntary. Standard Transformer Corporation included among creditors.

CORPORATION REPORTS

Madison Square Garden Corporation reports net loss of $165,523 for the three months ended August 31, 1933. after deduction of charges and taxes. In the same period of the preceding fiscal year the net loss was $156,144. These figures are exclusive of net loss of $31,839 on Boston Madison Square Garden Corporation, a partly owned subsidiary, compared with $35,893 net loss for the same period in 1932.

A-C INSTRUMENTS

Their Calibrations and Use— Input Voltages and Output Powers Measured

By Einar Andrews

MEASUREMENTS of a-c currents and voltages are necessary for learning about the performance of radio receivers. Sometimes it is necessary to measure the a-c input voltage, sometimes the output voltage, sometimes the output power, sometimes the input voltage to certain tubes.

An instrument often used for measuring a-c is a thermocouple galvanometer. This instrument is intended primarily for the measurement of resonance and selectivity, but it may be also used for measuring currents and voltages provided that it is suitably calibrated.

Calibration of Galvanometer

The galvanometer differs from an ammeter only in that in the galvanometer the scale is arbitrary, usually from 1 to 100, while in the ammeter it is in terms of current units. The ammeter gives the current directly in amperes or in one of its subdivisions, the galvanometer merely gives a deflection that is proportional to the current. Hence to calibrate the galvanometer it is only required to find out the relation between the current and the deflection.

In Fig. 1 is a circuit set-up suitable for calibrating a thermocouple type of galvanometer against a d-c milliammeter. The current through the circuit is varied by varying both the voltage of the battery and the resistance in the rheostat Rh. G is the galvanometer to be calibrated and RS is a reversing switch. M is the d-c milliammeter.

Calibration Curve

The object of the reversing switch is to enable the operator to send the current through the thermocouple in both directions. This is necessary because a thermocouple is not equally responsive in both directions, and all alternating current flows first in one direction and then in the other. Hence to get a true calibration it is necessary to note both deflections on the galvanometer and to record the average value against the d-c reading on M. If the deflection on M changes when the current through G is reversed it is necessary to readjust the rheostat so that the deflection on M is the same in both instances. It is not likely that there will be any change in M when RS is reversed.

The average deflection on G should be observed for every major division on the d-c meter scale and the two sets of values should be entered on a graph, with average deflections on G as abscissas and corresponding readings on M as ordinates. This curve is the calibration of the thermocouple meter G and holds for alternating as well as direct current.

It is clear that the range of the meter M should be about the same as that of G. For example, if the maximum deflection on G occurs when the current is 100 milliamperes, M should be a meter of 0-100 milliampere scale, or one of still greater scale. For most accurate calibration the two ranges should be equal.

Calibration of Thermocouple

It may be that a thermocouple is available, possibly one that has been constructed at home by crossing two wires of dissimilar metals. The circuit for this calibration is indicated in Fig. 2. This differs from Fig. 1 only in that we need a microammeter M1. TC and M1 in Fig. 2 together form the galvanometer G in Fig. 1.

The sensitivity of the meter M1 depends on the sensitivity of the thermocouple and on the range of currents to be measured with it. If the thermocouple has been purchased the range is known, but if it has been constructed it must be determined experimentally. For very sensitive thermocouples there are required microammeters as sensitive as 0-20 microamperes and for much less sensitivity 0-1 milliampere.

The calibration of the circuit in Fig. 2 is done exactly the same way as that in Fig. 1, where M2 now takes the place of M.

Obtaining A-C Voltage

In work on vacuum tubes it frequently happens that it is desired to impress a known alternating voltage on the grid. Fig. 3 shows an arrangement that is often employed. Suppose that E is a generator of a pure alternating wave. When this is connected in series with a variable resistor Rh, an a-c milliammeter M, and a resistance R, an alternating current flows. The r.m.s. value of this current is indicated by M. Now if R is known, the voltage across it is also known, since it is the product of the current indicated by M and the value of the resistance R. Since R is in the grid circuit of the tube, the a-c voltage impressed on the tube is known.

The resistance might have a value of 100,000 ohms and the meter may indicate that a current of 0.1 milliampere is flowing. In that case the voltage impressed on the grid of the tube is 10 volts. The rheostat Rh is inserted in the circuit for the purpose of varying the current, and hence for varying the voltage that is impressed on the tube. Additional variations, if required, may be effected in the generator E.

When the range of voltages to be impressed on the tube is low a lower value of R might be used. For example, R may be only 1,000 ohms, in which case the voltage impressed on the grid is numerically equal to the number of milliamperes indicated by the meter M.

By pure wave generator is meant that there should be no d-c component and that there should be no harmonics.

Measuring Output

Fig. 4 is a circuit suitable for measuring the output of a tube. Here the generator E may be the amplifier preceding the last tube or it may be an arrangement as described under Fig. 3. We are not now concerned about the precise way that the input of the tube is produced, but only in the output.

L is an audio frequency choke coil of at least 100 henries and C is a stopping condenser having a capacity of about 10 mfd. R is a pure resistor which should have the value of load resistance specified for the tube in question.

L and C separate the d-c and a-c components of the output so that only the a-c flows through R and the meter M. This, of course, should be an a-c meter like the calibrated meters in Figs. 1 and 2.

The power output of the tube is equal to the square of the a-c current, expressed in amperes, and the value of the resistance R. That is, if I is the current in amperes and R the resistance in ohms, then the power in watts is RI^2.

For standard output this should have a value of 0.05 watts. Thus if the tube is one that requires a load resistance of 4,000 ohms, the current will be 3.535 milliamperes. The standard output is used when sensitivity measurements on receivers are made, for then the radio signal that will give standard output is determined. The output meter can also be used for lining up tuners in t-r-f and superheterodynes, for studying the effect on the amplification of couplings and

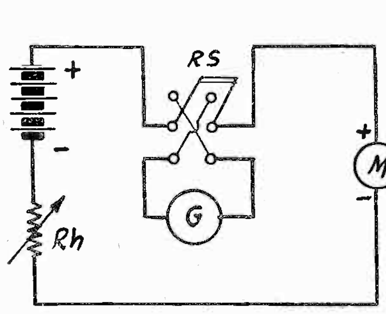


FIG. 1

An arrangement for calibrating a thermocouple type galvanometer against a d-c milliammeter.

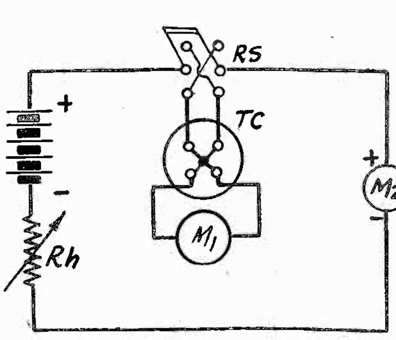


FIG. 2

This arrangement can be used when calibrating a thermocouple with the aid of a microammeter and a milliammeter.

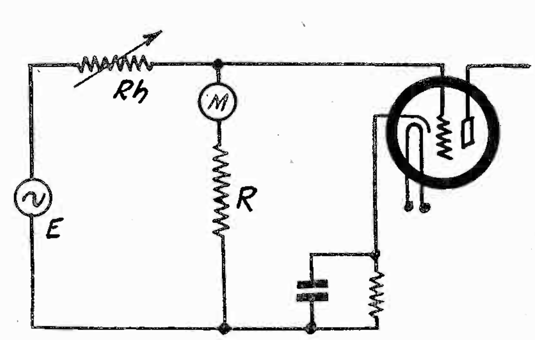


FIG.3.

A known a-c voltage can be obtained by measuring the alternating current through a known resistance R.

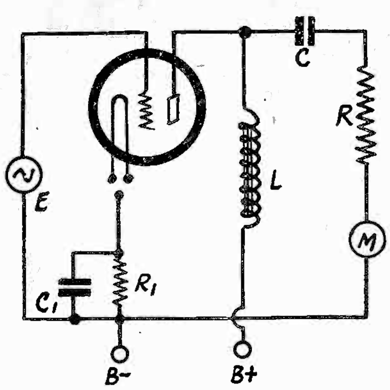


FIG. 4

For measuring the a-c output power of an amplifier a circuit of this type can be used.

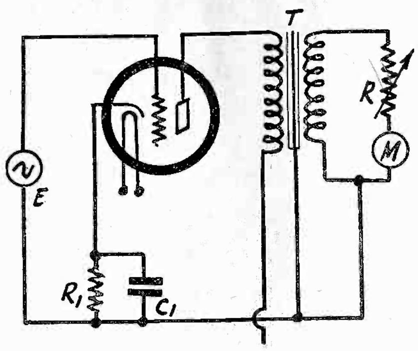


FIG. 5

This is another arrangement that can be used for measuring the output power. A step-down transformer is used.

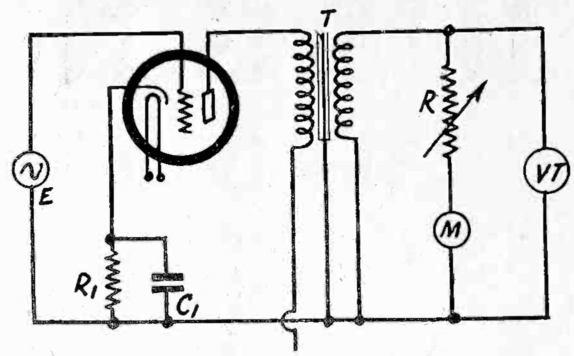


FIG. 6

The power output can also be measured by measuring the current through a resistor and the voltage across it.

voltages, and for making many other tests. In such cases it is usually required to find maximum power output, as in the case of tuning, or for determining which of two adjustments will give the greater output.

Output Transformer Used

Sometimes the measurement of output power is done in the secondary of an output transformer. The connection of the a-c meter is then done as in Fig. 5. R should now be adjusted so that the plate of the tube "looks into" an impedance equal to the optimum load resistance. This depends on the ratio of the transformer as well as on the resistance. If the ratio is known to have a value A, then the proper adjustment is such that $RA^2 = R$, in which R is the value of resistance in the secondary and r is the proper load resistance. Thus if the ratio of the transformer is 10/1 and the proper load resistance is 4,000 ohms, R should have a value of 6.4 ohms. It is clear that the current meter in this case must have a wide range, since the current will be large. Even for standard output the current would be close to 0.1 ampere, and if the output power were 10 watts the current would be 1.25 amperes.

This adjustment is not that which gives greatest power output, for the optimum load resistance is not the same as the resistance required for maximum power output. The resistance required for maximum output can be obtained readily by this arrangement. If R be varied and the resistance and the current be measured for each setting, the product RI^2 will vary. A curve will show what value of R gives the highest value of RI^2.

Alternative Method

Another way of measuring the power output is indicated by Fig. 6. Here the current is measured with meter M, just as it was in Fig. 5, but the voltage across the secondary is measured with a vacuum tube voltmeter VT. The power output is the product of the current as indicated by M and the voltage indicated by VT. M should measure the r.m.s. value of the current, as in all the other cases, and the voltage should also be measured in r.m.s. values. Hence the vacuum tube voltmeter should have been calibrated in r.m.s.

If a sensitive a-c milliammeter is available it can be converted into a voltmeter by suitable series resistances, and this meter can be used in place of the vacuum tube voltmeter. This is quite feasible when a step-down transformer is used to step down the voltage and up current.

High Frequency Measurements

We have assumed that we were mainly dealing with audio frequencies. The meters are not limited to this, however. The two calibration circuits in Figs. 1 and 2 apply equally well to audio and radio frequencies. So does the circuit in Fig. 3. Fig. 4 can be converted to a radio frequency circuit by substituting a suitable radio frequency choke for L. The impedance of a 100-henry choke at 1,000 cycles is the same as that of a 0.1-henry choke at one million cycles. The stopping condenser C does not have to be changed provided it is not of the electrolytic type. If it is, it should be changed. In selecting the value of a radio frequency circuit it should be remembered that the reactance is inversely proportional to the frequency so that a condenser of 0.1 mfd. is as effective at one million cycles as a 10 mfd. condenser is at 1,000 cycles.

Figs. 5 and 6 are applicable to radio frequency circuits when the transformers are made radio frequency transformers.

Application of A-C Measurements

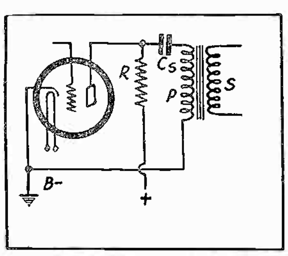


FIG. 1

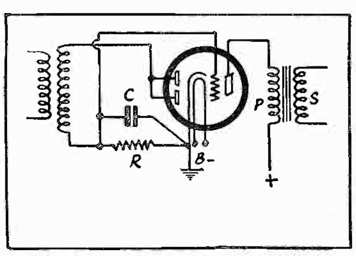


FIG. 2

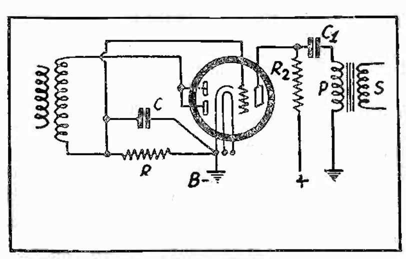


FIG. 3

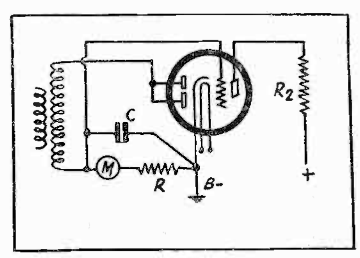


FIG. 4

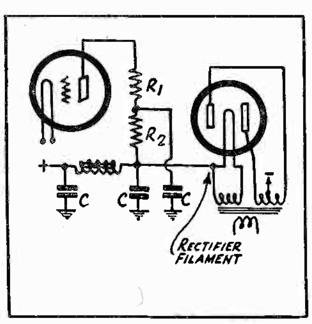


FIG. 5

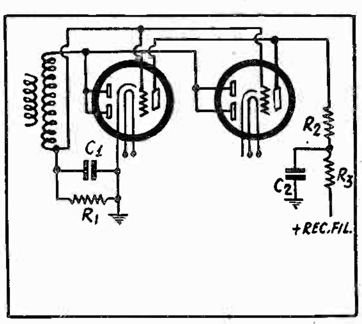


FIG. 6

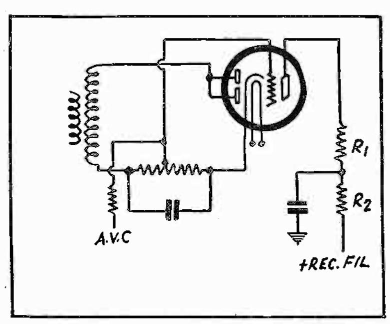


FIG. 7

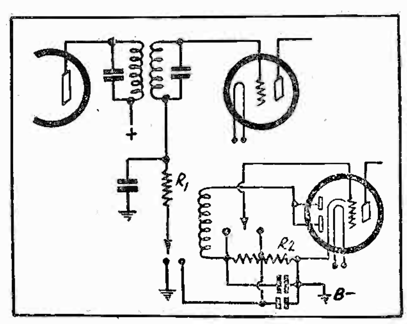


FIG. 8

FIG. 1—The a.c. output can be measured in the secondary of the transformer. FIGS. 2, 3 and 4—Peak voltage can be measured by noting when the plate current cuts off and comparing with previous calibration. FIG. 5—The a.c. should be measured only in R1. FIG. 6—When two tubes are in parallel the same a.c. measurements apply as when an individual tube is used. FIG. 7—A small condenser removes the a.c. from the load resistor, therefore with the condenser included the a.c. residue voltage may be determined. FIG. 8—The object of the large condenser in the filter of the automatic volume controlled tube is to remove the a.c.

JUDGING A RECEIVER

The Demonstration Has Its Advantages and Perils

By Lawrence T. Holcombe

THERE are various ways of judging a receiver. Every one has his own taste. There is no standard measurement, either. Curves are commonly used for expression of selectivity, sensitivity and tone quality. Even these are of some importance only when the weight to be given to each is known. And he who judges a receiver may not know just what weight he attaches to each quality. If he is actually buying the set it does not matter.

One of the most familiar ways of course is to listen to a set. The volume and the tone are judged and the result expressed in rather unscientific terms, since the method of "measurement" is unscientific. Great, excellent, good, fair, poor, etc. At least a person, and particularly a prospective customer, is entitled to say what he likes. And that is just what he is doing—expressing an individual preference.

Quantity of Sound

Even that preference should be guided by some basic knowledge concerning radio. It can not well be so generally, as it would be preposterous to say: "Before I can sell you a set I must teach you some radio fundamentals." You would never hold the customer long enough either to complete the teaching or the sale.

Let us take the quantity of sound as one consideration. If the receiver does not possess automatic volume control, some idea of the sensitivity is attained by listening to the volume from local stations, comparing it to familiar amounts of volume attained in the same location with other receivers. In fact, set for set, demonstrations can be made on the same premises by a store salesman, so the customer can form his own ideas. Such formation is inevitable, anyway. Radio is peculiarly like medicine, as the cutsomer and the patients always have, and are entitled to, their own private diagnosis.

Simple tuned radio frequency receivers can develop as much quantity of sound from locals as a.v.c. superheterodynes that have twice as many, or more tubes. The reason is that the a.v.c. reduces the volume of the strongest stations the most. It would have to be so if any appreciable extent of leveling were to take place. Blasting of locals is prevented, by a.v.c., providing the driver and power output capabilities are adequate.

Noise Level Is Limit

As reported in these columns recently, tests of one receiver showed that a diode detector developed 120 volts from the strongest local station without a.v.c., and 6 volts with full a.v.c. Compromises are possible. Instead of the full rectified voltage being used for a.v.c. only part of it may be used, that is, the a.v.c effect reduced. It would have to be under the maximum voltage condition just discussed, as 120 volts negative bias (not to mention a small self-bias by the usual cathode-resistor method) would lead to distortion.

It should be realized, therefore, that sensitivity is sacrificed if a.v.c. is included, and it is not quite practical to make up the difference by introducing more stages, for the r-f and i-f channels may be built to their maximum non-squealing degree of amplification and the amount of radio amplification is limited by several factors, also including how much noise is to be tolerated. Either by more r-f, i-f or a-f amplification the noise level is reached and there one must stop.

However, as to quantity of sound, that alone does not constitute a sufficient criterion unless the a.v.c question is settled first, and the amount of sound is of no significance unless there is negligible extra distortion at the maximum level.

When Tone Is "Great"

This, of course, concerns tone quality in one way, for the tone should be good on loud signals as well as on weak ones. Overloading due to loud signals is familiar. Distortion due to weak signals is rather new in receivers, and has to do with certain minimum voltage values required by diode detectors, and even by power tubes in some instances, before the quality is good. Incomplete rectification in diodes is distortion. Though as much as is consistent with reason be put into diodes, so that weak stations will deliver a voltage on the safe side, not always the maximum can be put into the next tube, which is an audio amplifier and may be in the same envelope as the diode. The reason is that the triode or pentode amplifier has its own voltage-handling limitations, and what is not a bit too much for the diode may prove far too much for the triode or pentode. Saturation due to too high a negative bias created by the signal if the tube is diode-biased, or operation on the positive characteristic, with grid current through a very high resistance if the tube is otherwise biased, are both examples of distortion.

As to tone quality in general, as each has his own idea about this, and indeed it is individually controlled by the various sensitivities of the persons' ears, as well as by previous habits of listening, plus acquisition of ideas from others, if the tone quality satisfies the purchaser or user, why then it's great. Curves may tend to prove just the opposite, but one doesn't listen to a set with meters but with ears.

Suggested Test for Technicians

Besides, the curves as to tone may express the receiver itself, independent of the speaker and its baffling. The best way to test the receiver for tone is to put in a pure radio wave, modulated 100% by pure tones of the standard frequencies, and have the speaker and its baffling all a part of the test, in a room that duplicates an average room in which listening is done. There may be some assumption on the room question, but average size is determinable from building statistics, and even average acoustic conditions may include the familiar walls with the inevitable pictures, a rug under foot and, let us say, a copy of RADIO WORLD in the magazine rack.

A delicate instrument for measuring the sound pressure at the output at a standard distance from the speaker (standard to be adopted soon, let us hope) would give a picture that even personal taste might not quite overcome. Even an opinionated customer would have to show some respect for a measurement made under operating conditions and in a manner agreed upon by the lights of the science. Still, if the customer could not bring himself to agree with the scientists, that is, could not be overawed, why then you still know who is right, if you've ever worked in a store.

Even Engineers Applaud

Despite all this, there is such a difference in tone that even an untrained ear, or an unversed purchaser, will know the difference. Nobody need be a musician to tell the difference between raucous distortion and authentic tone. So, there is a difference between good tone and excellent tone that the customer is well able to distinguish, and it is of great importance to the custom-set builders, stores and others who sell sets, as well as to home constructors who build just for their own use, that they capitalize on the difference between the good and the excellent. Even radio engineers like the tone of the new console receivers they have designed, and the main reasons are improvement of detector circuit and output tubes. The best tone results from the use of the diode, after the safeguards have been taken regarding low-intensity distortion, and from the use of conservative audio amplification, feeding a power output stage gaited to stand more gaff than will be really required.

More power output for the set means support of those occasional passages where great stress is put on the whole audio and speaker system, as a sudden crescendo of a symphonic orchestra, or even the unexpected shout of a speaker fired with a moment of extra animation, beyond the monitored value.

Linear Detector

Compare the condition of a "class" receiver that takes care of these considerations to one that, while equally well designed, is intended to serve economy to encourage sales. The local stations will come in loud—even too loud for the output accommodations—and the set of more tubes may seem outclassed completely.

The diode as a detector is practically linear when properly loaded, which means a high impedance, a resistor of 0.5 meg. up being the common satisfaction of this requirement.

A linear detector is one in which the output is directly proportionate to the input. This direct proportion is not utterly complete, but so nearly complete as to warrant the appellation. No other vacuum tubes used in radio sets are linear. The output is not only not directly proportionate to the input, but if controlled by a circuit that is linear, as in a.v.c., the controlled tubes still are not linear in operation. They could not well be and still remain amplifiers. The non-linear detectors include all tubes, save diodes, we have known so far, excepting additionally the leak-condenser detector over a portion of the characteristic.

Selectivity Judgment

The customer judges on the basis of apparent selectivity. The selectivity truly is a term expressing the change in impedance and amplitude with change of frequency in the tuning system. It is the ability of a receiving system to discriminate among different frequencies.

USE OF A SLIDE RULE

How to Multiply, Divide and Do Other Operations

By J. E. Anderson

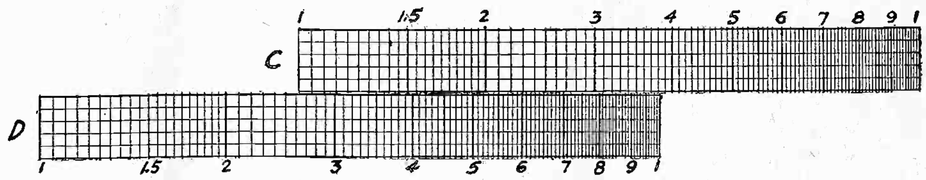


FIG. 1

Typical setting of a slide rule for multiplication or division. Left index of C is on D.

IN engineering work of all kinds there is a great deal of computation. Numbers must be multiplied, divided, raised to powers both integral and fractional, and roots of numbers must be extracted. Most of the operations can be performed by the ordinary rules of arithmetic, but to do even the simplest ones requires much time, and possibility of error is numerous.

Logarithms were invented several hundred years ago to simplify complicated arithmetical computations. With the aid of them problems involving much arithmetical work can be done in a small fraction of the time it would take to do the same problems by the long-hand method. But logarithms in their tabular form are seldom used in everyday engineering work, for they, too, require more time than is necessary. They are now used only when a high degree of accuracy is essential.

The Slide Rule

But the principle of logarithms can be used in another way, which we might call the graphical. Instead of picking out the logarithms from tables and performing the various operations, such as addition, subtraction, division, and multiplication, they are set down on a scale and most of the operations are performed mechanically. The mechanical device for performing the operations is usually called a slide rule. This takes many mechanical forms. It may be straight like an inch ruler, or it may be in the form of a circle, or again in the form of a drum. Regardless of the form, the principle is the same in all instances—mechanical addition or subtraction of logarithms.

Logarithms

Before we proceed with the slide rule it may be well to explain logarithms. Suppose we raise a number A to the power n and that the result is P, that is, if $P = A^n$, then n is the logarithm of P to the base A. This may be called the defining equation. When it is written in this form, n is called the exponent of A. The exponent indicates the power to which the base is raised. Hence the logarithm of a number, P, is the power to which the base, A, must be raised to produce that number.

The base of a system of logarithms may have any value whatsoever, but there are only two bases in common use. One is the natural base, which is an incommensurable number approximately equal to 2.718, and the other is the common base, which is the number 10. The common system is used in nearly all numerical computations because of its simplicity. In the common system the defining equation takes the form $P = 10^n$, or $A = 10$.

Operation with Logarithms

Operations with logarithms are based on a number of rules easily deducible from the defining equation. They are:

The logarithm of a product is equal to the sum of the logarithms of the factors. That is, $\log (PQ) = \log P + \log Q$. This holds for any number of factors. Multiplication of numbers with the slide rule or with tabular logarithms is based on this rule.

The logarithm of a quotient is equal to the logarithm of the dividend diminished by the logarithm of the divisor. That is, $\log (P/Q) = \log P - \log Q$. If either the dividend or the divisor contains factors, the summation rule holds in regards to these factors. In other words, the logarithm of the quotient is the sum of the logarithms of all the factors in the numerator diminished by the sum of all the factors in the divisor. Division with the slide rule or with tabular logarithms is based on this difference rule.

The logarithm of a power is equal to the logarithm of the base multiplied by the exponent. That is, $\log P^n = n \log P$. Involution and evolution, or extraction of roots and raising to powers, are based on this rule. For the extraction of roots the exponent is fractional and for the raising to powers it is a whole number. When the exponent is a mixed number, both involution and evolution are involved, but the rule holds without modification.

As an example of an exponent of mixed variety, let us take 4 raised to the 3/2 power. This means that we first raise 4 to the third power and then extract the square root, or, that we first extract the square root of 4 and then raise the root to the third power. Either sequence of operation leads to 8. By the rule we have $\log 4^{3/2} = (3/2) \log 4$. If the base is 10 we have $\log 4^{3/2} = (3/2)\ 0.6021 = 0.9031$, which is the logarithm of 8 to the same base.

Logarithmic Scales

In the simplest form the slide rule consists of two equal logarithmic scales, each covering one cycle from 1 to 10 and placed so that one may be displaced longitudinally with respect to the other. While the scales are logarithmic the numbers themselves are indicated. At the left end is the number 1, for the logarithm of unity is zero. At the right end is also the number 10, for the logarithm of 10 is unity, that is, one complete cycle of the scale. But 10 is not indicated on the scale, but rather 1, for this end is the beginning of another cycle as well as the end of the first. The second cycle is not needed because it would be an exact repetition of the first, and it is just as well to use the first and only cycle.

The use of the scales can be explained by example. In Fig. 1 we have two equal logarithmic scales, for convenience called C and D. The D-scale is supposed to be fixed and the C-scale movable along the D-scale. The index, that is, the left end, of the C-

(*Continued on next page*)

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF MARCH 3, 1933,

Of Radio World published weekly at New York, N. Y., for October 1, 1933.

State of New York }
County of New York } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Roland Burke Hennessy, who, having been duly sworn according to law, deposes and says that he is the Editor of the Radio World, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher Hennessy Radio Publications Corp., 145 West 45th St., N. Y. C. Editor Roland Burke Hennessy, 145 West 45th St., N. Y. C. Managing Editor, Herman Bernard 145 West 45th St., N. Y. C. Business Manager Herman Bernard, 145 West 45th St., N. Y. C.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of the stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) Hennessy Radio Publications Corp., 145 West 45th St., N. Y. C. Roland Burke Hennessy, 145 West 45th St., N. Y. C. Mrs. Mary J. McArthur, 9823 Lake Avenue, Cleveland, Ohio.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers, during the months preceding the date shown above is .... weekly. (This information is required from daily publications only.)

ROLAND BURKE HENNESSY
(Signature of Editor.)

Sworn to and subscribed before me this 26th day of September, 1933.

[Seal.] HARRY GERSTEN.

Notary Public, Kings Co. Clks. No. 195, Reg. No. 4226, N. Y. Co. Clks. No. 520, Reg. No. 4G288. My commission expires March 30, 1934.

Note.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

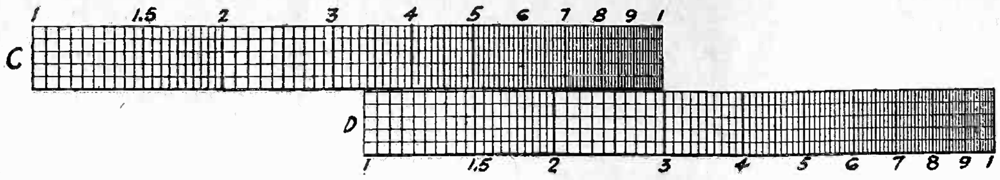


FIG. 2

Typical setting of slide rule for multiplication or division. Right index of C on D.

(*Continued from preceding page*)
scale, is set opposite 2.625 on the D-scale. Now 2.625 is not the logarithm but it is the actual number we wish to multiply with some other number. The logarithm is the distance from the left index, or end, on the D-scale to the point at which the index of the C-scale is set. Now suppose we wish to multiply 2.625 with the number 2. According to the rule we are to add the logarithm of 2 to the logarithm of 2.625. The distance from the left index on the C-scale to 2 on that scale is proportional to the logarithm of 2. Hence directly under 2 of the C-scale, on the D-scale, we find the logarithm of the product of the two, for we have added mechanically the logarithms of the two numbers. On the D-scale we find the number 5.25. That is the number we wish. The logarithm of this number is proportional to the distance between the left index on the D-scale to the point 5.25 on the same scale.

It is clear that once we understand that we add logarithms we can forget about them and pay only attention to the numbers given on the scale.

Division

Division is the opposite of multiplication. Suppose we wish to divide 5.25 by 2. We set two on the C-scale opposite 5.25 on the D-scale and read the quotient 2.625 under the index of the C-scale on the D-scale. We have subtracted the logarithm of 2 from the logarithm of 5.25 and obtained the logarithm of 2.625, but we know by the rule that we have also divided 5.25 by 2 and obtained 2.625. We can forget about the logarithms and pay attention only to the numbers of the scales.

Now suppose we wish to multiply two numbers of such values that the product is over 10. Let us attempt, for example, to multiply 2.625 by 8. In Fig. 1, 8 on the C-scale is beyond the right index of the D-scale. If it were not for the cyclic nature of the scale we would have to extend the D-scale toward the right so that 8 on the C-scale were over some part of the D-scale. Indeed, we would have to double the length of the D-scale in order to get all possibilities. But since the extension of the D-scale would be an exact duplicate of the first cycle we can use that cycle and imagine that we are dealing with the extension. This we can do by the simple expedient of setting the right hand index of the C-scale where the left hand index now is. In so doing we divide the number by 10, but that does not change the sequence of the digits and therefore we get the right result with proper interpretation of the location of the decimal point.

Resetting of Slide

In Fig. 2 we have reset the sliding scale C with respect to the stationary scale D so that we can multiply numbers the product of which is over 10. The right index of the C-scale is set opposite 2.97 on the D-scale. Now let us multiply this number by 5. Under 5 of the C-scale we read 14.85 on the D-scale, which is the product.

Now actually we do not set scales at 2.97 or 29.7 but only on the sequence 297 without any reference whatsoever to the location of the decimal point. Likewise we do not read 14.85 on the D-scale but only the sequence of digits 1485. The decimal point is not involved in any way, on the slide rule, but it must be kept in mind by the operator of the rule. If we were to multiply a certain number by 5, or 0.05, or 5,000,000, we would read under 5 on the scale C. In the same way, if we are to multiply 0.025, or 25, or 25 million, we set the index on the C-scale on the sequence 25 on the D-scale.

An Ambiguity

When one first begins to operate a slide rule, especially in division, there is often an ambiguity as to where to read the result. One should always read the quotient on the D-scale under the C-scale index that is on the D-scale. In multiplication one always reads on the D-scale under the multiplier on the C-scale, and that C-scale index must be used which leaves the multiplier on the D-scale.

On most slide rules there is also an A-scale which is used for obtaining squares or square roots. The A-scale has two equal cycles, the sum of the two being equal to a single cycle on the D-scale. The left index of the A-scale is directly over the left index of the D-scale, and the right indexes of these two scales are also opposite each other. Then there is a middle index on the A-scale which is directly over the midpoint of the D-scale, or over the number sequence 3162. This is the sequence for the square root of 10.

If any number is selected on the D-scale and the number directly opposite on the A-scale is found, that number is the square of the first number. For example, directly over 5 on the D-scale is found 25 on the A-scale. Also, directly over 1582 on the D-scale is found 2.5 on the A-scale.

The first half on the A-scale represents numbers from 1 to 10 and the second from 10 to 100.

Extracting Square Roots

Square roots are extracted by setting the number on the A-scale and reading the root directly under it on the D-scale. In this an ambiguity may arise. Since there are two cycles on the A-scale, the same number sequence will occur twice. Only one of them gives the proper sequence for the square root.

In order to select the correct setting, a knowledge of the position of the decimal point is essential. Move the decimal point to the left or to the right two places at a time until the number lies between 1 and 100. If the number lies between 1 and 10 use the left hand cycle of the A-scale, and if it lies between 10 and 100 use the right hand cycle.

Suppose, for example, we wish to find the square root of 0.0289. Shall we set the number on the left or the right cycle of the A-scale? We move the decimal point two places to the right and get 2.89. This lies between 1 and 10 and therefore we use the left hand cycle of the A-scale. This yields 1.7 as the square root. But since we multiplied the original number by 100, we must divide the square root by the square root of 100, or by 10. Therefore the square root of 0.0289 is 0.17.

Suppose now that the number is 2,809. Let us move the decimal point two places to the left. We get 28.09, which lies between 10 and 100. Hence we use the right hand cycle of the A-scale. The square root is 5.3. But since we divided the original number by 100 we must multiply the square root by 10. Hence the square root of the original number is 53.

It is more accurate to get squares by multiplying the number by itself than by using the A-scale. But in extracting the square root, the A-scale is necessary. And it is only when extracting square roots it is necessary to determine which of the two cycles on the A-scale is to be used.

Cubes and Cube Roots

Many slide rules also have a scale usually called the K-scale. This has three equal cycles the total length of which is equal to the length of a single cycle on the D-scale. The K-scale has four indexes, the two ends and two interior division points between cycles.

The cube of any number can be found by setting the number on the D-scale and reading the K-scale directly over it. This, however, is not very accurate since the K-scale is crowded. The cube can be found more accurately by multiplication, using the same number three times as factors.

For extracting the cube root of a number the K-scale is essential. In this case there are three possible settings for any number sequence. Only one is correct. To determine which we proceed in a manner similar to that for removing the ambiguity in the case of square root. We move the decimal point as before, but in this case three places at a time until the number lies between 1 and 1,000. If the number lies between 1 and 10, use the left hand cycle of the K-scale. If it lies between 10 and 100, use the middle cycle, and if it lies between 100 and 1,000, use the right hand cycle. When the cube root sequence has been found on the D-scale, the number is multiplied or divided by 10 as many times as the decimal point was moved three places at a time in the original number. If the decimal point is moved so that the number lies between 1 and 1,000, the cube root will lie between 1 and 10 and therefore there is no ambiguity as to where the decimal point is, nor where it should be ultimately.

Fractional Roots

If the rule has both an A-scale and a K-scale in addition to the C- and D-scales, the fractional powers 3/2 and 2/3 can be found directly. It is only necessary to remember that the 3/2 power means the square root of the cube of the number, and that the 2/3 power means the cube root of the square number. If the 3/2 power is involved the slider is set on the proper cycle of the A-scale and the result is read opposite on the K-scale. The ambiguity here is the same as that of extracting the square root. If the 2/3 power is involved, the slider is set on the number on the proper cycle of the K-scale and the result is read opposite on the A-scale. Here the uncertanity is the same as that involved in extracting cube roots.

When fractional powers are involved it is more accurate to use logarithms, even if they have to be obtained from the rule. Nearly all slide rules have a scale that is called the L-scale. This is a scale of a large number of equal divisions, or it is a linear scale. By means of this scale the logarithm to the base 10 of any number can be found. The arrangement of the L-scale is not the same on all rules, but on many good rules it appears on the face of the rule directly under the D-scale. The logarithm of any number is read on the L-scale under the number on the D-scale. In other rules the L-scale is on the back of the slide. The left index of the slide is set on the number on the D-scale and the logarithm is read on the L-scale at a special index at the back of the rule.

Logarithmic tables and the L-scale on slide rules do not give complete logarithm of any number, but only the mantissa, or the fractional part. The whole logarithm includes the characteristic, and this is found by inspection of the number. If the number is greater than unity, the characteristic is positive, or zero, and it is equal to the number of digits left of the decimal place, less one. If there are two places, the characteristic is 1, if there are three places, the characteristic is 2, and so on. If the number is between 1 and 10 the characteristic is 0. If the number is less than unity, the characteristic is negative, and its value is equal to the number of ciphers after the decimal point, plus 1. That is, the characteristic of 0.05 is —2, of 0.16, — 1, of 0.0004, —4, and so on.

The mantissa is always positive. Hence when the characteristic is negative, the minus sign cannot be placed in front of the complete logarithm, for this would indicate that the mantissa also is negative. To avoid this difficulty the negative sign is placed over the characteristic. This does not prevent writing the entire logarithm as negative, but then it will have a different sequence of numbers in the fractional part. It is usually possible to avoid writing it in the negative form.

Computation with Logarithms

Let us apply logarithms to a few cases involving fractional or mixed exponents. Let it be required to find the 2/3 power of 64. The characteristic of 64 is 1, which is found by inspection. The mantissa, which may be obtained from a log table or from the L-scale of a slide rule, is 0.806. Hence the total log of 64 is 1.806. The logarithm of the 2/3 power of 64 is 2/3 of 1.806, that is, 1.204. We look up the sequence of numbers in a log table or on the rule opposite 0.204. We get the sequence 16. The characteristic in the log is unity. Hence there are two digits to the left of the decimal point in the number. That is, the result is 16.0.

Now let us find the 3/2 power of 64. The log of this power is 3/2 times 1.806, or 2.709. We look up the number for which 0.709 is the mantissa. We find 512. But the characteristic is 2, and the number contains three digits to the left of the decimal place. Hence the number is 512.0.

Let us now try a fractional number with a fractional exponent, for example, the 2/5 power of 0.00032.. The characteristic of this number is —4 and the mantissa is 0.5052. This can be written 1.5052 —5 by adding and subtracting 5 to the characteristic. The first part is now all positive and the second part is all negative. Multiply this by 2/5 to get the log of the power. The result is 0.6021 —2, in which the negative characteristic is written after the positive mantissa. The number that has a mantissa 0.6021 is 4. Hence the result is 0.04, for the characteristic of this number is minus 2.

The device of adding and subtracting 5 to the logarithm did not change the value in any way, but it brought the number into such a form that it could be readily divided by 5 without running into fractions. This device is always possible when dividing logarithms. It is useful when the characteristic is negative.

Usefulness of Slide Rule

The slide rule is useful because by its means complicated arithmetical computations can be carried out quickly. A problem that may require the better part of an hour to do by long hand can be done in less than a minute by the rule. Even if the time required by the long hand method only were 10 minutes there would be a great saving of time. In the extraction of roots the saving in time is particularly great. In a series of multiplications and divisions where there are many factors in both the numerator and the denominator computations are done quickly. It takes no longer to divide by any number than to multiply, even if the divisor contains three and four digits. The two operations may be done alternately, that is, first two numbers are multiplied together, then the product divided by another, then the quotient multiplied by still another, and so on. It is not necessary to stop to read the intermediate results but run through all the factors and divisors until they have all been used. Then the result is read.

In engineering work it frequently happens that a certain constant number is to be multiplied or divided by a large number of varying numbers. This can be done just as quickly as the various results can be read off the scale. In such cases the problem is first reduced to the simplest terms. There may be a large number of factors which will not change during the variation of some other factor. All the constant factors are first reduced to a single number and the index set on that number. As an illustration of this we might have the equation $C = k^2/F^2$, in which we want to find C for a large number of values of F. In this k is a constant of some kind that has been previously found. To find C the constant k is divided by F and the square is taken. The runner is set on k on the D-scale, F on the C-scale is set to the runner, and C is read at the index on the A-scale. The runner is left in position and only the slider is moved for each new value of F. Before this can be done the constant k has to be prepared by extracting the square root of some other constant.

A somewhat simpler case that occurs frequently in the radio laboratory is the determination of power expended in a resistance. Suppose we have a resistance of value R and we measure the current I that flows through this resistance. We want to determine the power expended in that resistance for a large number of different currents. The equation is $P=RI^2$. This equation is prepared for computation by extracting the square root of R and expressing the equation in the form $P=(R^{1/2}I)^2$. Here we have multiplication and squaring. We set the index of the C-scale on $R^{1/2}$ on the D-scale and read P on the A-scale directly over I on the C-scale. To make the entire run it is only necessary to move the runner to each value of I. The hair line on the runner is directly over P on the A-scale. It may be that it is necessary to reset the slider once, but not more than once, by setting the right index of C on $R^{1/2}$.

Resetting the index more than once is avoided by picking out all the values of I which can be used on the first setting. The second setting then will cover all the remaining values of I. To obtain the correct position of the decimal point it is only necessary to work out one case, and this can usually be done mentally. After that a change in the location of the point will occur only when the values of P pass through an index on the A-scale, including the end as well as the middle.

As an illustration, let R equal 20,000 ohms and let I have the successive values 1, 2, 3, and 4 milliamperes. Required to find the corresponding powers in watts. By inspection we get the first value P=0.02 watts. The square root of 20,000 is 141.4, and we set the index accordingly. The runner indicates that the next power is 0.08, the next 0.18, and the next 0.32. Between 2 and 3 it passed over the index on the A-scale and accordingly the decimal point change one position.

TRADIOGRAMS

By J. Murray Barron

Those familiar with the radio industry, especially the parts and kits division, know that fans and home constructors have always been ready buyers and continually on the lookout for the latest worthwhile things in radio and that about only one thing would prevent them from buying, i. e., the lack of spare cash. When one looks back over the past two years and realizes how well the radio mail order business has gotten along, notwithstanding the great amount of unemployment, and then studies the greatly improved situation now, with the hundreds of thousands of new hands taken on in the industrial plants and ever-increasing payrolls, there can be but one thought, that the outcome will be a very excellent one.

That there will be more money to spend this fall and winter can not be questioned. Regardless of the number who may now be unemployed, records show more than 2,000,000 have gone back to work since March. That in itself is a healthy army of wage-earners with money to spend and to which will be added many more millions before the snow flies.

While prices in radio merchandise are bound to rise, with possibly more than one increase, with greater purchasing power better things will be expected, especially when better mechanics and help can be hired at the increase in wages.

The cut-throat crowd of the past two years naturally did not give anything away for nothing, so in many instances turned out some mighty poor jobs that were not worth the low price asked. With the crowd eliminated one may look forward to real merchandising this season. At the same time there are now some excellent buys at the lower prices from the factories of reliable organizations which will bear higher price tags in the near future and in fact which may be impossible to obtain later at any price.

For those interested in short-wave and short-wave-broadcast combination, also radio-phonograph combination, some of the New York retail stores and mail order houses are offering buys that can not be duplicated again. There are also some long-wave and all-wave receivers that can be bought at a low figure.

The Continental Microphones, an auxiliary line of the Universal Microphone Co., of Inglewood, Cal., has gotten into production and distribution. There are several models of two-button improved carbon-type which heretofore have only been available in the higher-price lines. The Continental line will be sold only direct from factory to jobber. There will be no direct or dealer distribution.

* * *

In the earlier days of radio, about everybody took it for granted that the interest was over when summer came along. How greatly this idea has changed can be testified to by the exceptionally large numbers of the small ac-dc radio sets that were sold this 1933 season. In addition to these, plenty of kits for quality sets were bought, and not overlooking the short-wave sets and kits. An important item of real interest this season was the automobile radio set. That there was a large sale can not be questioned, for about all one desired to hear could be heard coming forth from the auto loudspeaker, everywhere one went, whether at the seashore or mountainside. Do not imagine that the demand for or sale of automobile sets has let up, for now the demand is not only large but perhaps a bit more particular. The public has learned to know either through their own experience or through friends and radio publications and newspapers, that if one is to install an automobile raido receiver it should be a good one. A powerful and sensitive set, preferably a superheterodyne, would be the wiser selection. A new addition to this line is the new 1934 six-tube superheterodyne automobile radio receiver put out by Fanning Radio Labs., 377 Eighty-seventh Street, Brooklyn, N. Y. It uses one 6A7, one 41, one 75, two 78's, and one 84 tubes, has automatic volume control, one-hole mount and the latest features generally.

* * *

An important announcement comes from A. M. Flechtheim & Co., 136 Liberty St., New York City, to the effect that the Flechtheim electrolytic and paper condensers are now made in U. S. A. and Great Britain. They are of the same characteristics as heretofore.

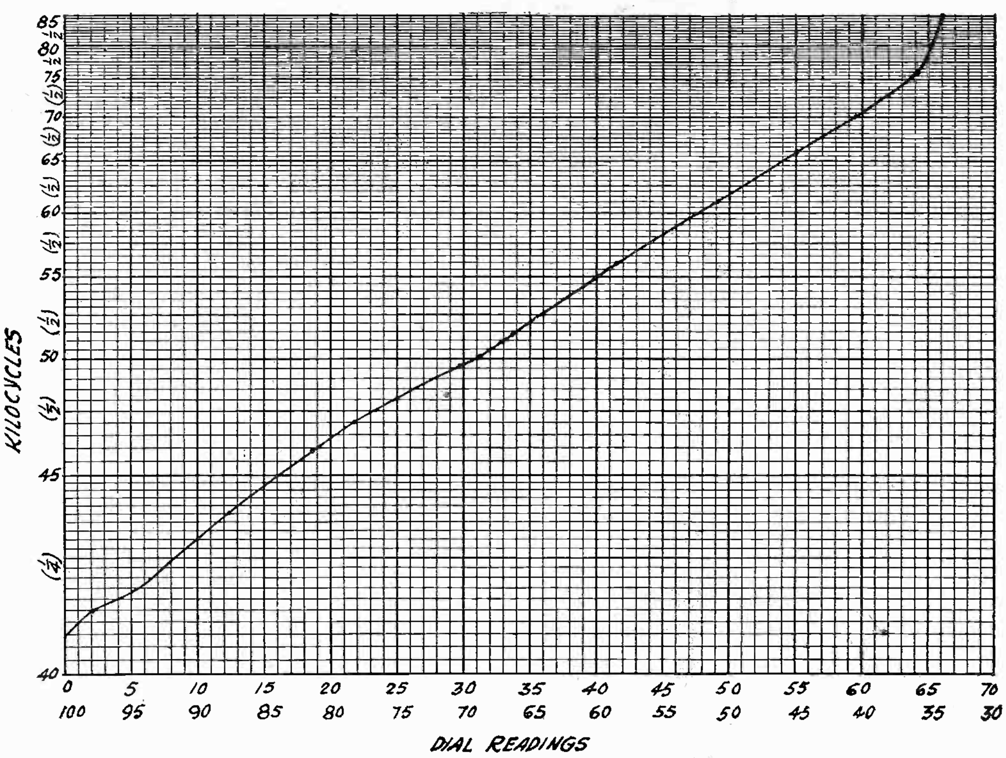


FIG. 1

Curve relating dial settings and frequencies for the lower frequency ranges of the low-frequency coil. The condenser was the G.R. 247. The inductance was a 25-millihenry honeycomb coil. The curve may be used as reference by duplicating the parts used. Note that the sub-divisions represent in twenty instances one-quarter kc each, for the rest one-half kc each.

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EXPERIMENTAL determination of frequency of an oscillator, application of a known capacity to enable computation of the inductance, and determination of the capacity present independent of the tuning condenser, enabled the plotting of curves that should be of considerable assistance to those interested in direct frequency measurements and capacity and inductance tests by substitution.

Some preliminary data were given last week, but these are brought to a point of still higher accuracy, and made more extensive, in the present discussion. Besides, the frequency curves are shown for two ranges.

Since some particular tuning condenser has to be selected, the model used was General Radio Company's No. 247. In the broadcast band an unshielded coil of 260 microhenries inductance was used. This coil may be on 1", using No. 32 enamel wire, 130 turns, tapped at the 20th turn from the ground end. The tuning range will be from about 402 kc to about 1,600 kc for this coil. Using the same condenser and a 25-millihenry coil, from about 40 kc to nearly 200 kc, will be the low-frequency range. This coil is a honeycomb of 1,300 turns, tapped at the 500th turn. So the honeycomb has an inductance of almost ten times that of the other.

Frequencies between 200 and 400 kc may be measured by fourth harmonics of 50 to 100 kc with excellent stability.

Checked by Known Capacity

The oscillator was checked with no external tuning condenser in the circuit, but only the other capacities, and the resultant frequency, in the light of the known inductance of 25 mlh, made possible the computation that the distributed capacities totalled only 10 mmfd. When the tuning condenser's minimum was included, and the new frequency registered, the computation showed that the total was 25 mmfd., hence the condenser's minimum 15 mmfd.

The honeycomb coil has a very low distributed capacity, especially a coil of such a large number of turns, and this capacity may be neglected. However, the broadcast coil was assumed to have no greater self-capacity than the honeycomb, which is manifestly not a fact, but the difference is too small to be considered in any save precision measurements, and the data herewith supplied are not for precision work, but for general use about home, shop and service laboratories.

A checkup of a known capacity across the honeycomb coil simply provided verification of the inductance and of one capacity computation based on that inductance and known frequency.

The tuning condenser is widely distributed, the broadcast coil can be wound by any, some can even wind the honeycomb coil, commercially obtainable at less than 50 cents each.

Frequency Curves

Plug-in forms were used, one to contain the broadcast coil which was wound on a separate form, the other to contain the honeycomb coil, which was on a 3/8-inch bakelite dowel. Stiff bus to the form prongs provided the anchorage.

Fig 1 shows a detail of the dial readings plotted against frequency for the important part of the low-frequency tuning. The importance is derived from the stability of the oscillator at the low frequencies, and the curve stops at about the point where grid leak-condenser type oscillators lose some of their stability.

Fig. 1 allows for 40 to 85 kc, but the oscillator did not quite go as low as 40, the lowest frequency being 40.714 kc, so the curve stops there. Note that between 40 and 45 kc there are four sub-divisions for each 1 kc on the chart, or one-quarter kc for each division, whereas for the rest of the frequencies covered by this curve the subdivisions represent one-half kc each. The remainder is included on the kilocycle side of the cross-section paper.

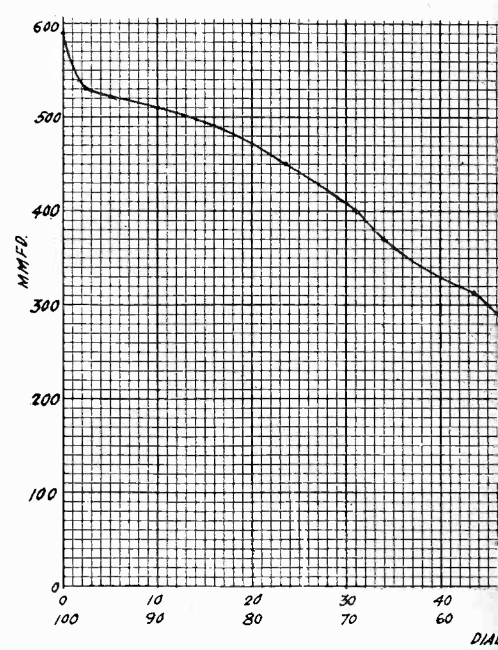
The Points of the Curves

The dial readings are detailed for both directions and should be read in a manner consistent with the dial used. For the G. R. condenser, which closes to the left, the dial preferably should be such as to reac higher numbers for higher capacities, sim ply because that habit is implanted.

The curve has been drawn so that it fol lows the registered points only where the curve actually coincides with those points but where there are points off the regular shape of the curve the curve has been made regular, but the points have been left as they were truly found. The reason for this is that the off-curve points may be due to coupling functions and other considerations that affect registrations to the slight extent noted, and it is scarcely practical to make the curve smooth and all the selected points actual in any instance. One reason is the resonance effect of the tickler, another is the capacity effects of brackets and the like affecting a rotating member (condenser rotor) and the other is the hours of work needed to obtain hundreds of points to satisfy the exacting requirements of a supposedly perfect curve. And then the curve positively would not be regular, that is, not in an oscillator.

Four-fold Check

The other frequency curve-sheet serves for the complete calibration for both coils. The curve to the left is for broadcast frequencies the one to the right for the low frequencies The actual frequencies used for registering the points are noted, and these notations also distinguish the curves. For the broadcast band refer to the column of kilocycles at left, and read as printed. For the low fre-



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This is the capacity curve of the G mentally. The curve relates to the had been determined and excluded. Fig. 3, were used as a computation a known accurate capacity. Using t denser within the 15-590 mmfd.

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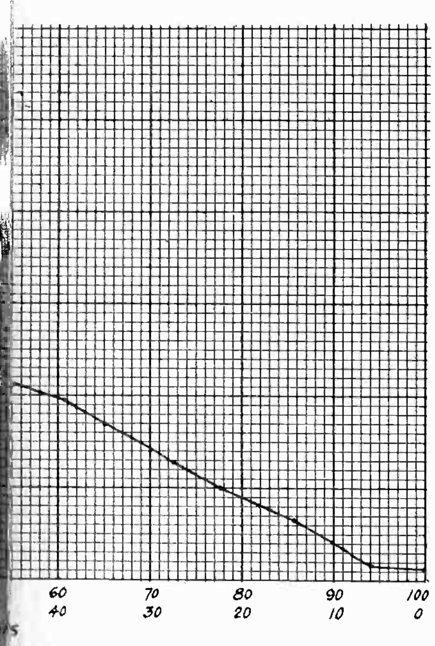
quencies read the same column of frequencies at left as one-tenth of the frequencies noted, i. e., 40 to 150 kc. The higher frequencies of both curves are not treated intimately, as the oscillator is unstable in that region. Harmonics of lower frequencies (more capacity in circuit) should be used.

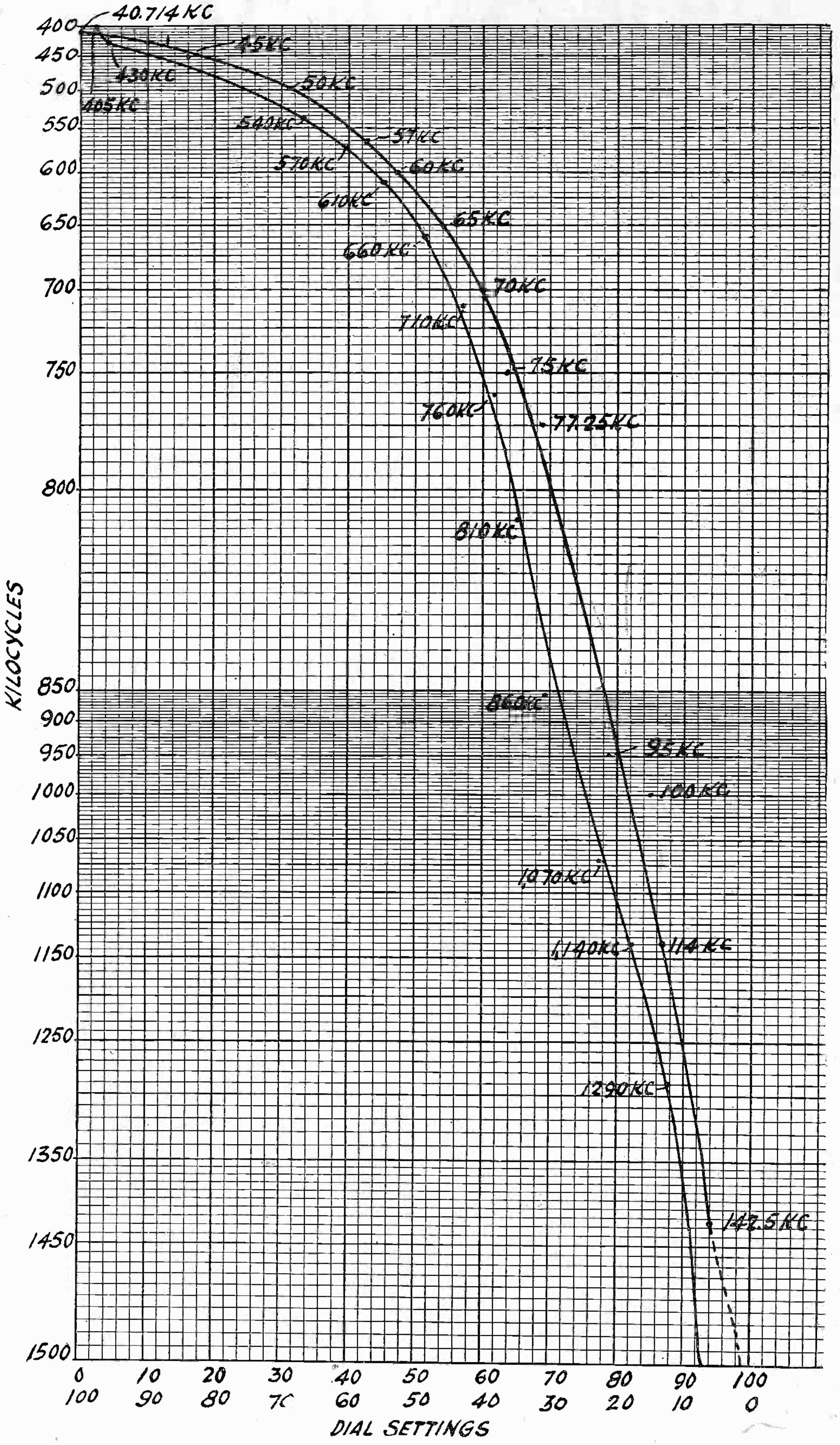
One of the outstanding advantages of these curves is that one knows approximately what the frequencies will be, for particularly in the low-frequency band it is quite a stunt to identify them, when using broadcast stations' transmitted frequencies as standards. They are high standards, but harmonics of the test oscillator are being beaten with broadcast fundamentals, and a few beats at or about a certain dial position surely do create confusion and language. However, the most exacting tests were made and the verification of the final finding (the results included in Figs. 1 and 3) is unquestionable. Four checks were made, thus going Amos 'n' Andy two better.

Condenser Calibration

The curves may be used as reference charts without further to-do, by using either home-wound coils or factory-made coils the specified condenser, a 56 tube, and the line voltage of 105-120 volts, and grid leak of 2 meg. and stopping condenser of 0.00005 mfd. If oscillation is blurry at the low capacity end, the grid condenser should be increased. A precision dial is recommended, and National Company's German silver gift to the science was used. Such a dial is a laboratory type,



7 condenser as obtained experi-ser alone, as the circuit capacity ts on the low-frequency curve, after a preliminary check with ne inductance, any capacity con-ity range may be calibrated.



Keuffel & Esser Plotting Paper

FIG. 3.

Broadcast and lower frequencies plotted against dial settings. The broadcast band is at left, the lower frequencies are at right. Due to the large capacity ratio of the condenser, almost 400 kc is reached at the low end of the broadcast band, while 1,500 kc is struck before the minimum of the condenser is reached. The low-frequency region of the low-frequency oscillator duplicates Fig. 1, but on a narrower scale.

with true vernier, hence enabling readings in tenths of a division.

Moreover, the capacity of the condenser will be pre-calibrated from the Fig. 2 chart. The dial settings are plotted against capacity of the condenser alone, as when the required capacity was computed, the distributed capacities were deducted. Thus an unknown capacity, if within the range of the tuning condenser, may be determined simply by substitution, and checking the resultant frequency. Of course, capacities outside the range of the tuning condenser may be

(Continued on next page)

LINEAR DETECTION

Diode Affords It With High Load Resistor

By Brunsten Brunn

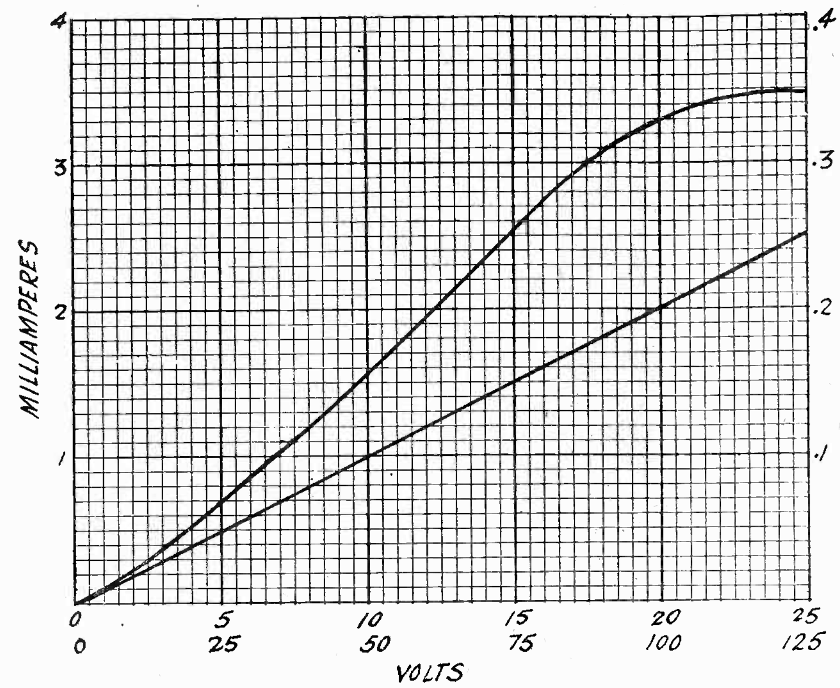


FIG. 1

Characteristic curves of a diode rectifier. The upper curve is for the rectifier alone and, the lower for the tube and a half megohm resistance.

CHARACTERISTIC curves of diode rectifiers have been published, and these curves are not straight lines. Many fans have interpreted the curvature as indication, and even as proof, that there can be no linear detection with such rectifiers. How can there be linear detection, they ask, when the rectifier current is not proportional to the voltage?

Linear detection, so called, is a matter of relativity. Strictly, there cannot be linear detection if there is ever so little curvature of the characteristic. Practically, however, the detection can be so nearly linear that it is impossible to measure the divergence, much less to hear the result of such divergence.

Then what becomes of the marked curvature seen in the characteristic curves? It is removed by something that does respond faithfully according to the linear law. It is the pure resistance load on the rectifier that is linear, not the rectifier itself. If the load resistance is so large in comparison with the internal resistance of the rectifier that the internal resistance can be neglected, then the curvature of the characteristic can also be neglected.

Let us suppose that the internal resistance of the rectifier element is 10,000 ohms, which is a reasonable value. Then if the load resistance on the rectifier is 500,000 ohms, the total resistance in the circuit is 510,000 ohms, and only about 2 per cent. of this resistance is subject to a small variation as the voltage changes. Hence the total distortion due to curvature cannot exceed two per cent. Actually, it will be much less than this because the characteristic itself is nearly linear over the voltage region covered. Therefore when the detection is called linear, the exaggeration is not worthy of mention.

In Fig. 1 we have a characteristic curve of a diode rectifier covering the voltage range of 25 volts and the current range of nearly 3.5 milliamperes. It is only after the current exceeds about 3 milliamperes that the effects of saturation are appreciable, which begins when the voltage drop in the tube is about 17.5 volts.

When the tube functions in a practical rectifier circuit in which voltage output is the main consideration, the actual voltage across the tube is extremely small and the rectified current is correspondingly small. Suppose, for example, that the load resistance is 500,000 ohms, as we assumed before, and also suppose that the signal voltage impressed on the circuit is 100 volts. For practical purpose we can say that the load resistance is the only resistance in the circuit. Therefore the current through the load resistance and the tube will be only 0.2 milliampere. This makes the drop in the tube 1.75 volts, as judged from the curve. The resistance the tube offers is then only about 10,000 ohms, and only this portion is variable, and only slightly variable at that. Even when the applied voltage is as high as 100 volts we are a long way from entering the saturation portion of the tube.

The straight line in Fig. 1 is an approximation of the rectified current that would result when there is a 500,000-ohm resistance in series with the tube. The lower voltage scale, which is five times the upper scale, applies to the circuit as a whole, while the upper scale refers to the tube alone. The current scale on the right refers to the entire circuit. The curve is a straight line because the effect of the small internal resistance of the tube is so small that it is impractical to allow for it in drawing the curve of the entire circuit. The error in the curve at 125 volts is not more than 5 microamperes out of 250 microamperes, or 2 per cent.

The rectified voltage, which is the drop across the load resistance, is practically free from distortion.

Instantaneous Values

Linearity of detection does not mean that all frequencies are detected to the same degree. Not at all. But the divergence does not depend on the lack of linearity of the rectifier as much as it does on the filter necessary across the load resistance. Due to the condenser across the load resistance, low frequencies are detected more effectively than high frequencies. The higher the filter capacity the higher is the loss on the high audio frequencies. This can easily be tested qualitatively, for if the condenser is increased the tone will become lower in pitch, which means that the high audio frequencies are not detected. Incidentally, this is an easy way of getting a tone control, for a small variable condenser across the load resistance could do just as much as a variable condenser of many times the value placed across the output of the last tube, where the tone control is often placed. The effectiveness of a given condenser is directly proportional to the value of the resistance across which it is connected.

Instantaneous values of rectified current are much higher than the instantaneous values obtained on the assumption that the load resistance is in the circuit. The reason for this is that the filter condenser shunts the resistance and puts a high voltage across the tube. And the instantaneous values of current are much higher for high carrier frequencies than for low. But the instantaneous values do not count so much in detection, but rather the mean values. The mean value of rectified current is that which is obtained when a d-c milliammeter is put in series with the load resistance. The detected signal is the fluctuation in the mean current due to the modulation, and this fluctuation is greater for the lower modulation frequencies than for the higher.

Valuable Calibration Data

(*Continued from preceding page*)

checked also, particularly larger ones, using the honeycomb coil. If one does not care to go through the computations for these larger capacities he may consult Edward M. Shiepe's book of curve-sheets, "The Inductance Authority," which enables accurate results at a glance.

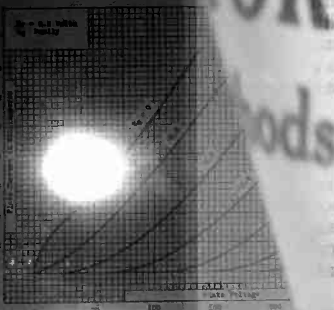
The curve is again irregular, which means there is truth in it, for these sylph-like curves of condenser-coil systems are mostly propaganda. The points are clearly shown, fifteen having been taken, and may be identified in respect to frequencies by any curious-minded reader who cares to read the frequencies from Figs. 1 and 3.

As will occur to many readers, some other tuning condenser could be used, and its capacity derived by noting the dial settings for the frequencies of the non-conforming condenser, and computing the capacity, deducting 10 mmfd. from each result, or the answers taken from Mr. Shiepe's book. This is possible because of the known inductance and frequency. In fact, the capacity curve of this other condenser could be plotted on Fig. 2.

As intimated previously, it is much better to use the low-frequency part of the curves, and this, it may be added, is true in both instances, because of the frequency-stability in that region, which approximates crystal-control results without temperature oven.

The G. R. condenser, while closing to the left, has no endstop, so might be turned or calibrated the wrong way. With plates totally enmeshed the dial, by causing the rotor to move to the right the lower capacities are obtained, and the dial should be adjusted numerically accordingly.

DE... and ...TOR ...ods



Curve... ...esy of Ken-Rad Co

FIG. 1

Plate voltage plate curre... teristics of the 75 high-... They apply also to the 2...

THE ...cteristics of many ... ne... ...lished without giv... am...cation factor. Instead the expected voltage amplification certain specified conditions is give... this is only given in ... because considerable ... expected.

When certain fa... given for a tube, the ... can be obtained app... those curves. In doing so we ... of the definition of voltage amplification factor, which is the ratio of the ... the pl... ...tage to the grid ... change ...roduces that plate ... change, the plate current remainin... In this it is particularly important ... the condition that the plate current is ... constant. Suppose we want to m... voltage amplification factor with ... First we measure the plate cur... given val... grid voltage and plate ... age. Th... ...rid voltage is changed by a small am... The plate voltage is now changed until the plate current is what it was before the change in the grid voltage. The change in the plate voltage divided by the change in the grid bias is the amplification factor.

...ect Definition

Strictly, ... change in the grid voltage should be extremely small, but if it is too small accurate values cannot be obtained from the meters. And if a large change is made in the grid voltage, the result is the average amplification factor over that range of grid voltage. If the characteristic in question is linear over this voltage range, which it may be to a fairly close approximation, the average value of the factor is the same as the value at the point in question.

There are many ways of getting the amplification factor from characteristic curves, all depending on the definition given. Refer to the plate voltage-plate current curves in Fig. 1. Let us obtain the amplification factor when the plate current is 1.2 milliamperes and the grid bias is 1.0 volt. When the bias is 0.5 volt, the plate voltage is 150 volts, and when the grid bias is 1.5 volts, the plate voltage is 242 volts. We have changed the grid voltage by one volt and the plate voltage by 92 volts, keeping the plate current at 1.2 milliamperes. Hence, the average amplification factor between 0.5 and 1.5 volts bias, which may be taken as the value

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...Co...

...g. 3 sh... ...stics fo... current cu... ...e the curren... ...ias is one volt ... ...and when the bi... ...ge is 275 volts. ... ...plate voltage for ... ...in the grid bias is 97 ... equal to the amplif... ...is a little higher ... ...the other curves ... ...to inaccuracy ... ...of the curves ... ...value of the ... ...tube always ... ...fied ... ...a lower ... If ...e factor ... ...eter and ... should be ... ...the tube is ... re...mended operating ... ...discussion is 1.35 ... ag...may therefore be ...

...tly proportional to the primary inductance, and it increases as the condenser ...ross the secondary decreases in the same ...ay as it increases as the resistance in the ...condary decreases. It also increases as ...e coefficient of the coupling increases. By ...e here is meant that condition in ...ere is no reactance in the secondary

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Why Platinum Is Used

...Y IS PLATINUM used for leading ...tors into vacuum tubes and electric ...?—J. A. E.

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* * *

Grid Current

...A TUBE ever draw grid current ...grid voltage is negative? If so, ... and under what conditions?—

... slight grid current for low ... values. How much depends ... plate voltage, on the amount ... tube, and on the bias. It ... amount to more than a few ... most. But even this may ...use a great deal of distor... ...igh resistance leak in the ...fest to use a moderately ...more than half megohm.

* * *

...oss Resistance

... give a formula for ... effective impedance ...denser in parallel?

... $1+C^2w^2R^2)^{1/2}$, in ... in ohms, C the ...s 6.28 times the ...tance is 1,000,- ...mfd., and the ...econd. What ...la gives 303,- ... that causes ...noticed that ... fr...tly

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Yes, this resistor causes a drop in the applied voltage so that the current will be less than it would be without this resistor. Also, the grid bias resistor will have to be larger because the current will be less. It is best not to make the filter resistor any larger than is absolutely necessary and to depend on the by-pass condenser for most of the filtering. An audio frequency choke coil with very lower internal resistance would be better than a resistor, unless it is necessary to filter out very low audio and sub-audible frequencies.

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Pentagrid Mixing

PLEASE SHOW the best way of using a pentagrid tube for mixing in a superheterodyne. Do you recommend this type of tube in a set designed for quality, when the number of tubes in the set is of no importance?—S. F.

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Supersonic Sound

JUST WHAT IS a supersonic sound wave? If anything is supersonic how can it at the same time be sonic? If it is sonic it is sound. Please clarify—H. G.

What is meant by the inconsistency is superaudible sound, if by sound we mean air vibrations. If we confine the term sound to audible air vibrations it would be all right to speak of supersonic air waves when the frequency of those waves is higher than the upper audible limit. But the expression supersonic sound cannot be right on either view of the term sound. The same confusion of terms occurs in light. We have heard the term ultravisible light. The question is whether or not electromagnetic vibrations are light if they are outside the visible spectrum. If they are, there is no inconsistency here. If we cannot see by the light, however, it is not very illuminating. But it may be blistering for all that.

* * *

Range of Tuners

IN AN OSCILLATOR with plug-in coils I have noticed that the range of the coils of higher inductance is not as great as that of the smaller coils. The tuning condenser is the same for all of them, and it would seem to me that the range would be the same. As it is, the range of the larger coils is barely 2-to-1 whereas the range of the smaller coils is considerably greater than 2-to-1. If there is to be a difference, it seems to me, it should be the other way about. What explanation do you have?—W. H. C.

There must be a difference in the distributed capacities of the coils. The minimum capacity in the larger coils is relatively larger than it is for the smaller coils. If the capacity ratio were the same in all cases, the frequency ratio would also be the same.

* * *

Construction of Precision Oscillator

WHAT PRECAUTIONS should be taken in the construction of a precision oscillator? I have in mind to construct one that is as nearly constant in frequency as possible. It should not only be unaffected by changes in the operating voltages, but also by vibrations, changes in temperature, moisture, and atmospheric pressure.—R. B. M.

That is a big problem, but many such oscillators have been constructed. First of all it is necessary to select a circuit that is as nearly independent of changes in the operating voltages as possible. Such a circuit will also be independent of changes in the load, provided that such changes do not involve changes in the reactances in the circuit. We have published stabilized oscillator circuits many times, and one that is particularly suitable is the symmetrical Colpitts. But it is not the only one. To guard against vibrations the oscillator can be mounted on stock absorbers, such as sponge rubber. To guard against changes due to moisture and barometric pressure, the circuit should be inclosed in a container where these factors can be kept constant. Changes of frequency due to temperature changes are likely to be the largest in such an oscillator. Thermostatic control of the temperature will solve that problem. Naturally, it will not be a simple oscillator.

* * *

Production of Superauble Air Waves

WHAT IS THE GENERAL method of producing air waves of such high frequencies that they cannot be heard? I have tried loudspeakers and high frequency oscillators but have not been able to detect any high frequencies in the air.—E. R. W.

There is no problem in producing the oscillation, for a suitable vacuum tube oscillator will do that. There remain the problems of transferring the vibrations to the air and to detect them after they are in the air. For "loudspeaker" it is possible to use a piezo crystal, which may be of quartz or of Rochelle salt. There is no difficulty in driving a Rochelle salt crystal at frequencies between 10,000 and 100,000 cycles, provided its size is suitable. Quartz crystals can be driven at higher frequencies, mainly because they are smaller. But a Rochelle salt crystal can be made small too. Once the high frequencies are in the air there remains the problem of detecting them. How to do that depends on what they are to be used for. It may be possible to use another crystal tuned to the frequencies, or a specially constructed microphone.

* * *

Choke Coupling

WILL YOU kindly explain how it is that an audio frequency choke can be used in a direct coupled amplifier in the same manner as a high resistance, even though the resistance of that choke may be less than 500 ohms? It seems to me that there would be no amplification when the resistance is so low. Yet I know that it is just as great as when a high resistance is used.—J. Y.

It is not the d-c resistance that counts when the choke is used. It is the resistance of the choke. This reactance may be very high. Suppose, for example, that the effective inductance of the choke is 100 henries. The reactance is then 628f ohms, where f is the frequency of the signal. Now if f is as low as 100 cycles per second, the reactance is 62,800 ohms. It is true that the reactance is directly proportional to the frequency so that at low frequencies the amplification should fall off. But this does not occur appppreciably until the reactance is less than the internal plate resistance of the tube. When the d-c resistance of the choke is low the internal resistance of the tube is low, and therefore the reactance of the coil can be quite low before there is any appreciable diminution in the amplification. Suppose that the internal resistance of the tube is 7,500 ohms. Then at 25 cycles per second the amplificaiton is 0.94u, where u is the mu-factor of the tube. At 1,000 cycles per second the amplification is practically equal to the mu-factor. Hence there has been a drop of only 6 per cent. What happens below 25 cycles per second is of no interest in a broadcast amplifier. Of course, had we used a high-mu tube with a high internal resistance the results would not have been so favorable.

* * *

Characteristics of Phototubes

IT IS SAID that the response of phototubes is directly proportional to the illumination, or to the amount of light flux that enters the cell. Yet a gaseous cell shows strong curvature between the current and the anode voltage. Does not this indicate that the proportionality is true?—R. L.

It is the variation of the current with the light flux that is linear, not the variation with the anode voltage. The voltage is supposed to be held constant as the light varies. If that is done the proportionality holds quite accurately, both for gaseous and high vacuum phototubes.

* * *

Use of 2A6

WILL YOU kindly give specifications for the 2A6 in a resistance coupled amplifier so as to get the greatest output voltage? Is it possible to get enough out of this tube to load up a 2A3 power triode?—W. R.

Make the plate supply voltage volts, the bias resistance in the cathode leg 5,600 ohms, the plate coupling resistance half megohm, and the grid leak preceding the power tube half megohm. Under these conditions the grid bias will be 1.35 volts, negative, the plate current will be 0.24 milliampere, the voltage amplification about 40, and the amplitude of the output voltage about 58 volts. This is very near the maximum input voltage to the 2A3.

* * *

Measuring High Voltages

IS THERE any way of measuring high voltages with a vacuum tube by applying the voltage to be measured in the plate circuit and then measuring the grid bias? It seems to me that this is a possibility of measuring high voltages without the use of expensive meters. If this has been done or can be done will you kindly outline the method?—G. H. A.

This has been done. Suppose a given high voltage is applied in the plate circuit. A current will flow unless the grid bias is very high. If now the grid bias is increased until the plate current cuts off as judged by

Actual Voltage Gain in Resistance A. F.

(*Continued on next page*)

volts in the plate circuit. The slope of this curve multiplied by the load resistance and taken at the operating grid voltage is then the amplification.

To get the slope the plate current is noted at two different grid voltages about the operating voltage. For example, if the operating point is 1.5 volts bias, the current is read off the curve at one and two volts. For illustration let these currents be, respectively, 0.05 and 0.5 milliampere. The difference is 0.45 milliampere. That is the change in the current for a change of one volt in the grid voltage. Hence it is numerically equal to the slope. Now if the load resistance is 100,000 ohms, the voltage amplification is 45 times.

If the coupler after the tube is a plate resistor and a grid leak the d-c method just explained does not give the true voltage amplification because the grid leak is not taken into account. This can be allowed for by using a load resistance equal to the plate and grid resistances in parallel. For example, if the plate resistor is 250,000 ohms and the grid leak is one megohm, the effective load is 200,000 ohms, and this should be used in taking the curve. Later when the set is used the 0.25-megohm plate resistor should be used. This method gives the voltage amplification except at the two extremes of frequencies. On the high frequencies it fails because it does not take account of the capacity between the grid-plate side and ground. On low frequencies it fails because it does not take account of the effect of the stopping condenser. But for all important frequencies it gives a close approximation to the true voltage amplification, closer the smaller the shunt capacity and the larger the series resistor.

a sensitive milliammeter, there is a definite relation between the grid voltage and the plate voltage, and the ratio is the mu-factor of the tube. If the grid voltage is measured it is only necessary to multiply it with the mu of the tube. Since the mu may not be accurately true, and also since the simple relation just stated may not hold accurately in all cases, it is well to calibrate the circuit. In doing this the plate current can be held constant at the lowest deflection that can be accurately read. This is preferable to reducing the plate current to zero because the cut-off is not very sharp. The device permits measurement of high voltages with a low-range voltmeter and at the same time it makes the high range voltmeter one of extremely high resistance. Consider, for example, the case when the voltage in the plate circuit is 500 volts and the milliammeter is such that the lowest distinctly readable deflection represents 50 microamperes. The resistance to the voltage in this case is then equivalent to ten million ohms. Naturally, a sensitive milliammeter in the plate circuit of such a device is in a very dangerous position. To be on the safe side, the grid voltage at first should be very high and then gradually reduced until plate current begins to flow. The change in grid voltage should be continued so that there will be no sudden and large changes in the plate current, or else the plate voltage should be disconnected while changing the grid voltage.

* * *

Power Ratings of Tubes

WHEN A CERTAIN tube is rated for power output as an amplifier it is one thing and when it is rated as an oscillator it is something entirely different. The number of watts output from the oscillator is usually many times greater than the number of watts from the amplifier. Yet the plate voltages in the two cases may be the same. Why are there two ratings for the same tube?—B. V. S.

The output depends on the grid swing. In the amplifier the grid swing is limited to a portion of the range between zero bias and the cut-off bias. There can be comparatively little variation in the plate current. But when the tube is working as an oscillator there is no such limitation. The grid may not only swing into the positive region but it may swing a long way beyond the cut-off. Therefore there will be a wide variation in the plate current. The efficiency of the oscillator is much higher than that of the amplifier. In the oscillator plate current does not flow all the time. Indeed, it may not flow half the time.

* * *

Change of Tuning

FROM DAY TO DAY the settings of my tuner for given stations change. Sometimes the change is as much as one division of a dial calibrated in kilocycles, that is, it is equal to 10 kc. If the change is due to capacity entirely, how much is the change in micromicrofarads?—R. W.

It depends on what the frequency is and also on the inductance in the circuit. If we suppose that the inductance is 250 microhenries and the frequency is 1,000 kc, the change in the capacity amounts to about 2 mmfd. Such change might be effected by changes in the temperature of the condenser and also by moisture. It is also possible that part of the change is caused by changes in the inductance. We have no more reason for believing that the inductance remains fixed than that the capacity stays put. Both are subject to temperature variations.

* * *

Impedance of a Tuned Circuit

IS THE impedance presented to a tube by a radio frequency transformed with tuned secondary high or low at resonance? Does it depend a great deal on the size of the primary inductance? In what way does it depend on the resistance of the secondary circuit?—T. H. Y.

At resonance the impedance is high. It is higher the lower the resistance in the secondary circuit. The impedance is directly proportional to the primary inductance, and it increases as the condenser across the secondary decreases in the same way as it increases as the resistance in the secondary decreases. It also increases as the coefficient of the coupling increases. By resonance here is meant that condition in which there is no reactance in the secondary circuit.

* * *

Why Platinum Is Used

WHY IS PLATINUM used for leading conductors into vacuum tubes and electric lamps?—J. A. E.

The reason platinum has been used is that its expansion coefficient with temperature is very nearly the same as that of the glass. Therefore the seal is not broken by expansion and contraction.

* * *

Grid Current

DOES A TUBE ever draw grid current when the grid voltage is negative? If so, how much and under what conditions?—E. T. T.

There is a slight grid current for low negative bias values. How much depends on the effective plate voltage, on the amount of gas in the tube, and on the bias. It usually does not amount to more than a few microamperes at most. But even this may be sufficient to cause a great deal of distortion if there is a high resistance leak in the grid circuit. It's safest to use a moderately large leak, say not more than half megohm.

* * *

Condenser Across Resistance

WILL YOU kindly give a formula for the computation of the effective impedance of a resistance and a condenser in parallel? —W. N.

The formula is $R/(1+C^2w^2R^2)^{1/2}$, in which R is the resistance in ohms, C the capacity in farads, and w is 6.28 times the frequency. Suppose the resistance is 1,000,000 ohms, the capacity 50 mmfd., and the frequency 10,000 cycles per second. What is the impedance? The formula gives 303,000 ohms. It is the condenser that causes the great reduction. It will be noticed that the values here assumed are those frequently used in a diode rectifier circuit, and the reduction computed is that of the highest audio frequency usually considered. The reduction at the carrier frequency is very much larger. Suppose, for example, that the carrier frequency is 1,000 kc. What is the impedance then? Well, the formula gives 3,180 ohms. This formula is also useful in estimating the drop in voltage in resistance coupled amplifiers when there is an appreciable capacity across the coupling resistors, either stray or intentional.

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IF A PHONOGRAPH record has been recorded at a certain speed and it is later played at a faster speed, will there be distortion? Will the correct relationship be maintained between the fundamentals and the harmonics?—R. V. L.

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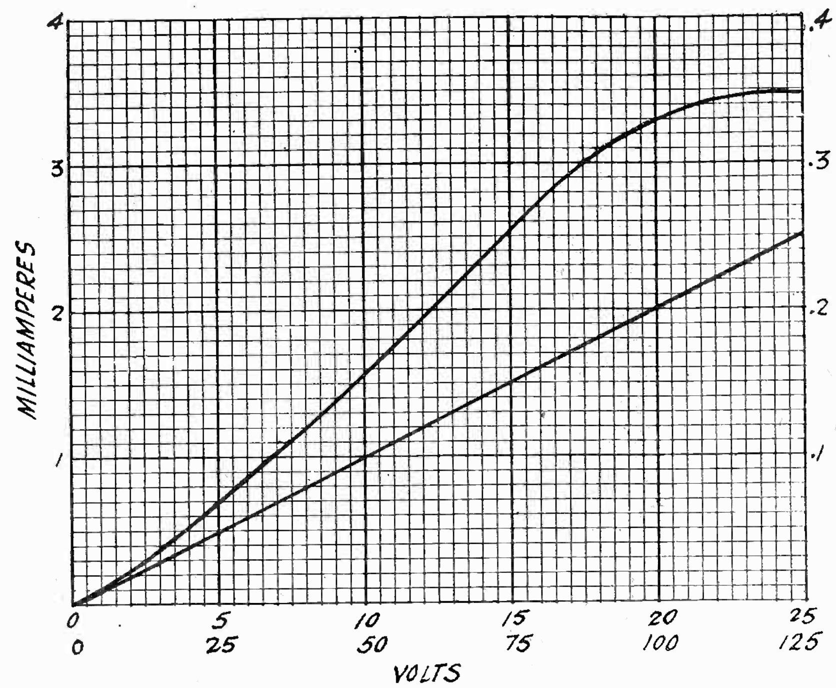

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Let us suppose that the internal resistance of the rectifier element is 10,000 ohms, which is a reasonable value. Then if the load resistance on the rectifier is 500,000 ohms, the total resistance in the circuit is 510,000 ohms, and only about 2 per cent. of this resistance is subject to a small variation as the voltage changes. Hence the total distortion due to curvature cannot exceed two per cent. Actually, it will be much less than this because the characteristic itself is nearly linear over the voltage region covered. Therefore when the detection is called linear, the exaggeration is not worthy of mention.

In Fig. 1 we have a characteristic curve of a diode rectifier covering the voltage range of 25 volts and the current range of nearly 3.5 milliamperes. It is only after the current exceeds about 3 milliamperes that the effects of saturation are appreciable, which begins when the voltage drop in the tube is about 17.5 volts.

When the tube functions in a practical rectifier circuit in which voltage output is the main consideration, the actual voltage across the tube is extremely small and the rectified current is correspondingly small. Suppose, for example, that the load resistance is 500,000 ohms, as we assumed before, and also suppose that the signal voltage impressed on the circuit is 100 volts. For practical purpose we can say that the load resistance is the only resistance in the circuit. Therefore the current through the load resistance and the tube will be only 0.2 milliampere. This makes the drop in the tube 1.75 volts, as judged from the curve. The resistance the tube offers is then only about 10,000 ohms, and only this portion is variable, and only slightly variable at that. Even when the applied voltage is as high as 100 volts we are a long way from entering the saturation portion of the tube.

The straight line in Fig. 1 is an approximation of the rectified current that would result when there is a 500,000-ohm resistance in series with the tube. The lower voltage scale, which is five times the upper scale, applies to the circuit as a whole, while the upper scale refers to the tube alone. The current scale on the right refers to the entire circuit. The curve is a straight line because the effect of the small internal resistance of the tube is so small that it is impractical to allow for it in drawing the curve of the entire circuit. The error in the curve at 125 volts is not more than 5 microamperes out of 250 microamperes, or 2 per cent.

The rectified voltage, which is the drop across the load resistance, is practically free from distortion.

Instantaneous Values

Linearity of detection does not mean that all frequencies are detected to the same degree. Not at all. But the divergence does not depend on the lack of linearity of the rectifier as much as it does on the filter necessary across the load resistance. Due to the condenser across the load resistance, low frequencies are detected more effectively than high frequencies. The higher the filter capacity the higher is the loss on the high audio frequencies. This can easily be tested qualitatively, for if the condenser is increased the tone will become lower in pitch, which means that the high audio frequencies are not detected. Incidentally, this is an easy way of getting a tone control, for a small variable condenser across the load resistance could do just as much as a variable condenser of many times the value placed across the output of the last tube, where the tone control is often placed. The effectiveness of a given condenser is directly proportional to the value of the resistance across which it is connected.

Instantaneous values of rectified current are much higher than the instantaneous values obtained on the assumption that the load resistance is in the circuit. The reason for this is that the filter condenser shunts the resistance and puts a high voltage across the tube. And the instantaneous values of current are much higher for high carrier frequencies than for low. But the instantaneous values do not count so much in detection, but rather the mean values. The mean value of rectified current is that which is obtained when a d-c milliammeter is put in series with the load resistance. The detected signal is the fluctuation in the mean current due to the modulation, and this fluctuation is greater for the lower modulation frequencies than for the higher.

Valuable Calibration Data

(*Continued from preceding page*)

checked also, particularly larger ones, using the honeycomb coil. If one does not care to go through the computations for these larger capacities he may consult Edward M. Shiepe's book of curve-sheets, "The Inductance Authority," which enables accurate results at a glance.

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As will occur to many readers, some other tuning condenser could be used, and its capacity derived by noting the dial settings for the frequencies of the non-conforming condenser, and computing the capacity, deducting 10 mmfd. from each result, or the answers taken from Mr. Shiepe's book. This is possible because of the known inductance and frequency. In fact, the capacity curve of this other condenser could be plotted on Fig. 2.

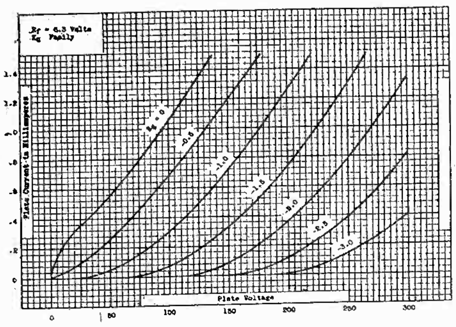
As intimated previously, it is much better to use the low-frequency part of the curves, and this, it may be added, is true in both instances, because of the frequency-stability in that region, which approximates crystal-control results without temperature oven.

The G. R. condenser, while closing to the left, has no endstop, so might be turned or calibrated the wrong way. With plates totally enmeshed the dial, by causing the rotor to move to the right the lower capacities are obtained, and the dial should be adjusted numerically accordingly.

DETERMINING MU FACTOR

and Voltage Gain by Simple Methods

By Einar Andrews



Curves by courtesy of Ken-Rad Corporation

FIG. 1

Plate voltage plate current characteristics of the 75 high-mu triode. They apply also to the 2A6 tube.

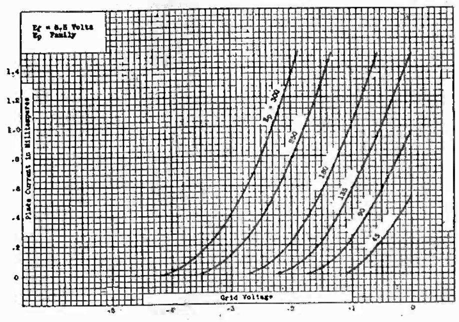


FIG. 2

Grid voltage plate current characteristics of the 75 high-mu triode as well as of the 2A6 triode.

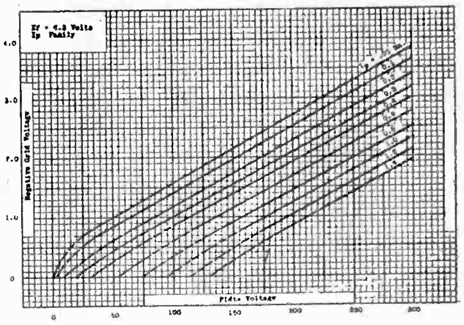


FIG. 3

Plate voltage grid voltage constant current curves of the 75 high-mu triode and of the 2A6 triode.

THE characteristics of many tubes are now published without giving the amplification factor. Instead of this the expected voltage amplification under certain specified conditions is given, and this is only given in round numbers because considerable variation can be expected.

When certain families of curves are given for a tube, the amplification factor can be obtained, approximately, from those curves. In doing so we take account of the definition of voltage amplification factor, which is the ratio of the change of the plate voltage to the grid voltage change that produces that plate voltage change, the plate current remaining constant. In this it is particularly important to note the condition that the plate current is to be constant. Suppose we want to measure the voltage amplification factor with voltmeters. First we measure the plate current for a given value of grid voltage and plate voltage. Then the grid voltage is changed by a small amount. The plate voltage is now changed until the plate current is what it was before the change in the grid voltage. The change in the plate voltage divided by the change in the grid bias is the amplification factor.

Correct Definition

Strictly, the change in the grid voltage should be extremely small, but if it is too small accurate values cannot be obtained from the meters. And if a large change is made in the grid voltage, the result is the average amplification factor over that range of grid voltage. If the characteristic in question is linear over this voltage range, which it may be to a fairly close approximation, the average value of the factor is the same as the value at the point in question.

There are many ways of getting the amplification factor from characteristic curves, all depending on the definition given. Refer to the plate voltage-plate current curves in Fig. 1. Let us obtain the amplification factor when the plate current is 1.2 milliamperes and the grid bias is 1.0 volt. When the bias is 0.5 volt, the plate voltage is 150 volts, and when the grid bias is 1.5 volts, the plate voltage is 242 volts. We have changed the grid voltage by one volt and the plate voltage by 92 volts, keeping the plate current at 1.2 milliamperes. Hence, the average amplification factor between 0.5 and 1.5 volts bias, which may be taken as the value of the factor at 1 volt bias, is 92. We are dealing with a high-mu triode tube.

Using Mutual Curves

Now let us consider the grid voltage-plate current curves in Fig. 2, which are for the same tube. Again let us hold the plate current constant at 1.2 milliamperes. When the plate voltage is 250 volts the grid voltage is 1.59 volts. When the plate voltage is 180 volts the grid bias is 0.81 volt. The change in the plate voltage is 70 volts and the corresponding change in the grid bias, keeping the plate current at 1.2 milliamperes, is 0.78 volt. The ratio of 70 and 0.78 is 90. This agrees with the preceding value of 92 as well as could be expected.

We might try at another current value. For example, when the current is 1 milliampere and the plate voltage is 180, the grid voltage is one volt. When the current has the same value and the plate voltage is 135 volts, the grid voltage is 0.5 volt. Therefore, a change of 0.5 volt in the grid bias has made a change of 45 volts in the plate voltage. Hence the amplification factor is 90. This agrees exactly with the value obtained before on the same curves.

Constant Current Curves

Fig. 3 shows an unusual family of characteristics for the same tube, namely, constant current curves. Let us take the curve where the current is 1 milliampere. When the bias is one volt the plate voltage is 177.5 volts, and when the bias is 2 volts the plate voltage is 275 volts. Hence the change in the plate voltage for a change of one volt in the grid bias is 97.5. This is numerically equal to the amplification factor. This value is a little higher than that obtained from the other curves, but this is due, mainly, to inaccuracy in reading off the voltages, and also to a slight variation in the slope of the curves.

As the value of the amplification factor of this tube always comes out around 90, we are justified in assuming that this is the value. This may be an average of all the tubes of this type. Some of the tubes will have a lower factor, others a higher factor. If the factor is to be measured with a voltmeter and a milliammeter, the measurement should be made around the bias at which the tube is to work. For example, the recommended operating bias for the tube under discussion is 1.35 volts. The grid voltage may therefore be adjusted first to 0.85 volt and then to 1.85 volts. The plate voltage is to be adjusted so that in both cases the plate current is the same. The bias should be measured from the cathode and there should be no other resistance in the plate circuit other than that of the milliammeter. If it is not convenient to make the measurements at these grid voltages, they can be made at one and two volts.

The Tube

The tube on which the curves had been taken is the 75 duplex diode high-mu triode, which is a 6.3-volt tube of the heater type. The corresponding curves taken on the 2A6 duplex diode high-mu triode are the same and give the same results as to the amplification factor. Hence we conclude that these tubes differ only in respect to heater voltage requirements. The 2A6 takes 2.5 volts on the heater.

The amplification obtained from a tube in a resistance-coupled circuit is not equal to the amplification factor, but is considerably less than that. How much less depends on the relative values of the load resistance and the internal resistance of the tube. If the internal resistance of the tube is R1 and the load resistance is R2, then the voltage amplification is uR2/(R1+R2), in which u is the amplification factor of the tube.

The value of R1 is not that which is usually given as the a-c internal resistance of the tube, but a higher value. It is higher because the effective plate voltage is much less than the voltage at which the internal resistance was measured.

Suppose we assume that the mu of the tube is 90 and that the internal resistance then is 25,000 ohms when the load resistance is 100,000 ohms. The amplification then is 72, according to the formula. For the 75 tube the amplification is given as 50 to 60 times, which indicates that the internal resistance is still higher than the value assumed. Indeed, it is more nearly 100,000 ohms.

Measuring Amplification

The actual voltage amplification can be obtained experimentally if a grid voltage-plate current curve is available, taken with the load resistance in the circuit. The appearance is like that of the curves in Fig. 2, but, naturally, drawn to a different current scale, since the currents will be much smaller. Suppose such a curve is taken with 250

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LINEAR DETECTION

Diode Affords It With High Load Resistor

By Brunsten Brunn

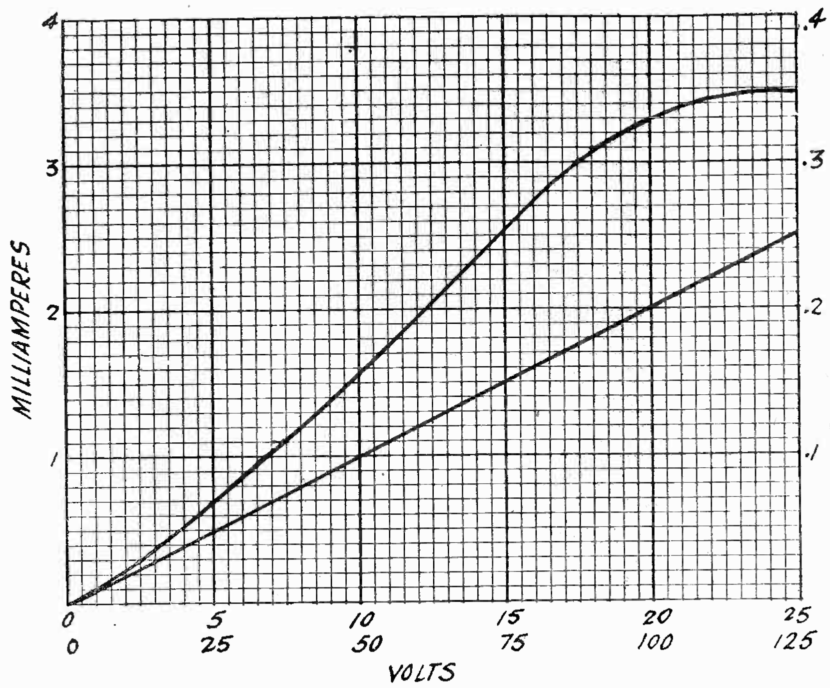

FIG. 1

Characteristic curves of a diode rectifier. The upper curve is for the rectifier alone and the lower for the tube and a half megohm resistance.

CHARACTERISTIC curves of diode rectifiers have been published, and these curves are not straight lines. Many fans have interpreted the curvature as indication, and even as proof, that there can be no linear detection with such rectifiers. How can there be linear detection, they ask, when the rectifier current is not proportional to the voltage?

Linear detection, so called, is a matter of relativity. Strictly, there cannot be linear detection if there is ever so little curvature of the characteristic. Practically, however, the detection can be so nearly linear that it is impossible to measure the divergence, much less to hear the result of such divergence.

Then what becomes of the marked curvature seen in the characteristic curves? It is removed by something that does respond faithfully according to the linear law. It is the pure resistance load on the rectifier that is linear, not the rectifier itself. If the load resistance is so large in comparison with the internal resistance of the rectifier that the internal resistance can be neglected, then the curvature of the characteristic can also be neglected.

Let us suppose that the internal resistance of the rectifier element is 10,000 ohms, which is a reasonable value. Then if the load resistance on the rectifier is 500,000 ohms, the total resistance in the circuit is 510,000 ohms, and only about 2 per cent. of this resistance is subject to a small variation as the voltage changes. Hence the total distortion due to curvature cannot exceed two per cent. Actually, it will be much less than this because the characteristic itself is nearly linear over the voltage region covered. Therefore when the detection is called linear, the exaggeration is not worthy of mention.

In Fig. 1 we have a characteristic curve of a diode rectifier covering the voltage range of 25 volts and the current range of nearly 3.5 milliamperes. It is only after the current exceeds about 3 milliamperes that the effects of saturation are appreciable, which begins when the voltage drop in the tube is about 17.5 volts.

When the tube functions in a practical rectifier circuit in which voltage output is the main consideration, the actual voltage across the tube is extremely small and the rectified current is correspondingly small. Suppose, for example, that the load resistance is 500,000 ohms, as we assumed before, and also suppose that the signal voltage impressed on the circuit is 100 volts. For practical purpose we can say that the load resistance is the only resistance in the circuit. Therefore the current through the load resistance and the tube will be only 0.2 milliampere. This makes the drop in the tube 1.75 volts, as judged from the curve. The resistance the tube offers is then only about 10,000 ohms, and only this portion is variable, and only slightly variable at that. Even when the applied voltage is as high as 100 volts we are a long way from entering the saturation portion of the tube.

The straight line in Fig. 1 is an approximation of the rectified current that would result when there is a 500,000-ohm resistance in series with the tube. The lower voltage scale, which is five times the upper scale, applies to the circuit as a whole, while the upper scale refers to the tube alone. The current scale on the right refers to the entire circuit. The curve is a straight line because the effect of the small internal resistance of the tube is so small that it is impractical to allow for it in drawing the curve of the entire circuit. The error in the curve at 125 volts is not more than 5 microamperes out of 250 microamperes, or 2 per cent.

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Valuable Calibration Data

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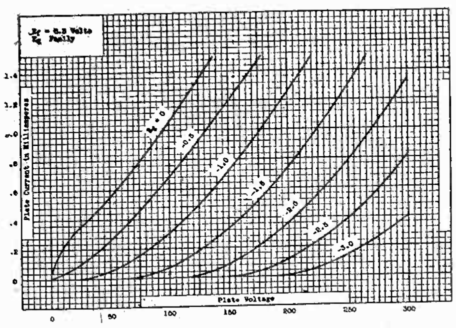
DETERMINING MU FACTOR

and Voltage Gain by Simple Methods

By Einar Andrews



Curves by courtesy of Ken-Rad Corporation

FIG. 1

Plate voltage plate current characteristics of the 75 high-mu triode. They apply also to the 2A6 tube.

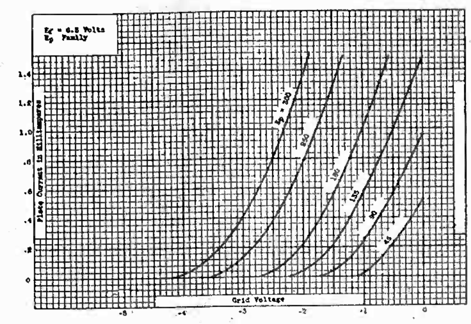


FIG. 2

Grid voltage plate current characteristics of the 75 high-mu triode as well as of the 2A6 triode.

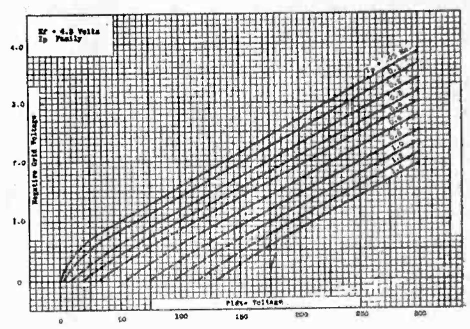


FIG. 3

Plate voltage grid voltage constant current curves of the 75 high-mu triode and of the 2A6 triode.

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Strictly, the change in the grid voltage should be extremely small, but if it is too small accurate values cannot be obtained from the meters. And if a large change is made in the grid voltage, the result is the average amplification factor over that range of grid voltage. If the characteristic in question is linear over this voltage range, which it may be to a fairly close approximation, the average value of the factor is the same as the value at the point in question.

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Supersonic Sound

JUST WHAT IS a supersonic sound wave? If anything is supersonic how can it at the same time be sonic? If it is sonic it is sound. Please clarify—H. G.

What is meant by the inconsistency is superaudible sound, if by sound we mean air vibrations. If we confine the term sound to audible air vibrations it would be all right to speak of supersonic air waves when the frequency of those waves is higher than the upper audible limit. But the expression supersonic sound cannot be right on either view of the term sound. The same confusion of terms occurs in light. We have heard the term ultravisible light. The question is whether or not electromagnetic vibrations are light if they are outside the visible spectrum. If they are, there is no inconsistency here. If we cannot see by the light, however, it is not very illuminating. But it may be blistering for all that.

* * *

Range of Tuners

IN AN OSCILLATOR with plug-in coils I have noticed that the range of the coils of higher inductance is not as great as that of the smaller coils. The tuning condenser is the same for all of them, and it would seem to me that the range would be the same. As it is, the range of the larger coils is barely 2-to-1 whereas the range of the smaller coils is considerably greater than 2-to-1. If there is to be a difference, it seems to me, it should be the other way about. What explanation do you have?—W. H. C.

There must be a difference in the distributed capacities of the coils. The minimum capacity in the larger coils is relatively larger than it is for the smaller coils. If the capacity ratio were the same in all cases, the frequency ratio would also be the same.

* * *

Construction of Precision Oscillator

WHAT PRECAUTIONS should be taken in the construction of a precision oscillator? I have in mind to construct one that is as nearly constant in frequency as possible. It should not only be unaffected by changes in the operating voltages, but also by vibrations, changes in temperature, moisture, and atmospheric pressure.—R. B. M.

That is a big problem, but many such oscillators have been constructed. First of all it is necessary to select a circuit that is as nearly independent of changes in the operating voltages as possible. Such a circuit will also be independent of changes in the load, provided that such changes do not involve changes in the reactances in the circuit. We have published stabilized oscillator circuits many times, and one that is particularly suitable is the symmetrical Colpitts. But it is not the only one. To guard against vibrations the oscillator can be mounted on stock absorbers, such as sponge rubber. To guard against changes due to moisture and barometric pressure, the circuit should be inclosed in a container where these factors can be kept constant. Changes of frequency due to temperature changes are likely to be the largest in such an oscillator. Thermostatic control of the temperature will solve that problem. Naturally, it will not be a simple oscillator.

* * *

Production of Superauble Air Waves

WHAT IS THE GENERAL method of producing air waves of such high frequencies that they cannot be heard? I have tried loudspeakers and high frequency oscillators but have not been able to detect any high frequencies in the air.—E. R. W.

There is no problem in producing the oscillation, for a suitable vacuum tube oscillator will do that. There remain the problems of transferring the vibrations to the air and to detect them after they are in the air. For "loudspeaker" it is possible to use a piezo crystal, which may be of quartz or of Rochelle salt. There is no difficulty in driving a Rochelle salt crystal at frequencies between 10,000 and 100,000 cycles, provided its size is suitable. Quartz crystals can be driven at higher frequencies, mainly because they are smaller. But a Rochelle salt crystal can be made small too. Once the high frequencies are in the air there remains the problem of detecting them. How to do that depends on what they are to be used for. It may be possible to use another crystal tuned to the frequencies, or a specially constructed microphone.

* * *

Choke Coupling

WILL YOU kindly explain how it is that an audio frequency choke can be used in a direct coupled amplifier in the same manner as a high resistance, even though the resistance of that choke may be less than 500 ohms? It seems to me that there would be no amplification when the resistance is so low. Yet I know that it is just as great as when a high resistance is used.—J. Y.

It is not the d-c resistance that counts when the choke is used. It is the resistance of the choke. This reactance may be very high. Suppose, for example, that the effective inductance of the choke is 100 henries. The reactance is then 628f ohms, where f is the frequency of the signal. Now if f is as low as 100 cycles per second, the reactance is 62,800 ohms. It is true that the reactance is directly proportional to the frequency so that at low frequencies the amplification should fall off. But this does not occur apppreciably until the reactance is less than the internal plate resistance of the tube. When the d-c resistance of the choke is low the internal resistance of the tube is low, and therefore the reactance of the coil can be quite low before there is any appreciable diminution in the amplification. Suppose that the internal resistance of the tube is 7,500 ohms. Then at 25 cycles per second the amplificaiton is 0.94u, where u is the mu-factor of the tube. At 1,000 cycles per second the amplification is practically equal to the mu-factor. Hence there has been a drop of only 6 per cent. What happens below 25 cycles per second is of no interest in a broadcast amplifier. Of course, had we used a high-mu tube with a high internal resistance the results would not have been so favorable.

* * *

Characteristics of Phototubes

IT IS SAID that the response of phototubes is directly proportional to the illumination, or to the amount of light flux that enters the cell. Yet a gaseous cell shows strong curvature between the current and the anode voltage. Does not this indicate that the proportionality is true?—R. L.

It is the variation of the current with the light flux that is linear, not the variation with the anode voltage. The voltage is supposed to be held constant as the light varies. If that is done the proportionality holds quite accurately, both for gaseous and high vacuum phototubes.

* * *

Use of 2A6

WILL YOU kindly give specifications for the 2A6 in a resistance coupled amplifier so as to get the greatest output voltage? Is it possible to get enough out of this tube to load up a 2A3 power triode?—W. R.

Make the plate supply voltage volts, the bias resistance in the cathode leg 5,600 ohms, the plate coupling resistance half megohm, and the grid leak preceding the power tube half megohm. Under these conditions the grid bias will be 1.35 volts, negative, the plate current will be 0.24 milliampere, the voltage amplification about 40, and the amplitude of the output voltage about 58 volts. This is very near the maximum input voltage to the 2A3.

* * *

Measuring High Voltages

IS THERE any way of measuring high voltages with a vacuum tube by applying the voltage to be measured in the plate circuit and then measuring the grid bias? It seems to me that this is a possibility of measuring high voltages without the use of expensive meters. If this has been done or can be done will you kindly outline the method?—G. H. A.

This has been done. Suppose a given high voltage is applied in the plate circuit. A current will flow unless the grid bias is very high. If now the grid bias is increased until the plate current cuts off as judged by

(Continued on next page)

Actual Voltage Gain in Resistance A. F.

volts in the plate circuit. The slope of this curve multiplied by the load resistance and taken at the operating grid voltage is then the amplification.

To get the slope the plate current is noted at two different grid voltages about the operating voltage. For example, if the operating point is 1.5 volts bias, the current is read off the curve at one and two volts. For illustration let these currents be, respectively, 0.05 and 0.5 milliampere. The difference is 0.45 milliampere. That is the change in the current for a change of one volt in the grid voltage. Hence it is numerically equal to the slope. Now if the load resistance is 100,000 ohms, the voltage amplification is 45 times.

If the coupler after the tube is a plate resistor and a grid leak the d-c method just explained does not give the true voltage amplification because the grid leak is not taken into account. This can be allowed for by using a load resistance equal to the plate and grid resistances in parallel. For example, if the plate resistor is 250,000 ohms and the grid leak is one megohm, the effective load is 200,000 ohms, and this should be used in taking the curve. Later when the set is used the 0.25-megohm plate resistor should be used. This method gives the voltage amplification except at the two extremes of frequencies. On the high frequencies it fails because it does not take account of the capacity between the grid-plate side and ground. On low frequencies it fails because it does not take account of the effect of the stopping condenser. But for all important frequencies it gives a close approximation to the true voltage amplification, closer the smaller the shunt capacity and the larger the series resistor.

a sensitive milliammeter, there is a definite relation between the grid voltage and the plate voltage, and the ratio is the mu-factor of the tube. If the grid voltage is measured it is only necessary to multiply it with the mu of the tube. Since the mu may not be accurately true, and also since the simple relation just stated may not hold accurately in all cases, it is well to calibrate the circuit. In doing this the plate current can be held constant at the lowest deflection that can be accurately read. This is preferable to reducing the plate current to zero because the cut-off is not very sharp. The device permits measurement of high voltages with a low-range voltmeter and at the same time it makes the high range voltmeter one of extremely high resistance. Consider, for example, the case when the voltage in the plate circuit is 500 volts and the milliammeter is such that the lowest distinctly readable deflection represents 50 microamperes. The resistance to the voltage in this case is then equivalent to ten million ohms. Naturally, a sensitive milliammeter in the plate circuit of such a device is in a very dangerous position. To be on the safe side, the grid voltage at first should be very high and then gradually reduced until plate current begins to flow. The change in grid voltage should be continued so that there will be no sudden and large changes in the plate current, or else the plate voltage should be disconnected while changing the grid voltage.

* * *

Power Ratings of Tubes

WHEN A CERTAIN tube is rated for power output as an amplifier it is one thing and when it is rated as an oscillator it is something entirely different. The number of watts output from the oscillator is usually many times greater than the number of watts from the amplifier. Yet the plate voltages in the two cases may be the same. Why are there two ratings for the same tube?—B. V. S.

The output depends on the grid swing. In the amplifier the grid swing is limited to a portion of the range between zero bias and the cut-off bias. There can be comparatively little variation in the plate current. But when the tube is working as an oscillator there is no such limitation. The grid may not only swing into the positive region but it may swing a long way beyond the cut-off. Therefore there will be a wide variation in the plate current. The efficiency of the oscillator is much higher than that of the amplifier. In the oscillator plate current does not flow all the time. Indeed, it may not flow half the time.

* * *

Change of Tuning

FROM DAY TO DAY the settings of my tuner for given stations change. Sometimes the change is as much as one division of a dial calibrated in kilocycles, that is, it is equal to 10 kc. If the change is due to capacity entirely, how much is the change in micromicrofarads?—R. W.

It depends on what the frequency is and also on the inductance in the circuit. If we suppose that the inductance is 250 microhenries and the frequency is 1,000 kc, the change in the capacity amounts to about 2 mmfd. Such change might be effected by changes in the temperature of the condenser and also by moisture. It is also possible that part of the change is caused by changes in the inductance. We have no more reason for believing that the inductance remains fixed than that the capacity stays put. Both are subject to temperature variations.

* * *

Impedance of a Tuned Circuit

IS THE impedance presented to a tube by a radio frequency transformed with tuned secondary high or low at resonance? Does it depend a great deal on the size of the primary inductance? In what way does it depend on the resistance of the secondary circuit?—T. H. Y.

At resonance the impedance is high. It is higher the lower the resistance in the secondary circuit. The impedance is directly proportional to the primary inductance, and it increases as the condenser across the secondary decreases in the same way as it increases as the resistance in the secondary decreases. It also increases as the coefficient of the coupling increases. By resonance here is meant that condition in which there is no reactance in the secondary circuit.

* * *

Why Platinum Is Used

WHY IS PLATINUM used for leading conductors into vacuum tubes and electric lamps?—J. A. E.

The reason platinum has been used is that its expansion coefficient with temperature is very nearly the same as that of the glass. Therefore the seal is not broken by expansion and contraction.

* * *

Grid Current

DOES A TUBE ever draw grid current when the grid voltage is negative? If so, how much and under what conditions?—E. T. T.

There is a slight grid current for low negative bias values. How much depends on the effective plate voltage, on the amount of gas in the tube, and on the bias. It usually does not amount to more than a few microamperes at most. But even this may be sufficient to cause a great deal of distortion if there is a high resistance leak in the grid circuit. It s safest to use a moderately large leak, say not more than half megohm.

* * *

Condenser Across Resistance

WILL YOU kindly give a formula for the computation of the effective impedance of a resistance and a condenser in parallel? —W. N.

The formula is $R/(1+C^2w^2R^2)^{1/2}$, in which R is the resistance in ohms, C the capacity in farads, and w is 6.28 times the frequency. Suppose the resistance is 1,000,000 ohms, the capacity 50 mmfd., and the frequency 10,000 cycles per second. What is the impedance? The formula gives 303,000 ohms. It is the condenser that causes the great reduction. It will be noticed that the values here assumed are those frequently used in a diode rectifier circuit, and the reduction computed is that of the highest audio frequency usually considered. The reduction at the carrier frequency is very much larger. Suppose, for example, that the carrier frequency is 1,000 kc. What is the impedance then? Well, the formula gives 3,180 ohms. This formula is also useful in estimating the drop in voltage in resistance coupled amplifiers when there is an appreciable capacity across the coupling resistors, either stray or intentional.

Speeding Up Phonograph

IF A PHONOGRAPH record has been recorded at a certain speed and it is later played at a faster speed, will there be distortion? Will the correct relationship be maintained between the fundamentals and the harmonics?—R. V. L.

If the phonograph runs at a higher speed than the recording speed there is no distortion of the type you mention, for if a fundamental is multiplied by a certain factor all its harmonics are multiplied by the same factor. This holds both for higher and lower speeds. Just the same, the sound will be unpleasant if the change in speed is great either way. Simply changing the speed a little will play the music in a different pitch.

* * *

Plate Resistance Filters

WHEN A HIGH resistance is put in the plate circuit of a resistance coupled amplifier for the purpose of filtering, does this have to be taken into account when figuring the plate current and the required grid bias resistor?—E. G.

Yes, this resistor causes a drop in the applied voltage so that the current will be less than it would be without this resistor. Also, the grid bias resistor will have to be larger because the current will be less. It is best not to make the filter resistor any larger than is absolutely necessary and to depend on the by-pass condenser for most of the filtering. An audio frequency choke coil with very lower internal resistance would be better than a resistor, unless it is necessary to filter out very low audio and sub-audible frequencies.

* * *

Pentagrid Mixing

PLEASE SHOW the best way of using a pentagrid tube for mixing in a superheterodyne. Do you recommend this type of tube in a set designed for quality, when the number of tubes in the set is of no importance? —S. F.

Two different connections of the pentagrid tube are shown. The first of the two is the simpler connection, but the second is said to have some advantages, as it is supposed to oscillate a little better. One thing that must be done is to return the grid leak of the oscillator to the cathode directly and not to ground. If this is not done, the circuit is not always self-starting. The grid of the modulator section of the tubes should be returned to an appropriate negative bias. In these circuits provision has been made so that the bias may be made greater than that provided by the bias resistor in the cathode lead. This is not necessary, for the

(*Continued on next page*)

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bias can be made right by the bias resistor, and this eliminates a 0.1 mfd. condenser. No, we do not recommend the pentagrid tube where there is no objection to using separate tubes for oscillator and for mixer. But the pentagrid tube has its uses in sets that must necessarily be small and at the same time sensitive.

* * *

Use of Pentagrid Oscillator

IS IT NOT A FACT that when a pentagrid tube is used for oscillation and mixing the coupling between the oscillator and the modulator is very close and that the harmonics generated by the oscillator are impressed on the modulator?—L. S.

It is true that the coupling is close, very close. It is also true that the plate current in the oscillator is very distorted. Then the plate voltage (that is, of the oscillator portion) must be also distorted. Thus we mix a distorted voltage with the signal voltage, and we can expect strong harmonics. But they may not cause any serious harm. Possibly, if the tuned circuit is put on the anode side that there would be less harmonics, for then we would at least have the resonance to eliminate harmonics, relatively.

* * *

Determining Inductance

IS IT POSSIBLE by means of a calibrated oscillator and a condenser of known value to determine the inductance in a circuit? If so, please give the formula.—R. E.

Yes, the inductance $L=0.0253/F^2C$, henries, cycles, and farads being the units. If a small condenser of known value is added to a large condenser, also of known value, the inductance can be computed from $L=0.01265dC/FC^2dF$, in which dC is the small capacity added, F the original frequency, C the original capacity, and dF is the change in frequency. Units are the henry, the farad, and the cycle per second. If this formula is to hold the value of dC must be very small compared with C.

* * *

Coupling in Supers

IS THERE ANY way of coupling a modulator and an oscillator in a superheterodyne so that it will be about equally effective at all frequencies? I have in mind a short-wave set with tapped coils. I do not wish to change the pickup.—S. D.

It can be done as shown in the accompanying drawing, in which a 56 oscillator and a 58 modulator are coupled together in such a manner that the coupling does not change with the frequency. The screen of the 58 is connected to the grid of the oscillator. Possibly a better way of doing this would be to connect the screen to a suitable positive voltage through a radio frequency choke and then connect the grid of the oscillator to the screen by a condenser. While this would not be non-reactive the change in the coupling with frequency would be small. It would have the advantage of operating the 58 with a definite positive bias. About the same effect can be obtained with a pentagrid tube, such as the 2A7, and a mixer using this tube is shown at the right of the two-tube mixer. These circuits are suitable both for tapped and plug-in types of coil.

* * *

Tone of Midgets

IS IT NOT a fact that the tone of midget and various miniature sets is just as good as the tone of the larger console model receivers? There seems to be no greater difficulty in understanding a speaker when heard on one of the miniature sets than when heard on a console. Music also seems to be equally good. If that is true, what is the object of having a console set?—W. H. C.

A person who cannot tell the difference between the tones from a console and a miniature set might just as well have the miniature. But perhaps others who can tell the difference will listen regularly to the set. Perhaps the person with the insensitive ears is not quite so insensitive to the feelings of other people. Few people, indeed, would play a radio receiver, or any other instrument, when they know that the music is distressing to friends, or when they have reason to suppose that the friends will not think much of their tonal judgment. There is a difference, all right, between the performance of a midget and a large console. Yet for all this difference, each type of set has its place. The powerful console set is distressing to friends and neighbors, too, at times, especially when it is giving the effect of an earthquake in an apartment house long after normal bedtime.

* * *

Change of Tuning with Volume

HOW IS IT that stations of equal frequency come in at slightly different points of the dial when the strength of these stations are different? Is it not a fact that tuning depends on frequency alone and not on intensity?—W. R. L.

There are many factors which affect the effective capacity of a tuned circuit when connected to a vacuum tube. If grid current flows the reactance of any circuit connected to that grid changes. Likewise, changes in the plate current will affect the reactance of a tuner connected to the plate

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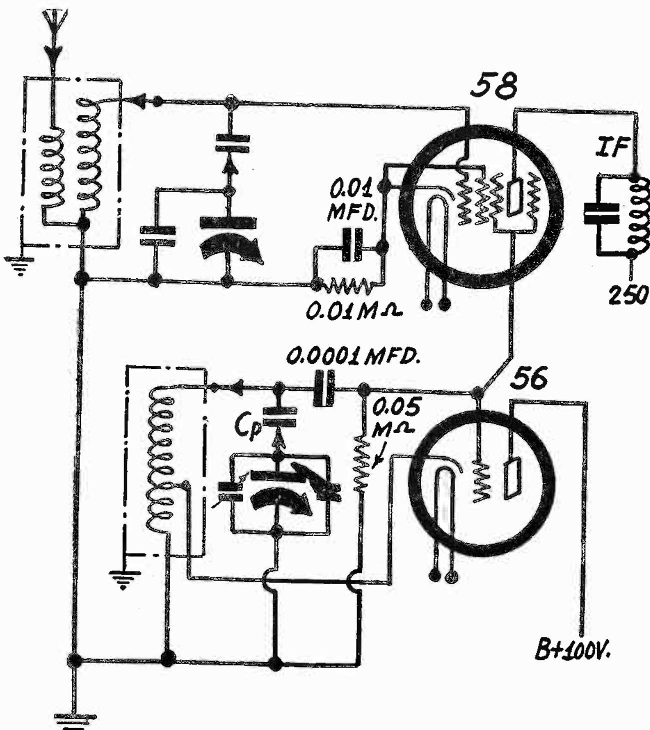
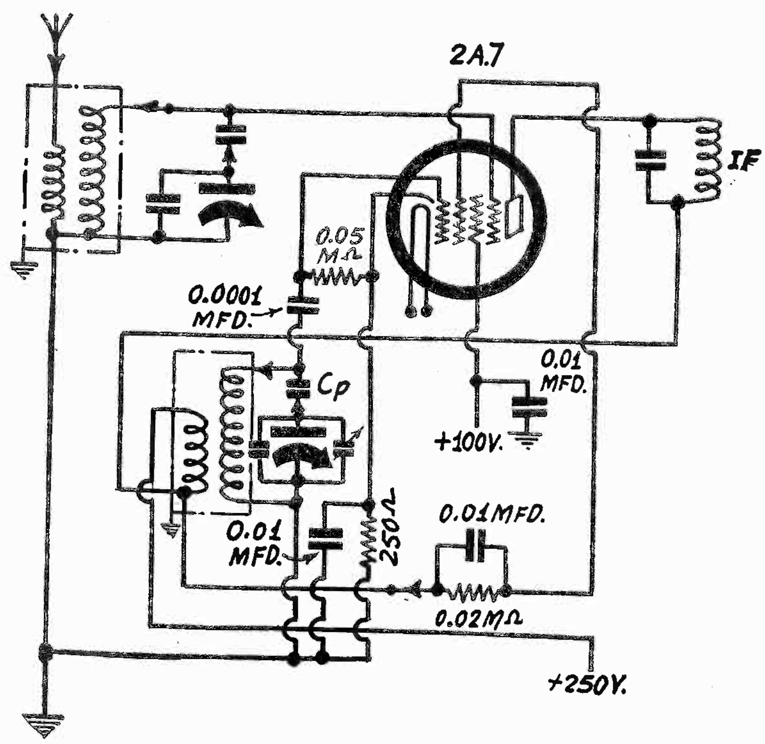
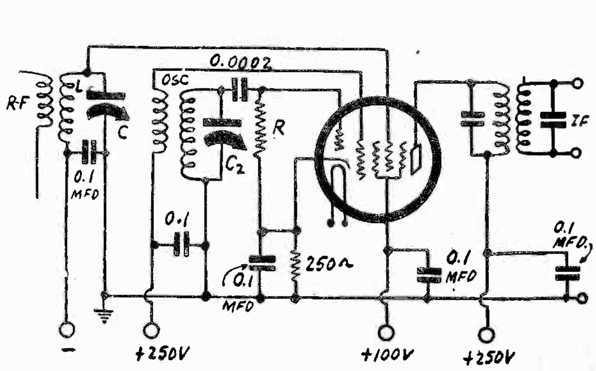
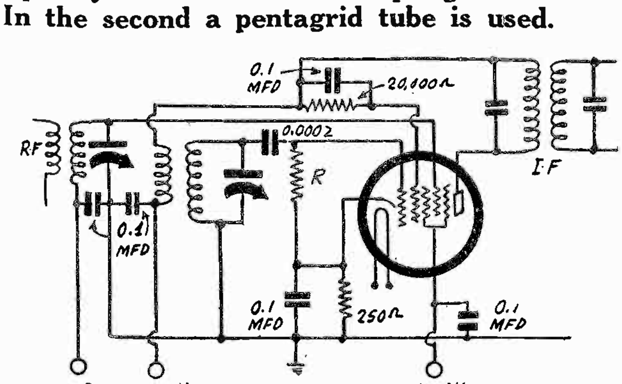




These methods of mixing are practicallly independent of frequency. In the first the coupling is between the grid of the oscillator and the screen of the mixer. In the second a pentagrid tube is used.





These two circuits illustrate two methods of connecting a pentagrid tube to produce mixing. It is important to return the grid of the oscillator to the cathode.

The Review

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

Questions

1. What effect have terminal voltages on an oscillator? Explain the inherent cause of the effect as disinguished from the apparent cause.
2. What are two of the methods used as adjuncts in maintaining the stability of an oscillator?
3. Is the a-c voltage higher in the grid or in the plate circuit of an oscillator, and why?
4. How can a test be made for grid current if one has a meter sensitive enough? Can you suggest some other way, if one's meter is not sensitive enough for the previous method?
5. If a diode or other rectifier is to be depended on for biasing an oscillator, what should be the relationship of the biasing voltage to the signal voltage?
6. What method of coupling makes for minimum detuning and for reduced intensity of harmonics?
7. In general, which type of oscillator is more stable, that with grid leak and condenser (grid current type) or that with a low d-c path (non-grid-current type)?
8. How is the stability related to the value of the leak in an oscillator, assuming a fixed value of grid condenser, and what is the limiting factor of the leak resistance?
9. Name two ways of shifting the saturation point of a tube.
10. What is one of the most acceptable stabilized oscillators?
11. What is "wobbulation." What is its effect? Remedy?
12. What is a fair value of bypass capacity across a resistor of a power output stage of an audio amplifier?
13. Give a formula for determining the effective percentage of modulation (single tone), using one a-c and one d-c meter.
14. What two factors are affected by percentage modulation, from the viewpoint of sending the carrier?
15. State the two problems connected with diode-biased triodes and give a solution for each.
16. How can a test oscillator be used for measuring capacities?
17. What is a zero beat? Do you think it is easy to establish zero beat?
18. Why is not cobalt steel used a great deal as a magnetic material?
19. Why are ultra-frequency transmitting aerials erected at considerable heights?
20. Is there a cure for fading? Is there a remedy that gives at least some help? What is the limitation of that helpful method?

Answers

1. The observed effect of change of terminal voltages is to change the frequency of the oscillation, but this is merely apparent. Voltage itself has no effect on frequency. But change in voltage does change the resistance of the tube itself, and change in resistance creates a change in frequency.
2. Two of the methods of aiding the stability of an oscillator are (a) to render it free from changing conditions of temperature, by enclosing it in a temperature oven and (b) to protect it against changes in humidity, by introducing moisture-absorbing acids.
3. The a-c voltage is higher in the grid circuit of an oscillator because that is the circuit in which the voltage is reinforced by feedback.
4. To test for grid current, a sensitive current meter may be put in series with the grid circuit. If one's meter is not sensitive enough, a vacuum tube voltmeter rig may be used, with stopping condenser and a high value of grid leak (100 meg. suggested). The various a-c input voltages will regulate the amount of grid current, which will bias the tube accordingly, hence will produce correspondingly large changes in plate current, and the plate current changes may be measured by a less sensitive instrument.
5. The biasing voltage derived from a diode or other rectifier should be at least as high as the a-c voltage of the oscillator. Preferably the biasing voltage should be higher, hence a step-up ratio prevail as between feed to oscillator grid and feed to the rectifier.
6. Loose coupling.
7. The grid-leak-condenser type of oscillator is more stable than the other type. The "other type" requires special precautions for stabilization, but when these are taken, even as to either type, the stability is higher than that of the plain leak-condenser type.
8. The stability is greater the higher the leak value. The limiting factor in determining the leak value is the point where "grid blocking" occurs, that is, a form of modulation.
9. The saturation point of a tube may be shifted by (a) decreasing the filament voltage or (b) increasing the plate voltage.
10. The stabilized symmetrical Colpitts circuit is one of the best.
11. Wobbulation is carrier frequency change. Its effect is to interfere and distort. A remedy is stabilized oscillation.
12. 10 mfd.
13. Using the two current meters, the effective percentage modulation may be derived by using high inductance choke coil in the plate circuit, and stopping condenser, measuring the d.c. (I_1) through the choke and the a-c (I_2) through the condenser, then the formula is $141.41 \times I_2/I_1 =$ effective percentage modulation.
14. Percentage of modulation should be high, so quality will be high, and penetration of distance increased, the two factors concerned.
15. The two diode-biased triode problems are (a), rectification does not take place at extremely low values of carrier input, one remedy being to boost the gain ahead of the detector until any receivable station gets past this distortion threshold; (b), the voltage fed to the triode easily may become far greater than the tube will stand without saturation, and automatic volume control will take care of this, provided a safe limit is used in the first instance, as by not putting all of the rectified voltage into the triode.
16. A test oscillator may be used for measuring capacities by ascertaining the inductance, calibrating the oscillator in frequencies, and computing the capacity settings for a sufficient number of frequencies to yield a good capacity curve. First the capacities outside the condenser should be determined, and these subtracted from the experimental result. Then unknown capacities may be substituted, frequencies determined, and capacity read from the chart by its relation to dial setting.
17. Zero beat is the establishment of no difference in frequency between two oscillators. It is extremely difficult to establish zero beat, and even then the adjustment has to be made with the aid of precision instruments. What passes for zero heat in practice is some small difference in frequency.
18. Cobalt steel has excellent magnetic properties, but is difficult to work. It could be worked while hot, but permanent magnets must be formed at a low temperature.
19. Ultra-frequency aerials are erected as high as possible so that the radiating distance will be increased. Since the propagation is more or less limited to the curvature of the earth, the height of the aerial has the effect of increasing the distance of the horizon.
20. There is no authenticated cure for fading, but automatic volume control tends to correct for it, not being effective where most effect is needed, that is, on weak, signals. Since the carrier amplitude determines the voltage for a.v. c., the controlling amplitude being small, the effect is smallest when needed most.

Radio University

(*Continued from preceding page*)

circuit. Plate current and grid current, if any, change with signal intensity. This is especially the case when the circuit is equipped with automatic volume control. In such circuits the plate current changes over wide limits, going down as the signal intensity goes up.

* * *

Capacity of Inductive Coupling

WHICH IS BETTER, inductive or capacitive coupling in a radio frequency tuner? In some circuits a small capacity couples the plate of an r-f tube to the tuned circuit and in others a small primary winding performs the function. Which gives the greater selectivity? Which greater gain?—T. H. Y.

For equal coupling, whether inductive or capacitive, the selectivity and gain are equal in the two. Inductive coupling is more effective the higher the frequency. Hence the selectivity is less the higher the frequency, just where it ought to be greater. Likewise, the gain is greater the higher the frequency, where it should be the same at all frequencies. When a small capacity is used between the plate and the tuned circuit, the coupling is not strictly capacitive. The smaller the condenser the looser is the coupling and the less is the gain. Also, the greater is the selectivity. This is because the condenser is in series with the signal. The true coupler is the choke connected between the plate and the B supply. With the arrangement of a choke and small condenser the gain is likely to be more uniform than with the inductive method of coupling, especially since the choke is usually so chosen that is resonates at a frequency where the gain otherwise would be least. The resonance brings up the amplification on the lower frequencies, and it may even be that the gain is highest at the lowest frequency covered by the tuner.

* * *

Measuring Deviation of Tracking

CAN YOU SUGGEST a simple method of measuring the difference between the r-f resonance frequency and the oscillator frequency of a circuit in which a tracking condenser is used in place of padding ? If so, please outline it.—W. F. A.

One simple method is to convert one of the r-f circuits to an oscillator and then measure the beat frequency between this oscillator and the regular oscillator. This may be done directly in the mixer. The beat frequency should be measured at every fifth division of the dial, or even closer if irregularities appear. The measurement can be made with an intermediate frequency oscillator covering the range of the intended intermediate frequency and 50 kc in both directions. The nearer the beat stays to one definite frequency the better is th tracking. In the same way the result of padding can be checked. It is clear that if this is to yield good results, the calibrated oscillator should be capable of being read to at least 500 cycles.

RADIO WORLD

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Twelfth Year

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HOME SAFELY

IT has not been the creed of the Roosevelt administration that recovery could be manufactured like some article of commerce, in fact, the President himself has said that he does not believe in panaceas. But it had been hoped that the correction of conditions that retard recovery could be speedily accomplished. A saner basis of conducting business certainly has resulted from the activities of the National Industry Recovery Administration.

Not all the expected speed has materialized, due to the complexity of our industrial and commercial structure, and the attempts of some industries to codify their own selfishness as manufacturers. Nor does either capital or labor find everything to its complete satisfaction. There is no pat solution to any of our major economic or social problems.

For the radio industry, it must be said that, after a poor start, it has done very well in realizing the prime objectives of the recovery movement, and has actually made sacrifices to lend a hand. The manufacturers are under the Electrical Code. The distributors and retailers will have their own codes, the bumps in these two codes being certain to be levelled in the usual manner of the Recovery Administration which, in the face of terrific onslaught, permitted only one bump, that of the labor clause in the automobile industry code, to get by.

On the negative side, stoppage of ruinous practices of competition and price-cutting, of overworking of employes with the result that unemployment fed on this vice, of exploitation of child labor; on the positive side, increase in the number of jobs and employes, with fixed minimum limits on pay and maximum limits on hours for the more numerous classes, are wholesome objectives with the theory of which none can complain. With the actual method of application and distribution of the burden there naturally would be some complaint, for the whole theory is based on raising the amounts of payrolls, the prices of materials, the number of employes, the available credit, and jacking up in other directions, all exclusively a burden on the employer generally. The economic consequence is to be the increased purchasing power and restored confidence, which will enure to the benefit of the employer as consumption rises to the heights required by capabilities of production and the necessity of employment. The engima of vast stores of food supply unsold while millions go hungry is to be solved this way.

The producer and the employe feel the effect of the recovery attempt at once, but in opposite directions. To this extent the experiment is at the expense of the employer, but since he has been losing money during the depression, he looks with eagerness to the continued resumption of profits. It is from profits, not prices, that all payments are made. Higher prices hurt nobody.

The first step toward national recovery is a success, for business has improved, practices are better, prices firmer, confidence higher, more employment, less hunger and privation, better protection for children (though not their complete eradication from the ranks of workers), and an unparalleled degree of co-operation for any large undertaking since the World War.

Credit has not kept pace. It has declined while dollar volume of sales has increased, thus creating an anomoly, but the Federal administration is providing for easing of credit by bank deposit insurance and collateralizing of sound but unliquid portfolios. We have ready means of expanding credit through the Federal Reserve System, so that for approximately every hundred dollars a bank has on deposit with the System it can emit $1,000 worth of credit, and this $1,000 credit can grow on itself by deposit, until bankers generally have executed loans in excess of their total deposits. At present loans and deposits are about equal.

The economics enacted and proposed under the recovery program are not without risk, but the risk seems worth the while, and so far has more than justified itself. Surely the objective is captivating. If it may be said that the recovery program does not coincide with everybody's ideas of economic soundness in all aspects, certainly it may be said with greater truth that the depression offered nothing as near such coincidence. In troubled waters, far from shore, one has to be expedient rather than consistent, self-preserving rather than punctilious, and with a bright beacon shining ahead, inspiration is added to the material comfort of getting home safely.

NBC Business Better; Shows Vital Confidence Rise, Says Aylesworth

Viewing the economic future, M. H. Aylesworth, president of the National Broadcasting Company, sees many reasons for optimism and confidence.

In a special interview with RADIO WORLD, he stated that, as far as the NBC was concerned, there has been a very definite upturn during the past few months, and prospects for the fall and winter are excellent.

"Broadcast advertising," Mr. Aylesworth said, "is an index to business conditions. But even more important at a time such as this, it also is a barometer which indicates the state of mind of the advertiser, the director of commerce and industry.

Increased Confidence

"If manufacturers and businessmen, many of whom have cut their advertising appropriations to the bone during the past few years, are making a general move toward resumption of their normal campaigns, then there must be a general increase in confidence.

"And that is one of the most encouraging signs that the famous corner is now behind us, with the prospect of a clear, if possibly still somewhat rough, road ahead."

Mr. Aylesworth pointed out that the National Broadcasting Company, far from curtailing its activities, during the past two years has been preparing for the coming move to Radio City, which will be celebrated November 15th, on the NBC's seventh anniversary.

The NBC will have 400,000 square feet of space in the huge new development, tripling its studio capacity. One studio alone is 78 by 132 feet, and three stories high. The building of this huge air castle, the greatest broadcasting plant in the world, has continued uninterrupted during the worst years of the depression.

Ready for New Deal

Now it is ready for the New Deal.

"We have already become cramped for space in our old quarters at 711 Fifth Avenue," Mr. Aylesworth said, "and with the new programs which we are booking almost daily it would be close to an impossibility to function efficiently. Fortunately, Radio City is being completed just when it is most needed, and it will provide space not only for our present requirements, but for future development and expansion as well.

"I believe that this is the best answer I can give to any question concerning our opinion of the business outlook."

PRICE RAISES ANNOUNCED

Many manufacturers of radio parts have notified their customers of price increases "due to the NRA." Some advanced prices 10%, others 15%. Consumer prices are increasing proportionately.

Stations Doing Their Part, Sacrifices Yield Dividends, Says Lafount

By HAROLD A. LAFOUNT
Federal Radio Commissioner

The new deal is a determined effort on the part of our President to give to every man, woman and child in America a fair deal; or as President Theodore Roosevelt put it, a square deal. The National Industrial Recovery Act was conceived by our President as the most effective means of reaching that goal, as the most efficacious plan of attack to conquer "Old Man Depression", who, like a devastating plague, has swept throughout the world for the past four years, paralyzing business, destroying homes, and starving men, women and children. Ordinary methods of attack were futile in the face of ever-increasing unemployment. The spirit of the times was a challenge for bold, drastic, and intelligent measures, and our President has heroically answered that challenge with the National Industrial Recovery Act.

As General Hugh S. Johnson, the vigorous administrator of the National Recovery Administration, recently pointed out in one of his dynamic speeches, the object of this law creating the organization is to remove obstruction to the free flow of commerce, to provide for the general welfare by cooperative action, to induce the united action of labor and management, to increase consumption, to increase purchasing power, to relieve unemployment, to improve standards of labor, to rehabilitate industry and conserve national resources. Actually this is being done to a noticeable extent although the campaign is barely under way. Hope and confidence have supplanted despair and despondency. The psychology of the nation has been changed and it appears we are now on the road to economic recovery.

Official reports indicate there has been a perceptible reduction lately of poverty and distress among our people. Such relief cannot be measured in dollars and cents, and fully justifies the heroic, if not revolutionary, measures adopted. No cost is too much to supply our people with the necessities of life and to make them happy and contented. All of us, regardless of party, creed or sect, must subscribe wholeheartedly to a plan that can do this. I have no patience with those who claim we are on the road to ruin. That cry of the alarmist is but the echo of the selfish standpatter who is unwilling to make any sacrifices for the common good, who glories in his material supremacy and refuses to yield an inch to the other fellow. The law is being carried out under voluntary codes proposed by the various industries, and are framed so as to be fair to all our people—the employer, the employee, and the consumer.

In this land of plenty, with inexhaustible resources, it is evident that our old system of trading has broken down and must be discarded, or, at least, drastically overhauled. The National Recovery Administration is designed to do that very thing in the present emergency. Its success, of course, depends largely on an educational campaign so that each man, woman and child will do his part. Each must be fully informed concerning its plans and purposes, its purport and philosophy. Rough spots will likely develop here and there but they will undoubtedly be ironed out. Once the nation gets back on its feet, we may look back on the depression as a blessing in disguise, a baptism of fire which eliminated many inequities and injustices.

To "put over" the National Recovery Administration's campaign, to use the vernacular, there must be hearty cooperation on the part of everybody—the employer, the employee, and the consumer. Sacrifices must be made by each and every group, in the common interest but such investments will yield dividends in personal contentment and national security.

Of all agencies supporting the National Recovery Administration none is more enthusiastic than the broadcasters operating 600 radio stations licensed by the Federal Radio Commission. With commendable ardor and enthusiasm they have rallied around the Blue Eagle. Undoubtedly these stations will be a mighty factor in driving home the important features of the campaign, keeping the public informed on this and other national affairs and securing its cooperation and sympathy with the government's efforts to end the depression. Without a single exception, as far as I know, the broadcasters stand ready and willing to do their part by making available their facilities to government officials and their representatives, and to otherwise assist in making the National Recovery Administration a profound success.

New Spirit Born in Few Months, Radio Aiding, Says Sarnoff

By DAVID SARNOFF
President, Radio Corporation of America

As this is being written the NRA campaign is moving on to its real test in actual operation with a brilliant recruiting record behind it. Business organizations throughout the United States have responded wholeheartedly to the appeal.

We are entering the Fall enlisted in a nation-wide, united effort to begin building from the ground up, eliminating many factors that have retarded recovery. There can be no doubt that a new spirit of cooperation and optimism has been created in a few brief months. Hundreds of thousands of men have been put to work again. Payrolls have been increased. Hours have been shortened. Buying has been stimulated.

The radio broadcasting industry may find gratification in the fact that it has been able to be of service in the national campaign that has given the people and business new encouragement and confidence.

DIVERSIFICATION

The radio industry is at once original and imitative. The originators are the leaders, but even some of the leaders become occasional copyists. "Duplicate this," is the frequent order of some small manufacturers.

Station Sparks

By Alice Remsen

UP AT THE AMALGAMATED

The latest development of radio in New York is the opening of Ed Wynn's station, WBNX. Many celebrities took part in the Amalgamated Broadcasting System's initial program. Messages were read from President Roosevelt, Secretary Will H. Woodin, Lee De Forest and many others. Radio stars were there by the score. Vaughn de Leath, the original radio girl, fainted in the crush, but portly Kate Smith bore up like a Trojan. George Hall, of Hotel Taft fame, beamed on all his admiring friends; George is head musical director of the new station; and a good time was had by all. Here's jolly good luck to Mr. Wynn and his associates! . . .

The New York Philharmonic-Symphony Orchestra has returned to Columbia for its fourth season and may now be heard in weekly Sunday afternoon concerts from 3:00 to 5:00 p.m.; these broadcasts will cover a period from October 8th, 1933, to April 29th, 1934, and will all originate in Carnegie Hall, New York; conductors will be Arturo Toscanini, Bruno Walter and Hans Lange. . . . Olsen and Johnson will be featured on the Swift Revue in the roles of editors of "The Comedy News," a newspaper as nutty as its staff. The program opens with a gala broadcast from the Civic Theatre in Chicago over a nation-wide network on Friday, October 6th, from 10:00 to 10:30 p. m., EST.; the series will be heard each week at that time; staff stars of "The Comedy News" will include Harry Sosnick's Orchestra in the guise of "The Printers' Devils," the Premium Quartet, also known as the King's Jesters, and the Brookfield Dairymaids, a song trio composed of the Doring Sisters, offering vocal and novelty interludes. . . . Georgie Jessel has been signed by Columbia to a long-term contract for a series of sustaining programs over its nation-wide network, making his debut on October 7th, at 10:30 p.m. . . . The Golden Rod Revue is now broadcasting from New York after two weeks at the Earle Theatre in Washington. . . . Fred Waring's band is on the road and their broadcasts will originate in whatever city they happen to be playing at the time. . . . Five CBS announcers are taking care of the World Series broadcasts—Ted Husing of WABC; Fred Hoey, of WNAC, Boston; Roger Baker, of WKBW, Buffalo; Gunnar O. Wiig, of WHEC, Rochester; and France Laux, of KMOX, St. Louis. . . .

HE GOES COLUMBIA

Another NBC artist has gone Columbia; it always has been Bob Armbruster's ambition to present an unusual musical ensemble of voices and strings; at last he has his chance on the Tidewater Oil program, each Monday, Wednesday and Friday at 7:30 p. m. EST, over WABC; listen in, I'm sure it will be worth while. . . . Cowboy Tom and his gang are back on the air under the sponsorship of Remington Rand, Inc., Mondays, Wednesdays and Fridays. at 5:45 p. m. EST, over WABC and network. . . . Bridge fiends will be glad to hear that "Easy Aces," that rollicking comedy of bridge in the home, will be back again commencing Tuesday, October 10th, at 2:00 p. m., and every Tuesday, Wednesday, Thursday and Friday thereafter at the same time; Goodman Ace, who writes the scripts and plays Mr. Ace, was formerly dramatic critic and columnist of the Kansas City Journal-Post. . . . And speaking of bridge, Lulu McConnell started something when she made her air debut on the Ex-Lax "Big Show": her contribution to the evening's festivities was a bridge sketch which made many tables of bridge players drop their cards, listen and laugh; at least, that is what happened up in Essex, Connecticut, where twenty bridge players have already formed the Lulu McConnell Listen-in and Dinner Club, meeting each Monday. . . .

WARDEN LAWES ON DECK

Over at NBC we find that Warden Lawes is back on the air again with his real dramas of Sing Sing Prison under the sponsorship of the makers of Sloan's Liniment, each Wednesday at 9:00 p. m.; Warden Lawes is known throughout the world for his humanitarian views and efforts to restore the unfortunates under his care to respectability; a very worth-while show. . . . All children should be interested in listening to the radio each Wednesday at 5:15 p. m., WEAF and network, for it is at that time and over that station you will hear those delightful "Winnie-the-Pooh" tales dramatized from A. A. Milne's children's classics; the stories deal with toy animals in the nursery of his little son, Christopher Robin, with Edward Bear, more widely known as the hero. . . . Did you hear the London rehearsal which was broadcast over WEAF on Sunday afternoon, October 1st? It came from back-stage at the Adelphi Theatre, London, and consisted of bits of dialogue, music and vocal numbers from the new Cochran show, "Nymph Errant," authored by Romney Brent, and musi-lyricized by Cole Porter; it was a very interesting affair, blurred here and there by distance static; the music sounded intriguing; Gertie Lawrence sang a clever number about a man who refused to tell her that he loved her; Cole Porter, Romney Brent and Charles Cochrane talked with varying accents and too close to the microphone; but it was altogether interesting and just a little bit different. . . .

RAY PERKINS, THE VERSATILE

Ray Perkins, a recent addition to the cast of the Rheingold program, over WJZ each Saturday night at 8:00 p. m., is one of radio's most versatile entertainers; he plays his own accompaniments on the piano, sings his own songs and writes his own material for all of his broadcasts. . . . Ford Bond, NBC announcer, is still waging war against an expanding waistline; he has dieted away thirty pounds, bringing his weight down to two hundred and twelve; he wants to lose twenty pounds more; can anyone tell him how to do it? . . . Baby Rose Marie returned to school this week; she attends the "Professional Children's School" in New York City, where she is in the fourth grade. . . . I think mavbe the next item is in the nature of a record—Don Bestor has made only one change in the personnel of his orchestra in the last six years. . . . The Don Hall Trio have been moved from 7:30 to 8:15 in the mornings on WJZ, Jolly Bill and Jane filling the earlier period. . . . There is a rumor around to the effect that George Givot and Mae West will be on a sponsored program together soon; that would be entirely too devastating . . . Peter Dixon says that Al Jolson is not a comedian—and maybe Peter's right; he usually is about most things. . . .

CHANGES AT WHOM

Over at WHOM there have been a few changes in the staff: Roland Trenchard has replaced Alexis Sanderson as program director of the New York studios, and Ed French has become its chief announcer; both lads were formerly at the Jersey City studios of WHOM; Atwood A. Klinger still continues as the commercial manager of the station, and Bob Eichberg remains in charge of publicity. . . . For at least the thousandth time since it was written I am listening to "The Last Round-Up"; it is being played, very delightfully, in Chicago by Wayne King and his grand orchestra on the Lady Esther program. . . . And speaking of Chicago reminds me that David Moll, youthful violin virtuoso, appearing on Dr. Bundesen's program over WLS, Chicago, plays a violin made by the famous Amati of Italy

(*Continued on next page*)

"Sales Largest Since 1930, Prices Rising, Insolvencies Fewer"—Dun & Bradstreet

While the radio industry suffered acutely from the weight of economic adversities during the last three years, it is emerging triumphant from the most severe period of business recession through which the world ever has passed, with a convincing demonstration of the indispensable usefulness and need of its products, says Dun & Bradstreet, Inc., the noted commercial rating agency. In view of the chaotic conditions prevailing during the first quarter and part of the second one of this year, when manufacturing was being discontinued and units were thrown on the market regardless of cost, the recovery which has been made during the months intervening has been little short of phenomenal. Orders are being received in such volume that manufacturers now are behind in their deliveries, despite increased operating schedules, and retailers are pressing for shipments as their old stocks have been cleared and consumer demand is forging ahead from week to week.

Many national advertisers who reduced their appropriations substantially last Spring have been coming back on the air, with augmented programs, while others have contracted for additional time. While the deficits of the large manufacturers of radio receiving sets were reduced sharply during the third quarter, it is unlikely that a profit will be shown for the year, even with the enlarged sales of the fourth one, because of the heavy losses sustained during the first six months.

The future of the radio industry seems brighter than it has been in several years, as prices have increased, stocks have been cleared of antiquated models, budgets have been adjusted, and many evil trade practices have been eliminated, according to a survey of the radio industry completed by the agency.

Factory Shipments Delayed

"Since June there has been an unusually strong upturn in the demand for radios in most parts of the country," the survey continues, "the poorest showing being made by the South and some sections of the Northwest. With many manufacturers of popular-priced sets, orders now are running ahead of production, with retailers placing fresh commitments, as soon as the delivery of former ones has been made. With the increase in the prices of sets and the shift of demand to the better-grade units, value of output has increased from 50 to 85 per cent, in comparison with the record for the nine months of 1932, while unit volume is higher by 15 to 45 per cent.

"Low stocks of both wholesalers and retailers are the principal cause of the pressure now being made on manufacturers for deliveries, as commitments were deferred earlier in the year, when the outlook was decidedly unfavorable. The quickening in the demand for new goods by the consuming public also caught manufacturers unprepared, as their fixed policy for more than two years has been to hold production down to orders actually in hand.

"Production of radio parts has almost trebed since last May, and a steady increase in the production of individual units or component parts is expected to continue until December 1 at least.

Credit Handicap

"One of the chief hindrances to expansion in the manufacturing division is the difficulty in obtaining financial assistance from banks, as many plants have a large backlog of orders, but have not the cash available with which to enlarge pay rolls. Radio receiving set manufacturers estimate that production costs have been increased by one-third by operating under the National Electrical Manufacturers' Association Code.

"Contrary to the established seasonal trend, the increase in sales persisted all during the Summer, with volume stepped up considerably by the wide popularity of automobile radios. The inability of manufacturers to make deliveries has benefited wholesalers, who have succeeded in clearing old stocks, and inventories at present with both wholesalers and retailers are at the lowest level reached in three years.

"The season's new sets will be ready for distribution during the early part of October and from orders on hand and the growing interest in radios, it is estimated conservatively that unit sales during the last three months of the year will be from 35 to 50 per cent larger than for the comparative period of a year ago. The replacement demand for worn and obsolete sets has been increasing gradually for several months, and is expected to gain considerable momentum with the coming of cooler weather.

"While the strongest demand continues decidedly in favor of units priced at $15 to $50, during the last sixty days more interest has been displayed in the small console sets falling within the price range of $30 to $70. Short-wave sets are increasing in popularity, as listeners are interested in tuning in on foreign programs.

Price Level Rising

"Quotations on some sets," the survey points out, "have been advanced from 20 to 35 per cent since May and further increases are in prospect when goods now being manufactured under the NRA regulations will have reached consumers' hands. Retailers now are compelled to require larger initial payments from customers, because of the higher prices and the narrower discounts allowed by distributors.

"Retail collections, which had been poor up to July, are becoming easier, running about 2 per cent ahead of the 1932 showing, and repossessions are less numerous than they were a year ago. In some sections, collections are better than they have been since 1929, and with most of the less expensive instruments now being handled largely on a cash basis, the number of installment accounts has been reduced.

"Wholesale collections have improved about 8 per cent over last year's record at this time, due to more stringent enforcement of regular terms, and curtailment of price-cutting and dumping. In the liquidation of old accounts, however, the progress thus far has been only moderate. It is the improved salary and employment situation which is helping retailers' collections, while the comparative slowness of wholesale payments is due to the tying up of funds by retailers in large quantities of merchandise.

Failure Record Improved

"The stronger financial position of the industry during the second and third quarters finds a reflection in the insolvency record, as during the four months from May 1 to August 31, only 7 manufacturers and 36 wholesalers and retailers were added to the failure list. During 1932, wholesalers and retailers were going into bankruptcy at the rate of 15 a month, but during the current year the number has been reduced to 10.

"While there has been a reduction of 24.2 per cent in the number of failures, as compared with last year's record, the involved liabilities have increased, a total of $4,116,516 for the eight months being 8.2 per cent higher than the $3,805,673 set down for the entire twelve months of 1932."

The complete insolvency record of the radio industry since 1930, including the eight months of the current year, as compiled by Dun & Bradstreet, Inc., shows:

Manufacturers

Year	Number	Liabilities
1930	40	$3,522,400
1931	15	4,088,445
1932	23	1,826,995
1933*	17	2,641,250

Wholesalers and Retailers

Year	Number	Liabilities
1930	217	$2,071,392
1931	160	4,979,359
1932	170	1,978,678
1933*	80	1,475,266

* January to August, inclusive.

STATION SPARKS

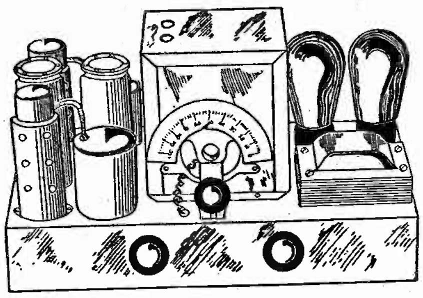
(*Continued from preceding page*)

in 1679. . . . While still comparatively a youthful man, 'Lasses White, of WSM, Nashville, Tenn., is one of the stars of old-time American minstrelsy; he broke into the business twenty years ago with Honey Boy Evans, served as Honey Boy's understudy and filled his place in the show when that beloved performer died. . . . "The Rhythm Jesters" are the most recent discovery of WLW, Cincinnati; they are four Columbus, Ohio, youngsters—Terry Lynch, Art Ryerson, Lee Baldwin and Joe Rockhold. . . . Albert Short, now head of the NBC program department in New York since last October, was formerly with the NBC studios in Chicago. . . . Heard two things tonight which I enjoyed very much: Frank Parker's singing of "Gypsy Rhapsody" on the Chevrolet program; his debut, by the way; and how that lad did sing; it was glorious! . . . and Will Wirges playing on a one-string fiddle he made when he was a kid. Okay, William!

Literature Wanted

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

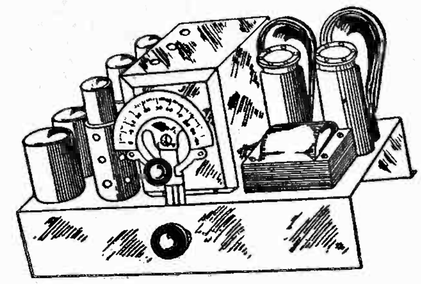
M. J. Wolf, care Hollywood Radio Shop, 1475 No. Bronson, Hollywood, Calif.
O. L. Robinson, 306 Tippett Ave., Morehead, Ky.
Russell R. Quaintance, 720 Gibbard Ave., Columbus, Ohio.
Thos. M. Morton, Beaver Lodge, Buckroe Beach, Va.
Harold H. Nathanson, Serviceman, 1250 51st St., Brooklyn, N. Y.
Leo R. Stonek, 910 Packard Ave., Cudahy, Wisc.
John W. Cook, Junior College, El Central, Calif.
H. D. Smith, 323 East Lake Drive, Station E, Atlanta, Ga.
Milton V. Warren, R. F. D. No. 5, Trenton, N. J.
Clarence Kay, P. O. Box 132, Hornell, N. Y.
A. H. Edgerly, Kensington, Conn.
C. S. Holderman, 2610 Aberdeen Ave., Hoquiam, Wash.
Wm. F. Littlefield, Marina Station, P. O. Box 42, Mayaguez, Porto Rico.
G. Kenneth Smiley, Sales and Service, R. D. 2, Carlisle, Pa.
F. L. Sprayberry, 132 Bryant St., N. W., Washington, D. C.
Ira L. Hines, Box 393, Riverdale, Md.
Sallas F. Chappell, care Sears Roebuck & Co., Winston-Salem, N. C.
D. S. Deem, 1317 Nicholson Ave., Lakewood, Ohio.
Matthew Kazolski, 19 Ellen Ave., Chicopee, Mass.
Charles F. Gosner, 5618 Carpenter St., Philadelphia, Pa.
W. McHaffie, 4706 Lafontaine St., Vianville, Montreal, Canada.
Wm. S. Buckley, 3830 Banks Ave., Butte, Mont.
Aubrey E. Fales, 12 Marvin Ave., Shelby, Ohio.
Henry C. Stryker, 820 Bank of America Bldg., Oakland, Calif.
Thos. J. Turner, Chief Engineer, The Bronx Hospital, 1276 Fulton Ave., Bronx, N. Y. City.
Alton Ritter, 31 Rossiter Ave., Paterson, N. J.
Portland Radio Supply Co., Guy B. Paine, 1300 West Burnside, Portland, Ore.
Walter M. Rogers, Fort Pierce, Fla.
A. E. Mayo, Souris, Man., Canada.
Allen Dessert, Dessert Radio Labs., 190 Admiral Road, Buffalo, N. Y.



BLUEPRINTS, COILS and CHASSIS

FOR THE TUNED R-F

DIAMOND OF THE AIR



FOUR-TUBE DIAMOND

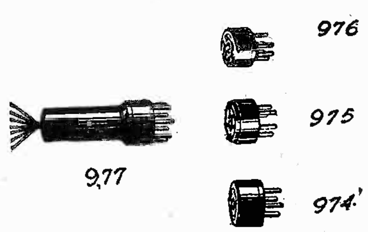
Extremely fine performance, including fetching tone quality, marks the Four-Tube A-C 1933 Diamond of the Air, blueprint of which is now available (half-scale). Many have been surprised that so much can be accomplished on a t-r-f set that costs so little to build. The circuit uses a two-gang 0.00035 mfd.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

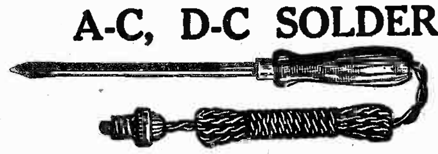
Vol. 2 contains additional diagrams on the same basis as above, but in Vol. 2 there is no duplication of any of the diagrams printed in Vol. 1.

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.

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

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