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RADIO WORLD
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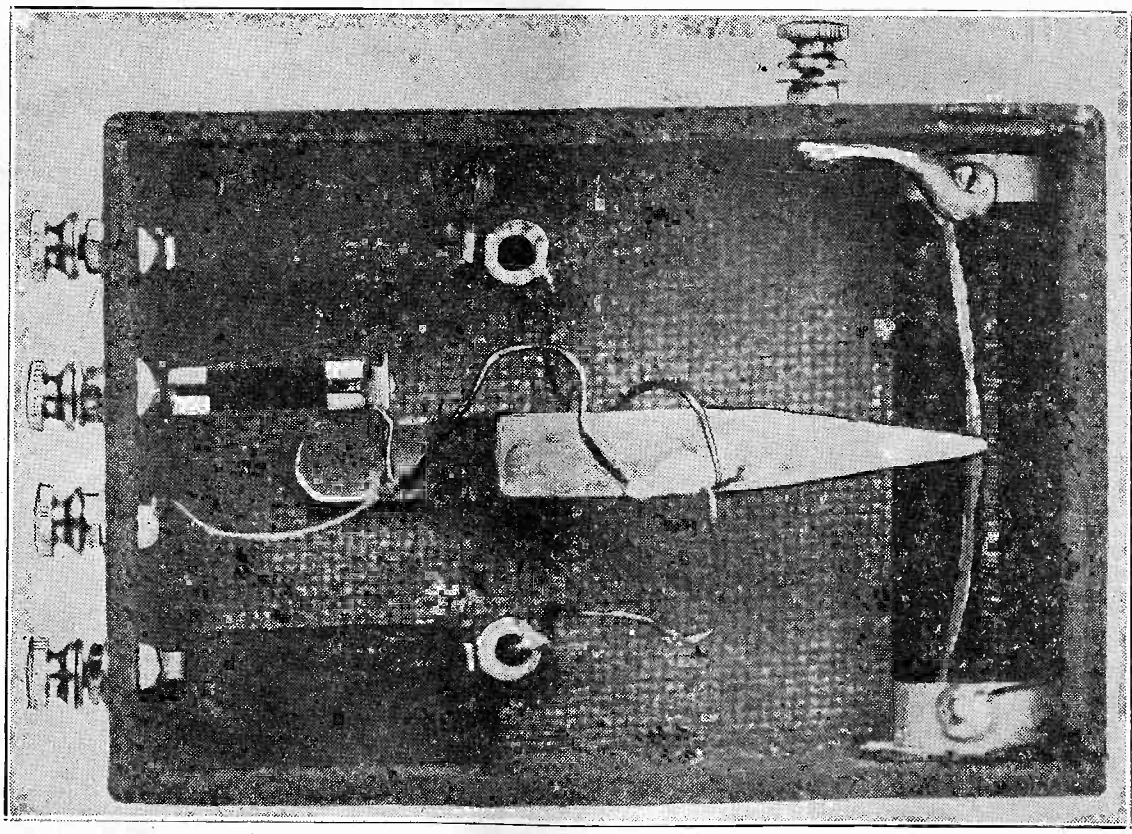
The First and Only National Radio Weekly
Eleventh Year 552d Issue

TWO INEXPENSIVE SET TESTERS

The EFFECT of PRIMARIES



A small device like this may be built for altering antenna constants, consistent with choice of correct primaries. See page 3.

VISUAL INDICATOR OF FREQUENCY RESPONSE

Oxide Rectifier for Radio Frequencies

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J. E. ANDERSON
Technical Editor

J. MURRAY BARRON
Advertising Manager

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EFFECT OF PRIMARY
On Tuning and Tracking

By Capt. Peter V. O'Rourke

IF the antenna circuit could be exactly the same as the succeeding circuits there would be a considerable increase in both sensitivity and selectivity, but the only methods brought out to date for establishing equal conditions are expensive and elaborate and have not found commercial suitability.

It is a fact that the antenna stage in virtually all types of receivers does not completely follow the tuning curve of the other stages, even in a tuned radio frequency set, and the greatest disparity may occur at or near one of or the other frequency extreme or even somewhere near the middle of the band.

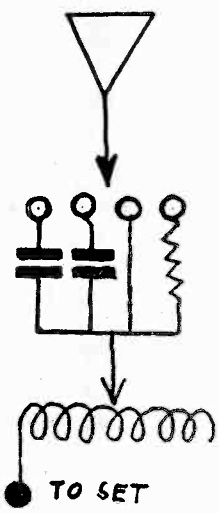
Waiving mere differences in capacity between sections of gang condensers, which is a condenser and not an antenna coupling problem, we find that all we have to do is to establish the same inductance, capacity and resistance in the antenna circuit as in the succeeding ones, and then for signal frequency tuning we have accomplished our aim. It sounds simple enough.

Standard Antenna

The standard antenna constants, those used in official testing, consist of a resistance of 25 ohms, an inductance of 20 microhenries and a capacity of 0.0002 mfd, selected because deemed to be close to the actual average conditions encountered in installations. Such a dummy antenna is shielded, and even if it were not the pickup (due to the stray interception by the coil) would amount to very little indeed. The dummy antenna may be said to have no intercepting properties, but represents simply equivalent constants of practical aerials. You could connect it to a set without rejoicing over a single signal. In fact, a signal is put into the dummy antenna in the testing operations for which such antenna is designed.

Now if the other coupling stages had the same constants it is hard to see where there'd be any problem. We must consider some special aspects, including the changed conditions due to difference in frequencies. That is, the actual impedances are not necessarily alike at all frequencies.

Take the usual system, consisting of a radio frequency transformer in the antenna and interstage positions. It had been the practice for years to make the antenna primary somewhat different, with fewer turns of larger diameter wire. A couple of years ago it became almost regular practice to make the coils alike.



Arrangement for varying the antenna constants. The pointer at the aerial input simply represents the switching opportunity afforded by the binding posts, to any one of which the antenna proper may be connected.

Vast Differences

The reasons for the change were that with high-gain tubes the set tended to oscillate more readily, and the more wire on the antenna primary, and closer coupling to the secondary, the greater the radio frequency resistance hence stability; and that with equal coils the effect of the primary on the secondary was equal, unless changed by external conditions.

Any one who has experimented with vastly different types of primaries knows that a most remarkable difference in the tuning characteristics results when the primaries are materially changed, though the secondaries have just as many turns of wire, and may be matched at any one frequency to a fraction of a microhenry of inductance. For instance, if a 200-turn honeycomb coil on a diameter small enough to fit inside the secondary's form is used as primary, the tuning may be from 1800 kc to 540 kc a frequency ratio better than 3.3 to 1. If an 800-turn coil is used as primary, same secondary as before, the frequency span may be from 1510 kc to 600 kc, a ratio of little better than 2.5 to 1.

Moreover, if a very small series condenser is used in the antenna circuit, as in the Four-Tube 1933 Diamond of the Air, the effect of the antenna capacity will be virtually eliminated, since the series capacity is 0.00002 mfd., while the antenna capacity itself may be 0.0002 mfd. Yet the antenna's inductive effect remains. likewise its resistance effect, although all three effects are changed as to the net reactance due to the insertion of this small condenser.

If the tuning curve is taken of the antenna circuit under the series-capacity condition stated, and with the series condenser connected direct to grid (no primary), and compared to the curve of the succeeding stage with its orthodox transformer, it will be noted that the highest frequency of the second stage is considerably higher than that of the first stage but that near and at the low end of frequency end the two circuits track.

Effect of Primary

All three of these tests have to do with practically the same condition, and that is the effect of the primary on the secondary. If the primary impedance is such that it is in the low radio frequency range (usually a large coil), then the mutual impedance is greater between primary and secondary at the low frequencies, and keeps changing considerably in the low frequency region as the tuning is done from one centum of frequencies to another. Due to the high mutual impedance, the primary swipes considerable induct-

(*Continued on next page*)

(*Continued from preceding page*)

ance from the secondary, to put the situation in the vernacular. Therefore the secondary inductance will be too low and the full wave band may not be covered, as was revealed in a case cited, for the full capacity of the tuning condenser resulted in a frequency of 600 kc, instead of 540 kc.

The example of the same tuning condenser across a secondary having the same number of turns as the one previously discussed, yet causing an extra-wide frequency coverage, ratio exceeding 3.3 to 1, was due to the smaller primary. In fact, the primary happened to be of such inductance that at or near the high frequency extreme of the broadcast band the mutual impedance effect became greater, the relative inductance of the secondary became less in consequence, and the circuit was tunable to higher frequencies than usual, yet did not miss out at the low frequency end, for then the reduction of the secondary inductance due to the primary was virtually nil.

Manual Trimmer

So, also, the same impedance effect is noted in the example of the series condenser in the antenna circuit. The antenna coil is a "tuned impedance", as a single winding of that type is called for some unknown reason. The interstage transformer has a primary. It is not a large primary, therefore the effect of the primary is to reduce the inductance of the secondary at the higher frequencies, say, from 1,000 kc up. Therefore to make the second stage keep pace with the first or antenna stage a manual trimming condenser was used across the secondary of the second stage coil, and its inclusion is absolutely necessary, for preservation of resonance possibilities throughout the tuning scale, where a gang condenser is used.

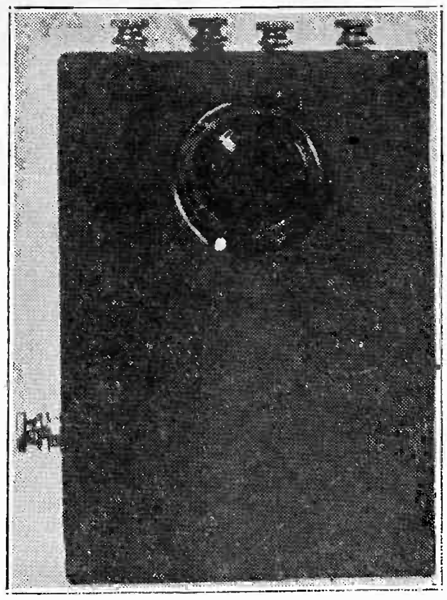
It can be seen therefore that relatively small primaries, say, 30 turns or less, even if tightly coupled, that is, wound over secondaries, tend to increase the frequency span, as compared to no primaries at all, or very large primaries (such as honeycomb coil primaries, as used in some types of transformers) tend to defeat full coverage of the wave band.

Every casual set builder knows that in operating a receiver, tuning in one station and another, the capacity in the tuned circuit is changed, but many will be surprised to learn that the same operation changes the inductance also, if there is any sort of load inductance in the antenna or plate circuit, whether it be a primary wound on the secondary's form, or on a separate form inside the secondary's form, or is a choke coil, with a capacity coupling it to the tuned secondary. The change in inductance, like the change in capacity, should be uniform.

Same Primaries

Therefore a good reason exists for having the primaries the same for antenna and interstage purposes, and not only should this hold true for plain tuned radio frequency systems, but also for superheterodyne oscillator coils, for disparity of the primary or equivalent coupling conditions, as compared to the signal selection circuits, introduces another difficulty into the padding of the oscillator for gang condenser use.

In a superheterodyne the inductance of the oscillator secondary is determined on the basis of the highest frequency to be generated and by the minimum capacity of the circuit. The padding condenser has a small effect at the high frequency end, possibly an average of 5,000 cycles out of 1,500,000 cycles, but at the low frequency end is almost controlling. However, it is not absolutely controlling, for a primary with high impedance to low radio frequencies might render the oscillator incapable of following the tuning curve of the modulator and t-r-f tube circuits, with possible missout of the lower group of frequencies. Many an instance of "failure of the oscillator to cover the broadcast band" is due strictly to an overdose of tickler or pickup winding.



The panel of the device, with knob for the slider. The binding post that goes to the set, and to which one side of the loading oil is connected, is on the side.

The Oscillator Frequencies

In tuned radio frequency systems the object is to keep the tuned circuits absolutely the same. In a superheterodyne this is true of the t-r-f section, but as to the oscillator the object is to keep the frequencies relatively the same. The relationship is that of the intermediate frequency to the signal frequency. It is virtually an unexcepted rule that the higher frequency of oscillation is selected, therefore the object is to keep the oscillator at a frequency higher than the signal frequency by the amount of the intermediate frequency, for every setting of the dial, from beginning to end. ($Fo = Fs + Fi$, where Fo is the oscillator frequency, Fs the signal frequency and Fi the intermediate frequency.)

An instance of middle-band high mutual impedance would result in tracking of t-r-f, and even oscillator systems with t-r-f systems, at or near the two extremes, but considerable missout in between. This is one of the most annoying cases, as the usual experimental observation is that the set is sensitive at the high and low frequencies and virtually dead in between them, except for producing a diabolical assortment of squeals in this disappointing region. Trouble like this may be due to certain complex phenomena in the padding itself, but one cause believed overlooked for the most part is that stated here, concerning the effect of the primary, pickup coil or tickler on the inductance of the secondary.

Dissimilar Capacities

It profits only a little to make the coils alike if the conditions under which they are used are not alike. For instance, we have made notation of the antenna capacity. Suppose it is 0.0002 mfd. Nowhere in succeeding circuits shall we find anything near its equivalent. The coil distributed capacity of the primary in a plate circuit is about the same as that of the secondary, regardless of number of turns, since the distributed capacity of a solenoid is approximately proportionate to the diameter. The capacity between primary and secondary, an independent or extra consideration, requires attention, for that and also on the length of the windings the length and the length of the windings and on some other factors. Tube input and output capacities may be neglected, as very small compared to others we are considering. Therefore we find that we can not well duplicate the antenna capacity condition, without setting up extra-special circuits, and we come to the conclusion that it would be much easier to make the antenna stage as nearly like the other stages as possible.

On a capacity basis this can be done by using a series condenser in the antenna circuit, feeding into a primary like the subsequent primaries, and adjusting this capacity for no other purpose at first than to establish the same frequency as in the succeeding circuit, at minimum dial setting, and also for the other frequency extreme. It may not be possible to do quite that a first, but at least one may observe how much (in this case it will be how little) the circuits are off.

Series Loads

Besides capacity and inductance, of which we have taken some care, there is resistance to be considered. Now, the resistance effect of the antenna on the primary it feeds, hence on the r-f circuit as a whole, is related to the series condenser. It is radio frequency resistance, not direct current resistance, and therefore is a quantity not many of us can measure readily, for lack of the expensive instruments. We do know, however, that the antenna resistance is lower than that of the subsequent stages (plate circuits) by from 50-to-1 to thousands to one. Plate circuit resistances are in series with their loads (for both a. c. and d. c.) but we can not well introduce an equal or equivalent series resistance in the antenna circuit, as that would practically stop the signal from getting to the first tube, as virtually all the voltage drop would be in this resistance, and not in the tube input circuit or representative primary of the transformer. So we have to pass up the resistance equalization hopes for some simple and inexpensive method of bringing about better tracking, and fortunately can afford to make such a sacrifice, since the effect of resistance on the frequency is not considerable, compared to the effect of inductance and capacity, provided the d-c resistance of the windings is small compared to their reactance, which is true of the transformers generally used in radio to-day. The vogue of the trick coils—toroids, figure eights, spider-web — has passed long since, and the solenoid reigns finally because of its superiority. (And yet persons say that success does not depend on merit!)

First Stage Selectivity

Some resistance may be used in the antenna circuit to offset the reduction in resistance due to the small value of series condenser. In many instances this series resistance stops the receiver from squealing, but if this effect is to be gained, the value of the resistance has to be relatively low, say, under a few thousand ohms. Then, too, there are special conditions of squealing where no amount of series resistance in the antenna circuit will stop it, but if the antenna circuit is to be attacked for this cure, the remedial resistance would have to be in parallel with the input circuit or equivalent primary, which reduces selectivity and also sensitivity. It would be better to postpone parallel resistances to anterior circuits because of the prevalent types of tubes requiring all practical selectivity in the first stage due to crossmodulation dangers, which are not experienced subsequently because the input has been subjected to two or more stages of tuning by that time.

Alteration of Constants

Variations of the constants in the antenna circuit may be made by using a simple device such as the one illustrated. The diagram shows the choice of two fixed condensers, no fixed condenser, and a resistor without choice of any series con-

(*Continued on next page*)

POWERS OF 10
Illustrations of Their Use

By Brunsten Brunn

WHEN computing time constants and frequencies from inductance, capacity, and resistance, very large or very small numbers enter. For example, we may have a resistance of 5 megohms, a capacity of 50 mmfd., or an inductance of 200 microhenries. All formulas, unless otherwise stated, are based on ohms, henries, and farads and to get correct results we must reduce all the factors into these units. To reduce a capacity of 50 mmfd. to farads we would have to write ten ciphers after the decimal point and then a 5. This is an extremely cumbersome number. To write 200 microhenries in terms of henries we would have to write three ciphers after the decimal point and then a 2, that is, 0.0002, which is cumbersome although not extremely so. To write 5 megohms we would have to write a 5 and then six ciphers, not a convenient number to deal with.

There is a simple way of avoiding writing such cumbersome numbers that will make computation easy and certain of correctness, and that is to express all factors in terms of powers of 10, either negative or positive, according to whether the number in question is less or greater than unity. Thus 5 megohms would be written $5x10^6$, which means 5 times the sixth power of 10, or it means 5 times one million, for the sixth power of 10 is one million. Likewise, 50 mmfd. would be written $50x10^{-12}$, which means 50 times the minus twelfth power of 10. This could also be written $5x10^{-11}$, for the significant cipher after the 5 cancels one of the tens in the power of 10. To write 200 microhenries we would put $200x10^{-6}$, or $2x10^{-4}$.

Law of Indices

The power to which 10 is raised is called the index, or the exponent. The fundamental law of exponentials is that to multiply them we simply add the exponents, or the indices, and to divide we subtract the exponent of the divisor from the exponent of the dividend. The addition or the subtraction is always done algebraically. In two of the preceding examples we added algebraically two exponents of 10. For example, when we write $200x10^{-6}$ we really have $2x10^2\ x10^{-6}$. To multiply the two powers of 10 we add the exponents 2 and -6 and obtain -4.

If the power of 10 occurs in the denominator of a fraction we have to divide by that power. But we can divide by changing the sign of the index and putting the power in the numerator. This is possible because any power of 10 is the reciprocal of the same negative power of 10. That is, 10^{-6} is the reciprocal of 10^6. If we make use of this we never have to divide, or we never have to deal with negative powers if that causes difficulty. Thus if we have negative powers in the denominator we can replace it by the same positive power in the numerator. Also, if we have a negative power in the numerator we can replace it by the same positive power in the denominator. After we have reduced all the powers occurring to positive we can proceed to divide. All we have to do is to subtract the index of the power in the denominator from the index of the power in the numerator. For example, suppose we have $10^{12}/10^7$. We subtract 7 from 12 and get 10^5 as the result. Again, suppose we have $10^2/10^8$. We subtract 8 from 2 and obtain 10^{-6} as the result.

When we have both negative and positive powers of 10 on both the numerator and the denominator we can proceed in different ways. We can first reduce the powers in the numerator to a single power and then the powers in the denominator to a single power and then proceed with the division. Thus if we have $10^2x10^8/10^{-6}x10^3$, we first change it to $10^{10}/10^{-3}$ and then to 10^{13}. A minus 3 subtracted from something is equivalent to 3 added. We can also proceed by canceling equal powers. Thus in the above example the 3 in the denominator cancels 3 in the numerator and we first get $10^2x10^5/10^{-6}$ and then by dividing we get 10^{13}. If there are equal powers in the numerator and denominator it is best to cancel such powers first. Or if there is one negative power and one equal positive power in either the numerator or the denominator we can add the exponents. For example, we may have $10^6x10^{-6}/10^7x10^{-3}$. The two powers in the numerator cancel each other giving 1. The two powers in the denominator become 10^4. Therefore the result is $1/10^4$ which equals 10^{-4}.

Powers and Roots

We stated that 10^6x10^{-6} is unity. But if we add the exponents algebraically we get 10^0. Why is this unity? Since one of the exponents is negative that can be placed in the denominator if we change its sign. Thus we have 10^0 equals $10^6/10^6$. If we divide any number by itself we get unity and therefore 10^0 is to be interpreted as 1.

Sometimes it is necessary to raise an exponential to a power, say the second or third. To do so all that is necessary is to multiply the exponent of the power of 10. Thus to square 10^6 we get 10^{12}. If we cube it we get 10^{18}. This holds for both whole numbers and fractions. If the power is fractional we extract a root. For example, if we want to raise 10^6 to the ½ power we multiply the exponent by ½ and obtain 10^3. To raise a power to ½ power is equivalent to extracting the square root. To raise it to 1/3 power is equivalent to extracting the cube root. The extraction of the square root occurs every time we compute frequency from capacity and inductance.

Let us illustrate the use of powers of 10 in a typical frequency computation. For example, what is the frequency of resonance of a coil of 250 microhenries and a condenser of 350 mmfd? First let us reduce the inductance to henries. We obtain $2.5x10^{-4}$. Now let us reduce the capacity to farads. We obtain $3.5x10^{-10}$. In the frequency formula the product of the capacity and the inductance enters. Therefore let us multiply them. We get $2.5x10^{-4}x3.5x10^{-10}$, which equals $8.75x10^{-14}$. But the product enters as a square root and therefore we have to extract the square root of this number. The square root of 8.75 is 2.96 and that of 10^{-14} is 10^{-7}. Hence the root is $2.96x10^{-7}$. Again, the square root of LC enters in the denominator. Hence we have to take the reciprocal of our root. We obtain $(1/2.96)10^7$, or $0.338x10^7$. The factor 2π also enters in the denominator. Hence we have to divide this number by 2π, or we have to multiply the number by the reciprocal of 2π, which is 0.159. Therefore the frequency is $0.0538x10^7$, or $0.538x10^6$, or $538x10^3$, which is 538 kilocycles.

Preparing for Extraction

When we extract a square root the index of the power of 10 must be even, that is, exactly divisible by 2, and when we extract a cube root the index must be exactly divisible by 3. This can always be brought about by taking a ten or two from the power of 10 and multiplying the numerical factors by 10 or 100. Let us illustrate. Suppose we have the number $2.5x10^7$ and we wish to extract the square root. We can write it $25x10^6$ when the square root becomes $5x10^3$. Again, suppose we wish to extract the cube root of $2.7x10^4$. We can write this $27x10^3$, when the cube root becomes cube root of 27 times the cube root of 10^3, that is $3x10^1$, or 30.

In dealing with large numbers of this type it is essential to have the right power before we extract the root, and one of the principal advantages of using powers of 10 is the ease with which we can prepare the number for the extraction of the root.

In determining the index of 10 in any case it should be chosen so that the decimal point comes after the first significant figure because then the numerical factor always comes between unity and ten. The index for the power of 10 is then the number of places between the decimal point where it was and where it is. If it was necessary to move the decimal point to the right, the exponent is negative, and if it was necessary to move it to the left, the exponent is positive.

(Continued on next page)

The Primary's Tuning Effect

(Continued from preceding page)

denser. Other combinations may be afforded with the same number of posts by putting the resistor in the aerial lead proper, outside the set, so that it will be in series with the condenser selected. Also, an antenna loading coil is shown. This may consist of a 1 inch diameter tubing wound with 100 turns of enamel wire, No. 28 for instance, and scrapped so that the arm of a slider will make contact with the exposed portion which describes the sweep of the slider across the coil. The two series condensers should be small, 20 mmfd. in one instance, half or less than half that in the other, or 35 mmfd. equalizer may be adjusted instead to the desired value. A small manual trimmer may be substituted.

The loading coil increases the antenna inductance. In not many instances will this purpose be wanted, especially as the loading coil, as the inductance becomes great enough, soon acts as a choke, and reduces the input. However, the circuit may be arranged so that the coil is put in parallel with a primary, as when an r-f choke is the primary.

[Other Illustration on Front Cover]

The October-November edition of Radio Bargain News, issued by Federated Purchaser, Inc., 25 Park Place, N. Y. City, is just off the press. It contains 108 pages, all indexed, and is free to dealers and servicemen.

IMPEDANCE
Calculations and Resonance

By J. E. Anderson

IMPEDANCE is the total obstruction offered by an electrical circuit to an alternating current. It is composed of two parts, resistance and reactance. Resistance is that property of a circuit by which power is dissipated in the form of heat, or in some cases, in the form of radiated energy. Reactance is that property of the circuit which opposes any change in the current flowing. As the name of the property indicates the circuit having reactance reacts to changes in the current.

We can best gain a conception of reactance by drawing on mechanics for analogies. Suppose a mass is moving at a fast rate. It may be an automobile. It resists any change in the speed and force is necessary to make any change. To speed it up we must give it more gas and to slow it down we must apply the brakes. The car has a positive reactance. That applies to any other mass, for example, that of the riders in the car. If the car start suddenly the riders move backward, apparently, because the mass of the riders resists an increase in the speed. Likewise, when the car stops suddenly, the riders move forward, their mass keeping them going. A body having mass reacts to changes in speed and direction. A coil having inductance reacts to changes in current. Both have inertia.

The Derivation of Impedance From Reactance, Resistance

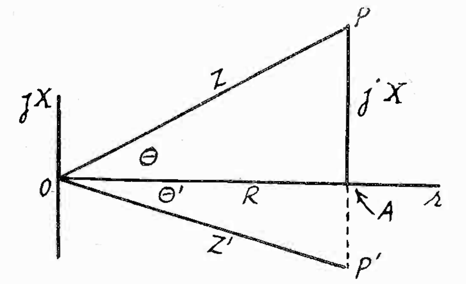


FIG. 1

A vector diagram showing how the impedance of a circuit is obtained from the reactance and the resistance.

Condenser Analogy

For an analogy of the condenser we must draw on the spring. As is well known, if a spring is depressed or stretched, it resists the change in shape. At first it takes very little force to change the shape, but as the displacement is increased the force required to increase the deformation becomes increasingly greater. The spring exerts a back force that must be overcome in order to deform the spring still more. An important feature is that at the beginning it requires very little force to produce a large displacement. The back force exerted by the spring is directly proportional to the displacement, and that its most important property. The spring is said to have resilience, which in plain language means springiness. Any body having elasticity, that is, any body which can be deformed and which will return to its original shape as soon as the deforming force has been removed, will act exactly the same way as the simple spring.

The spring, or any elastic body, has negative reactance. If it required more force to displace it at the beginning and less as the displacement increases then it would have positive reactance, but it works the other way. Sometimes the property of the elastic body, like the spring, is called compliance. This is just the reverse of reactance. A spring that has a high reactance has a low compliance and, conversely, one that has low reactance has high compliance.

Exact Correspondence

A condenser acts toward electric voltage in exactly the same way as a spring does toward mechanical force. When the condenser is uncharged it requires a very little voltage to produce a large current but as it becomes charged it requires higher and higher voltage to keep current flowing into it. When the voltage applied across the condenser is equal to the back voltage the condenser is fully charged and no more current can flow into it, unless the voltage is increased.

There is one voltage for every condenser at which it will break down. There

(*Continued on next page*)

Frequency Computation with Powers of 10

(*Continued from preceding page*)

Let us apply this to the multiplication of 0.00005 and 16,000,000. In the first number we have to move the decimal point five places to the right. Hence the number is $5x10^{-5}$. In the second number we have to move the point seven places to the left. Hence the number is $1.6x10^7$. The product of the two is $5x1.6x10^{-5}x10^7$, which equals $8x10^2$, or 800. There is little chance of losing or gaining a 10 if this method of multiplying is used. When one of the factors is very close to 10 it is sometimes better to put the decimal point before the first significant figure than after it. Of course the exponent of 10 would be one greater if the exponent were placed before the first significant figure than if it were placed after it.

The method is also useful in computing by Ohm's law. Suppose, for example, that we have a current of 75 microamperes through a certain resistance and the voltage across it is 150 volts. What is the value of the resistance? We have resistance equals voltage divided by the current. The voltage is $1.5x10^2$ and the current is $7.5x10^5$. Hence R equals $1.5x10^2/7.5x10^{-5}$, or 2 megohms. In this simple case it would have been preferable to write $150/75x10^{-6}$ which yields the same result more easily.

Let us take an example of power computation. A current of 60 microamperes flows in a resistance of 5 megohms. What is the power dissipated in the resistance? The power is the product of the resistance and the current square. Hence we have $(6x10^{-5})^2 5x10^6$, which equals $180x10^{-4}$, or 18 milliwatts.

Let us figure the time constant of a condenser of 1 mfd. and a resistance of 1,000 ohms. The time constant is the product of the resistance in ohms and the capacity in farads. Hence we have $10^{-6}x10^3$, which equals 10^{-3}, or 0.001 second. The time constant of a circuit having inductance and resistance is the quotient of the inductance in henries and the resistance in ohms. If the inductance is 250 microhenries and the resistance 10 ohms, we have $2.5x10^{-4}/10$, which equals $2.5x10^{-5}$, or 0.25 micro second.

Let us take one more illustration of the computation of resonant frequency. Let the coil have an inductance of 50 microhenries and the condenser a capacity of 5 mmfd. We have $5x10^{-5}$ for the inductance in henries and $5x10^{-12}$ for the capacity in farads. The product is $25x10^{-17}$. In this case the exponent of 10 is odd and therefore we have to write the number $2.5x10^{-18}$ before we extract the root. We obtain $1.582x10^{-9}$. The reciprocal of this is $0.632x10^9$, and this we must multiply by 0.159 to obtain the frequency. It turns out to be $1.005x10^8$. Expressing this in megacycles we get 100.5 mc. If we had not used powers of 10 in this computation we would have had to write numbers extending clear across the page.

Whenever a capacity is expressed in micro the exponent of the power of 10 is minus 6 and when the capacity is expressed in micromicro, the exponent is minus 12. Thus a capacity of 600 mmfd. is expressed as 600 times a power of 10 with the exponent minus 12. Or in this particular case we can express it as 6 times the minus 10th power of 10. The same applies to any other number expressed in micro or micromicro units. If we have a number expressed in mega units we write the number times the 6th power of 10. In other words micro means 10^{-6} and mega means 10^6. The prefixes milli and kilo mean respectively 10^{-3} and 10^3.

These prefixes occur always in radio work because the numbers involved are either so very large or so very small. The prefixes are used for no other reason than to avoid writing a large number of ciphers or for the purpose of avoiding pronouncing numbers that are next to unpronounceable. In computation these prefixes are replaced by suitable powers of 10, negative or positive.

Let us repeat the rule for obtaining the proper exponent of 10 in any case where the number is written out. Move the decimal point to the desired place. Count the number of places moved. That is the value of the exponent of 10. If it was necessary to move the decimal point to the right, the exponent is negative and if it was necessary to move it to the left, the exponent is positive.

To multiply powers of 10, add the exponents, algebraically. To divide one power of 10 by another, subtract the exponent of the divisor from the exponent of the dividend, algebraically, of course. The exponent of the product is the algebraic sum and the exponent of the quotient is the algebraic difference between the two, the exponent ot the divisor being subtracted.

is also one force for every spring at which that spring will snap. The analogy between the spring and the condenser is exact.

As has been indicated, reactance is divided into two types, negative and positive. An inductance coil has positive reactance and a condenser negative. The polarity of either is more or less arbitrary but the fact that the polarities of the two reactances are opposite is not. If the reactance of an inductance is positive then that of a condenser is necessarily negative.

Quadrature

The current that flows in a device having reactance only does not result in any loss of power, although a great deal of power is involved. The reason there is no loss is that the current and the voltage are in time quadrature, or the two differ by 90 degrees. Now the power dissipated is equal to the product of the voltage and the current and the power factor. The factor is the cosine of the angle between the current and the voltage, and the cosine of 90 degrees is zero. Hence regardless of the values of the current and the voltage the power is exactly zero, provided we take a whole period.

Just how the current and the voltage are 90 degrees out of phase can be illustrated with a spring. Suppose we apply a force on the spring. There is a large displacement. The back force is zero and the displacement is maximum. When the spring has been deformed as much as it can be with the force applied the back force is maximum but the motion is zero. Hence the maximum pressure occurs when the motion is zero.

In order for the two to be in phase, maxima and minima must occur simultaneously. If the minimum of one occurs at the zero of the other, they are out phase by 90 degrees.

We can also illustrate quadrature by means of a mechanical analogy. This time let us take a train on a frictionless track. Let us also assume that an alternating force is tending to pull the train first in one direction and then in the other, and that this has been going on for some time. The train has just come to a stop because the alternating force has been working for a quarter period. At this time the force is greatest. But the force continues in the same direction for another quarter period, and during that time the train gains speed in the direction of the force until the end of the half period. At that time the speed is greatest but the force is zero.

The force reverses at this time and the train begins to slow down. It again comes to rest at the end of the third quarter period, when the force is again maximum. During the fourth quarter the force dies down to zero and the speed increases to maximum speed. Thus at every part of the cycle the force and the motion are a quarter period apart, that is, 90 degrees. We assumed that the train had been moved back and forth in this manner for some time at the cycle we considered. That was to give the transient time to die down. We could have started with the train at rest at the instant the force was maximum in one direction or the other.

Difference of Predominance

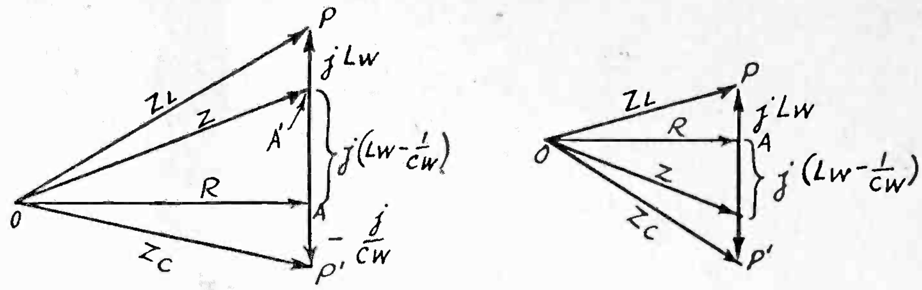


FIG. 3

These two vector diagrams show cases where there is both positive and negative reactance. At left the positive reactance predominates and at the right, the negative. Z is resulting impedance.

No power is dissipated during a cycle because half the time energy is put into the train and during the other half the train gives it back.

Vector Diagrams

Exactly the same thing occurs when an alternating voltage is applied across a coil. The inductance is the inertia or mass, the current is the motion, or the speed, and the alternating voltage is the force. The current is zero when the voltage is highest and the current is highest when the voltage is zero. Hence the current and voltage are 90 degrees out of phase and there is no power dissipated in the coil, the power factor being zero.

In a pure resistance the current is in phase with the voltage and the power dissipated in the resistance is equal to the product of the voltage across the resistance and the current through it. The power factor in this case is unity, since the voltage and current are in phase.

When there is both resistance and reactance in a circuit the power factor is no longer unity but depends on the relative values of the resistance and the reactance. The impedance, which determines the current, for a fixed voltage, is not the simple sum of the resistance and the reactance but is the vector sum, the vector sum of the two when the angle between them is 90 degrees.

The Composition

To illustrate the composition of resistances and reactances let us consider the drawing in Fig. 1. O*r* and jx are two lines at right angles with their intersection at O. Pure resistance is measured along the horizontal axis and the reactance along the vertical. The letter j represents the square root of —1, or it is the imaginary unit. It means nothing except that the reactance is at right angles to the resistance and we could omit it on the drawing if it is clearly understood that the two axes are at right angles. In formulas, however, we have to retain the imaginary unit as we have no other means of expressing the fact that the reactance is at right angles to the resistance.

Suppose we have a circuit having resistance R and reactance X. We draw a line of length R along the horizontal axis, terminating at A. At A we draw a line of length X at right angles to R, terminating in P. The line OP is then the impedance Z of the circuit. OR is the resistance vector and AX is the reactance vector. OP is the impedance vector, Z is the vector sum of R and X. The numerical value of the impedance in terms of the resistance and the reactance is the square root of the sum of the squares of R and X. That is, $Z = (R^2 + X^2)^{1/2}$. This is the well known formula for finding the hypothenuse of a right triangle in terms of the two legs. If we want to express the impedance in vector terms the sum is $z = R + jX$. The small letter z is used for the vector impedance to distinguish it from the absolute value Z.

In the above we drew the reactance upward and thereby assumed that we were dealing with the reactance of a coil. Suppose we had had a condenser in series with a resistance instead of a coil. Condenser reactance is negative and therefore we have to draw the reactance vector in the negative direction. In this case the vector might have terminated at P'. OP' would have been the impedance, but the absolute value of the impedance would be obtained in exactly the same way as before. But if we write the impedance vectorially we would have $z = R - jX$.

The phase difference between the voltage and the current is the angle AOP, or θ, in the case of a coil, and AOP', or θ' in the case of a condenser. The power factor of the circuit is the cosine of the angle. This cosine is the ratio R/Z if the reactance is that of a coil and R/Z' if it is that of a condenser. In the case of a coil the angle is positive but in the case of a condenser it is negative. In both cases, however, the power factor is positive.

In Fig. 2 we have two vector diagrams, one for inductance and one for capacity. At the left we have the reactance jLw, which is the reactance of a coil, and at the left we have the reactance —j/Cw, the reactance of a condenser.

Inductance and Capacity

When we have both inductance and capacity in series, in addition to resistance, also in series, we obtain the total reactance by subtracting the reactance of of the condenser from that of the coil. Since both are at right angles to the resistance they must be parallel and therefore we do not have to combine them by the hypothenuse method. Two cases of this kind are illustrated in Fig. 3.

(Continued on next page)

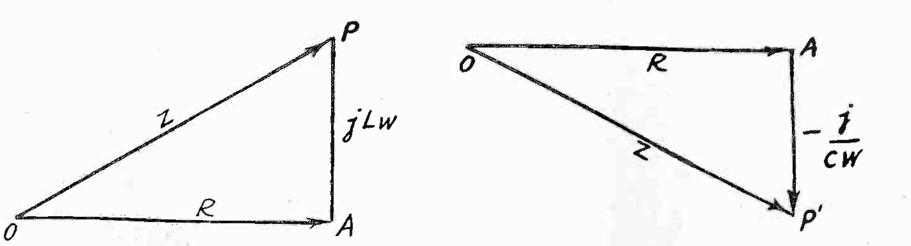


FIG. 2

Two vector diagrams showing the composition of resistance and reactance to form impedance when the reactance is positive, at the left, and when it is negative, at the right.

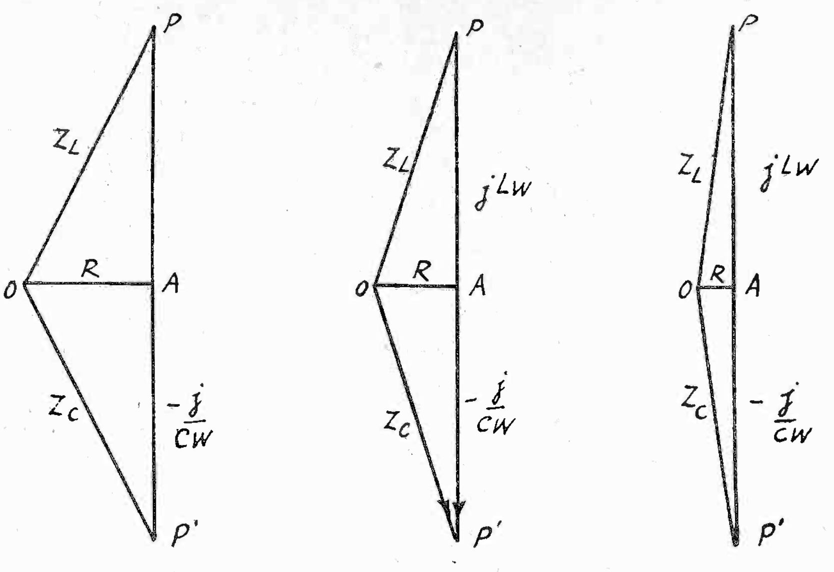


FIG. 4

These three vector diagrams illustrate cases where the negative and positive reactances are equal, or the resonance conditions. Different degrees of selectivity are indicated by the different values of R.

(*Continued from preceding page*)
In the left vector diagram the inductive reactance is supposed to be the larger. This reactance is jLw and the impedance of the resistance and the coil is Z1. The reactance of the condenser is —j/Cw and the impedance of the resistance and the condenser is Zc. To obtain the total reactance we lay off jLw and obtain OP. Then starting at P we lay off the reactance j/Cw in the direction PP'. We end up as far below P as P' is below A. The net reactance is AA', which is j(Lw—1/Cw) and the net impedance is OA', the value of which is Z. To obtain the absolute value of Z we add the squares of the resistance and the net reactance and extract the square root of this sum.

In the diagram at the right in Fig. 2 we have the same situation except that the condenser reactance is larger than the coil reactance. We end up at a point on the line PP' below A. Of course, the net reactance is negative.

Resonance

When the reactances of the condenser and the coil are equal the net reactance is zero and the termination of the impedance vector would fall at A. In that case there would be only resistance in the circuit, since the effects of the coil and condenser would cancel each other. That is the condition for resonance. The power factor would be unity for the angle between the current and the voltage would be zero. That is, the current would be in phase with the voltage.

The only thing that limits the current in the case of resonance is the resistance. Obviously, the lower the resistance the higher the current will be for a given voltage. In Fig. 4 we have three cases of resonance with different values of resistance. At the left the resistance is high and at the right it is low. If the voltage were the same in the three cases the current for the left case would be about one third that in the right hand case. In the middle case it would be about half way between.

The selectivity of the circuit depends on how high the resistance is. The most selective case is that at the right. The selectivity may be measured by the phase angle of the coil if we assume that all the resistance is in the coil. The tangent of the phase angle is the ratio Lw/R. This is our old familiar constant Q of a circuit, which is nearly always used as the selectivity of the circuit. The smaller R is the larger the ratio and hence the larger the selectivity.

Current in Resonant Circuit

Let us work out a formula that will show how the current in a circuit containing resistance, capacity, and inductance will depend on the selectivity factor Q and on the frequency ratio. First let the voltage in the circuit be E and the impedance Z. Then the current at any frequency is E/Z. Call this I. At resonance the reactance is zero and the impedance reduces to R. Hence the resonant current is E/R. Let this be I_r. Therefore $(I_r/I)^2 = (Z/R)^2$. Let us find the value of $(Z/R)^2$.

$Z^2 = R^2 + (Lw - 1/Cw)^2$. We found above that Q=Lw/R, and at resonance we have $w_r^2 = 1/LC$. Putting these values in the formula for Z^2 we obtain $Z^2 = R^2 [1 + Q^2(1 - f_r^2/f^2)^2]$. We use the frequency ratio because it is the same as the ratio of w_r/w. From this relation we obtain $(Z/R)^2 = (I_r/I)^2 = 1 + Q^2 [1 - (f_r/f)^2]^2$ as our required formula. In this formula Q is not strictly a constant for it contains w rather than w_r. But over a resonance curve Q does not vary much and it may be assumed to have the same value at any frequency as it has at resonance.

The formula may be used in computing resonance curves over any desired range of the frequency ratio and for any value of Q. To get the true current ratio, of course, it is necessary to extract the square root of both sides. The resulting curve is turned upside down. The lowest point will correspond with resonance. This is the way resonance curves are constructed now. In computing we may start at resonance and go either way, that is, we may make f either greater or smaller than f_r, but to get the complete curve we have to do both. Since we are dealing with a ratio we may express the frequencies in either cycles or kilocycles without affecting the result, so long as we use the same units for both.

Measure of Resonance

The sharpness of the curve depends on how rapidly the second part of the right hand member becomes very large compared with unity. It is clear that the larger Q is the quicker will this occur as we vary the frequency ratio. It is quite possible to have a value of 100 for Q in a radio frequency circuit. With this value what will be the current ratio when the frequency ratio 0.9? The square of the frequency ratio is 0.81. One minus the frequency ratio is 0.19, the square of which is 0.0361. When multiplied by the square of Q we get 361. Adding unit we get 362. Hence the current ratio is the square root of 362, which is nearly 19. Thus by detuning 10 per cent. we reduce the current to 1/19 of the resonance current.

In this case we assumed that the frequency ratio was less than unity. Suppose it had been 1.1. In that case the square of the frequency ratio would have been 1.21. Subtracting unity and squaring we get 0.0441. Therefore the current is about 1/21. Therefore the suppression by the tuner is not quite the same on both sides of the resonance curve. This means that one side frequency is suppressed more than the other when the carrier is tuned exactly.

Let us see how much a signal of 5,000 cycles is detuned when the carrier is 1,000 kc. In this case the side frequencies are 995 and 1,005 kc. The frequency ratios are 0.995 and 1.005. In the first case we get a current ratio of 1.412 and in the other 1.418. The mean sideband has been reduced to about 0.707 of the resonance frequency. This does not mean that the side bands are 0.707 as strong as the carrier but that the sidebands to 0.707 of what they would have been had the circuit had no selectivity.

Suppression of Interference

Let us see how much the relative suppression of interference is with a selectivity of 100. Let us take two carriers of 1,000 and 1,050 kc and let us tune the circuit to 1,050 kc. In this case the frequency ratio is 1.05. The current ratio turns out to be 3.35. Thus the resonant signal is 3.35 times as strong as the interfering signal, assuming that the two impress equal voltages on the tuned circuit. Of course, this suppression is not sufficient, and the overall selectivity of the receiver would have to be much greater than that of the circuit we are considering. But there may be three or more such circuits in the receiver, each contributing the same suppression ratio.

A resonant circuit working at a lower frequency is much more effective in suppression of interference, even when the selectivity constant is less. Suppose, for example, that we have a resonant circuit of 175 kc and that the selectivity constant is 100, as before. The most severe case is that requiring the separation of two adjacent carriers. Let one signal be operating at 1,000 kc and another at 1,010 kc. After the frequency changing the 1,000 kc signal becomes 175 kc, assuming that is the one we wish, and the other signal becomes 165 kc, for it is produced by the beating of the 1,175 kc oscillator and the 1,010 signal. We have to find the current ratio when the circuit is tuned to 175 kc and the interference has a frequency of 165 kc. The frequency ratio is 175/165, or 1.06, and the current ratio turns out to be 12.5.

Now by way of direct comparison let us see what the suppression of the interfering station is at the high frequency level, using the same selectivity. The circuit is tuned to 1,000 kc and the interfering frequency is 1,010 kc. Hence the frequency ratio is 100/101. Putting this in the formula and simplifying we obtain 1.725 as the current ratio. Therefore the intermediate frequency tuner is 7.25 times more effective in eliminating the interfering carrier 10 kc away from the desired signal. It would be still more favorable at frequencies above 1000 kc but less fa-

What Screen Voltage?

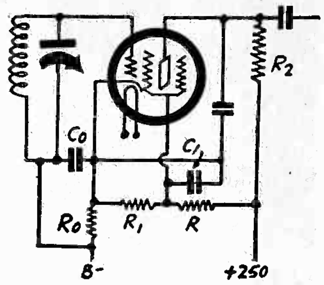


FIG. 1.

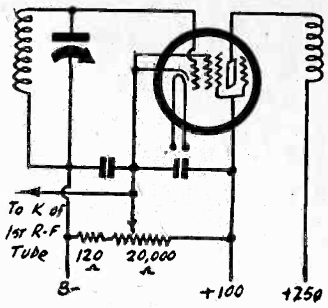


FIG. 2

Data on Highest Gain

WHEN a screen grid tube is used in a low resistance circuit, as an r-f amplifier or as a first detector in a superheterodyne, it is not necessary to lower the screen voltage. Indeed, it is well known that the greatest gain is obtained when the screen voltage is of the order of 85 volts on a 58, when the plate voltage is 250 volts. When a screen grid tube is used as a grid bias detector it may be operated with a low screen voltage, but apparently nothing is gained by doing so. Indeed, it is well to use a voltage so high that the necessary grid bias is placed far enough in the negative to insure that at no time will there be grid current. In a case where the screen voltage had been adjusted to about 6 volts, it was found that when the intermediate amplifier lost its gain, a greater output could be obtained by increasing the screen voltage. Beyond 22.5 volts there was little apparent increase, but there was no decrease either until the screen voltage was about 90 volts. In this case the plate voltage was only 135 volts. The tube was self biased and the grid voltage automatically increased as the required voltage became greater, due to the fact that both the plate and the screen currents increased with the increasing screen voltage.

Controlling the Volume

It has been found that when 58 tubes are used as r-f amplifiers and the volume is controlled by varying the grid voltage it is difficult to vary the bias enough to cut out the amplification completely. This is even true when the input is varied at the same time, as is done when a potentiometer is connected between the antenna and the cathodes of the controlled tubes. A way of overcoming this difficulty can be illustrated with the circuit in Fig. 1. Suppose this is one of the r-f amplifiers, the screen being connected to 100 volts, and the load resistance R2 being replaced with the primary of an r-f transformer. That is, we have a potentiometer between B minus and the screen with a total drop across this potentiometer of 100 volts. Let the cathode be connected to the slider of this potentiometer. Then the potentiometer resistance is divided into two parts, Ro and R1, by the slider. The drop in Ro is the grid bias and the drop in R1 is the screen voltage. It is clear that by sliding the cathode toward B minus we increase the screen voltage and decrease the grid bias. This makes the circuit more sensitive, provided we do not go all the way to B minus. As we move the slider toward the screen we increase the grid bias and decrease the screen voltage. Both will have the effect of making the amplification less. Surely if we have 100 volts on the grid and no voltage on the screen the amplification will be zero. Also, if we have about 3 volts on the grid and about 97 volts on the screen we have a very great amplification. Therefore this arrangement affords a means for complete control of the gain.

Small Fixed Resistor

To make this practical we should put a small fixed resistor between B minus and the potentiometer so that we cannot make the grid bias zero. This resistor should be of such value that the drop in it is about 3 volts. If we choose the resistors involved so that 15 milliamperes will flow, the limiting resistor should be 150 ohms. This current will come mostly from the tube, the potentiometer supplying about 5 milliamperes. What should the value of the potentiometer resistance be to cause a drop of 100 volts when 5 milliamperes flow? It should be 20,000 ohms. If we have two tubes on the same control we only need to change the limiting resistor, and the correct value would be 120 ohms. There should be a taper on the potentiometer and the end with the slow resistance change should be connected next to B minus.

In Fig. 2 is shown the arrangement for two 58 type tubes in the r-f amplifier, the first tube being indicated only by the lead to the cathode.

Tube List Prices

Type	List Price	Type	List Price
11	$3.00	'38	2.80
12	3.00	'39	2.80
112-A	1.55	'40	3.00
'20	3.00	'45	1.15
'71-A	.95	46	1.55
UV-'99	2.75	47	1.60
UX-'99	2.55	'50	6.20
'100-A	4.00	55	1.60
'01-A	.80	56	1.30
'10	7.25	57	1.65
'22	3.15	58	1.65
'24-A	1.65	'80	1.05
'26	.85	'81	5.20
'27	1.05	82	1.30
'30	1.65	'74	4.90
'31	1.65	'76	6.70
'32	2.35	'41	10.40
'33	2.80	'68	7.50
'34	2.80	'64	2.10
'35	1.65	'52	28.00
'36	2.80	'65	15.00
'37	1.80	'66	10.50

Alternative Impedance Formula

(*Continued from preceding page*)
vorable at the lower broadcast frequencies. This does not mean that a superheterodyne is less selective at the lower broadcast frequencies, but rather that it is more selective on the higher frequencies.

Tangent of Phase Angle

The formula for selectivity contains only the frequency ratio and the the selectivity factor Q. It was stated above that this was the tangent of the phase angle. This statement requires a little modification. Referring to Fig. 1, the tangent of the angle AOP is in the ratio AP/OA, or X/R. The X to be taken is not the net reactance of the tuned circuit but the reactance of the coil alone. The resistance that enters into the ratio is the resistance of the entire circuit and not only that of the coil. There is some resistance in the condenser and also some resistance due to losses to objects near the tuned circuits. Therefore the Q of the coil alone is higher than the Q of the circuit. The resistance of a good tuning condenser is so low that it can always be neglected in comparison with that of the coil. But resistance due to losses to shielding is not negligible as a rule, unless the shielding is considerably removed from the coil, say at least one diameter of the coil form.

Assuming that the Q of a 246 microhenry coil is 65 measured at a frequency of 1,000 kc, what is the resistance of the coil at that frequency? We have Lw/R equals 65. Therefore R equals Lw/65. The inductance is 246 microhenries and the frequency is one megacycle. Therefore R 246x2 π/65, or 23.7 ohms. That is the radio frequency resistance. The resistance measured with d.c. may be only a small fraction of this value.

A Symmetrical Curve

The values of the suppression obtained by the illustrative examples of the formula for selectivity showed lack of symmetry. This was due mainly to the fact that the frequency ratios used were not the same on the two sides. For example, if the resonant frequency is F and the other frequency is f, the suppression depends on F/f. If f is smaller than F then the frequency ratio is greater than unity, but if f is larger than F it is less than unity. If F is 1,000 kc and f is 990 kc the ratio is 100/99 and if f is 1,010 the ratio is 100/101. One is not the reciprocal of the other, which it would have to be if the resonance curve were to be symmetrical.

There is another formula derived on a slightly different assumption, namely, that Q is a constant and equal to Lw_r/R. The frequency in this case is constant but R and L may vary slightly. Over a resonance curve the variation in these is small and we are justified in assuming that this Q is constant also. With this assumption the formula becomes $(I_r/I)^2 = 1 + Q^2(f/f_r - f_r/f)^2$, which is exactly symmetrical in respect to the frequency ratio. However, it is not symmetrical if it is plotted on a frequency scale, for example, in kilocycles off resonance. The assumption in this formula is that L/R is constant.

Copper Oxide Rectifiers of Radio Frequencies

By Nagel Wallabout

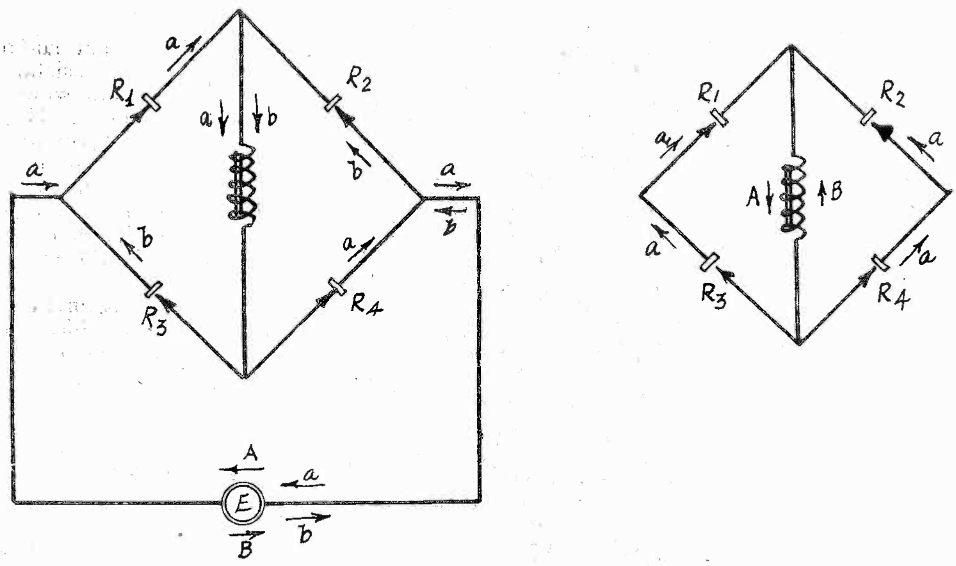


FIG. 1
A full-wave rectifier of the copper-oxide type which has now been applied to detection of radio frequency waves.

THE copper-oxide rectifier has been used for battery chargers, B battery eliminators, and alternating current meters. Now another use has been found for it, namely, as detector and automatic volume control in radio receivers. It had been thought that these rectifiers were not suitable for this purpose because of the high capacity of the rectifying elements, but this problem has been solved by the simple and logical expedients of making the elements very minute and by connecting them in series. When the rectifying surfaces are small, the capacity between two opposite metals is correspondingly small and when they are connected in series the capacity of the assembly is reduced in direct proportion to the number of elements so connected. For example, suppose that the capacity between two surfaces, that is, one rectifying element, is C and there are *n* elements in series, then the capacity is C/*n*.

Of course, if the rectifying surfaces are made very small the current capacity is also very small, but there is no objection to this because in a detector what we are after is a high voltage rather than high power. Hence if the load on the rectifier is a high resistance we need very little current to give us the desired voltage. And we do not need a very high voltage either for the rectifier would feed into a power tube, usually with a high amplification factor. A 47 type tube requires a peak voltage of only 16.5 volts, approximately, and we can get much more out of a copper-oxide rectifier than that.

Bridge Type Used

The most satisfactory connection of the rectifying elements is that of a bridge, the same connection as that used in alternating current meters using the same rectifier. That is, there are four equal rectifying elements, which are connected as in Fig. 1, R1 R2, R3, and R4 being the elements. The signal voltage is applied at E, and of course, it is alternating. No matter in which direction this voltage acts the resulting current through the load, which is here shown as a coil, will always be in the same direction. Both halves of the signal wave contribute to the rectified current. When the rectifier is used for detection the load takes the form of a high resistance, just as in the case of a diode rectifier, and the voltage developed across this load is used for input voltage to an amplifier tube. The usual stopping condenser and grid leak are necessary.

It has been found that the amount of distortion produced in a copper-oxide detector is of a very low order, even when fairly strong signals of high modulation are used. For example, measurements with from 4 to 10 volts per disc and a modulation percentage of 70 showed that in no case was the second order distortion attributable to the rectifier greater than 0.5 per cent.

In respect to frequency distortion the copper-oxide rectifier is also superior in that it will detect modulation frequencies practically without attenuation up to 10,000 cycles per second. This, of course, depends on the amount of filtering that is put across the load resistance, for the principle of detection does not change by changing the means of rectification. The statement regarding attenuation applies to the case when only the capacity of the elements is used, that is, the minimum shunt capacity possible.

The bridge type copper-oxide rectifier presents a capacity both to the input voltage and to the load resistance, and due to the relative values of resistance involved the load capacity is very much larger than the input capacity.

Linearity of Characteristic

Curves taken on typical copper-oxide rectifiers suitable for radio frequency work between the a-c input voltage and the d-c output voltage across a 250,000 ohm resistor show almost exact linearity except for input voltages less than about 10 volts. This linearity is better, of course, the higher the load resistance, so that on open terminals, that is, infinite resistance, the curve is nearly straight all the way.

The copper-oxide full-wave detector is said to have an advantage over the diode rectifier in that it absorbs less power from the source. This is because the equivalent load on the d-c side, when the resistance is very high, is a capacity reactance. Hence the voltage drop in this load and that in the resistance arms of the rectifier add vectorially and not linearly. There is no loss in the condenser because the voltage across it is in quadrature with the current, that is, the power factor is zero.

The attenuation at high modulation frequencies is low because full wave detection permits the use of very little shunt capacity across the load to remove the ripple. This would be true of any other full wave detector, such as the 55 duplex diode.

Automatic Volume Control

Automatic volume control can be associated with the full wave copper-oxide detector without difficulty. There is a direct current component in the load resistance. If the cathodes of the controlled tubes be connected to the positive end of the load resistance, either directly or through a limiting bias resistor, every point on the load resistor will be negative with respect to the cathode. Therefore if the grid returns of the controlled tubes be made to the negative end, or to some intermediate point, then the steady voltage drop in the load resistance will be applied as bias on the controlled tubes. Since the drop across the load resistance will be proportional to the signal intensity impressed, the bias will also be proportional to the signal. Hence the stronger the signal the less the amplification will be, and we have the correct conditions for automatic volume control.

There will, of course, also be an audio component across the load resistance. We do not want the bias to contain this component for that would affect the degree of modulation of the signal. Therefore it is necessary to introduce additional filtering. A high resistance, say about half megohm, connected between the negative end of the load resistance and the grid returns, with a shunt condenser of about 0.1 mfd. from the grid returns to ground, would effectively remove the audio ripple contained in the voltage. If desired, another resistor of the same value and also another condenser could be used in the same manner, in series, to remove completely all audio ripple. The d-c voltage obtainable across the resistor is nearly equal to the mean value of the signal voltage impressed on the rectifier. Thus if the signal voltage is 20 volts, effective value, the mean voltage available for bias is 18 volts, for the mean value is 0.9 of the effective value. This is sufficient for automatic volume control when 235 or similar variable mu tubes are used as r-f amplifiers. The audio component is also sufficient to load up a 47 type pentode. Hence we do not need more than about 20 volts signal input.

Construction

Satisfactory rectifiers have been made of copper discs 0.08 inch in diameter, which is just a little larger than 1/16 inch. One

Visual Amplitude Test, Any and All Wavelengths

SOME very splendid papers appear in the October, 1932, issue of "Proceedings of the Institute of Radio Engineers." The first is an important contribution by T. L. Eckersley, Research Department, Marconi's Wireless Company, Ltd., Chelmsford, England on "Direct-Ray Broadcast Transmission." The paper covers the frequency range from 150 to 5,000 kc and aims to work out a method whereby the field strength from stations operating within this range may be predicted with reasonable certainty from the distance and the power of the stations. Attention is given principally to day transmission but some consideration is given to night transmission and the influence of the Heaviside layer.

Visual Test Devices

O. H. Shuck, of the University of Pennsylvania, describes a very interesting device for studying and testing radio receivers by rendering the characteristics visual. Thus it will show on a screen the frequency-response curve of a tuned circuit, a tuned transformer, an amplifier, or a complete radio receiver.

The action is practically instantaneous and the effect of various circuit adjustments can be seen immediately. Many curves obtained with the device are shown.

The circuit consists of a vacuum tube voltmeter, a galvanometer with turning mirror, a light source for projecting a spot of light, a revolving mirror, a screen on which the curve appears, and an oscillator of variable frequency.

The vacuum tube voltmeter acts primarily as a grid bias detector to supply a direct current for the galvanometer. The revolving mirror, which is attached to the shaft of the variable condenser of the oscillator, serves to provide a frequency axis on the screen, while the mirror on the galvanometer serves to move the spot in the direction at right angles to the frequency axis.

Provision is made for covering a wide frequency range from 40 kc to 1,500 kc and the range covered by the complete sweep of the condenser can be varied from 30 per cent. to 0.1 of one per cent. of the mean frequency. There is also provision for measuring inductances from one microhenry to 100 millihenries and capacities from 3 mmfd. to 10 mfd. In an appendix is shown how, by the addition of a resistance-capacity coupled amplifier, the derivative of the curve can also be obtained. The derivative is the slope of the characteristic curve.

More details on this device will be printed in RADIO WORLD next week, issue of October 29th.

Copper-Oxide Detector

The paper by L. O. Grondahl and W. P. Place on "Copper-Oxide Rectifier for Radio Detection and Automatic Volume Control" is perhaps the most interesting development in this number of "Proceedings." It is the basis of the article appearing on the opposite page. The original paper deserves careful study by all who are interested in high quality detection by inexpensive means.

Detection of Microwaves

Nello Carrara, Leghorn, Italy, examines the conditions by which triodes may be used efficiently for detecting ultra-high frequencies, of the order of one billion cycles per second. From purely theoretical considerations he derives expressions which agree very well with experimental results. The conclusion of the study is that "it appears clearly that a triode detector of microwaves, under usual conditions, behaves like a simple rectifying diode with its electrodes very near each other."

Frequency Analysis

"A New Method of Frequency Analysis and Its Application to Frequency Modulation" is contributed by W. L. Barrow, Massachusetts Institute of Technology, Cambridge, Mass. This new method has for its object the finding of component frequencies in a modulated wave, such as sidebands, especially those occurring when the frequency is varied rather than the amplitude. The method employs an oscillograph and depends on the superposition of two sinusoidal waves, one of constant frequency and amplitude and one whose amplitude is constant but whose frequency is varied over a certain range. The resultant frequency is oscillographed so slowly that the individual oscillations are not quite resolved on the film. When there is a one-to-one relation between the two frequencies a very definite pattern appears on the record. Other typical patterns occur when the two frequencies bear other integral relationships but they are so complex that no mistake can be made as to the location of the one-to-one relation.

Suppose one of the oscillations is complex in the sense that it contains different sinusoidal vibrations. On the record there will be one one-to-one type pattern for each of the components and therefore the complex wave can be analyzed. The method has a very high resolving power, which means that frequencies very close together can be detected. Just how great the resolving power is depends on the speed of the recording film and the rate at which the variable frequency changes. The greater the speed of the film and the slower the rate of change the variable frequency the greater the resolving.

Note on Networks

L. B. Hallman, Jr., Chief Engineer, Montgomery Broadcasting Co., Montgomery, Ala., contributes a mathematical paper on "A Fourier Analysis of Radio-Frequency Power Amplifier Wave Forms," with special reference to those of Classes B and C. It is assumed that the plate current is given by $I_p = KE_g + k$, in which K and k are constants and E_g is the grid voltage. The coefficients of the Fourier expansion are obtained for various conditions of operation.

A brief "Note on Network Theory" is contributed by J. G. Brainerd, University of Pennsylvania. General expressions for the important properties of the resultant transducer when any passive transducer is connected to any other transducers the properties of which are known. The treatment covers transducers in parallel, in series, and in series-parallel.

A Copper Oxide Rectifier of R-F

(Continued from preceding page)

rectifier element consists of a copper disc, a cuprous oscide disc, and a lead disc suitably clamped together. Several of these elements may be stacked in series, the number depending on the voltage that is to be rectified. The various components of a rectifier unit of this type are stacked in a whole of right diameter in an insulator, such as bakelite, the hole extending all the way through. On one side of the insulator a metal plate is attached, to serve as terminal as well as bottom for the hole. First a copper disc is loaded into the hole, then a cuprous oxide disc, then a lead disc, then a copper disc, and so on until the required number of rectifying elements have been stacked up. On top of the highest lead disc is a metal spacer and this is followed by a spring, which comes next to a metal plate on the second side of the insulator. The spring is used to hold the various components together and to exert some pressure.

Clip Connection

For a full wave rectifier four of these assemblies are used. While it was stated that the hole was drilled in a plate, it could just as well be in a rod of insulating material. That is, tubing of suitable inside diameter could be used and the metal plates could be screw caps at the ends. When this method of assembly is used a rectifier element takes a convenient form for clip insertion. If the insulator is round and of a diameter that fits inside a tube base, four holes can be drilled in the insulator to match the pins of a UX base and the rectifying elements could be stacked inside the holes. In this case the end pieces could be screw plugs. There are four connections to the bridge, and one could be connected to each pin of the base. Then the full wave rectifier could be plugged into a socket suitably wired just as a vacuum tube is plugged in. It has been found that for radio frequencies where a 47 pentode follows the rectifier, four of the rectifying elements for each of the four units are satisfactory.

Full Description

Those who are interested in a more complete description of the copper-oxide type of radio frequency rectifier should consult an article on the subject by L. O. Grondahl and W. P. Place in the October, 1932, issue of the Proceedings of the Institute of Radio Engineers. It is well worth studying for it describes what promises to be the next popular detector, if not the ultimate.

AN ECONOMIC

Accessor Used with Built-in Su

By Edg

AS ONE'S interest in radio increases, or if one makes a business of radio, as one's work grows larger and more extended, which also widens interest, the greater the requirements put on testing equipment. It will be found that miscellaneous meters about the shop become rather unhandy to use. Also, if one has to make a test in a customer's home, the loose meters have to be transported thus, and again some confusion may arise about how to use them, or what connections to make, especially under the interested gaze of the customer.

So the standard grows higher and higher, and here is a device for those who have advanced beyond the early requirements of mere measurement of resistance and d-c voltage and current. Why not measure a-c as well, since it can be done by rectifying the a-c and then measuring the plate current output, which is d-c? For convenience the current may be measured in the cathode circuit, so that if the rectifier is a 57 tube the current is the sum of the screen and plate currents. It will be necessary to calibrate a curve, but this may be done with the aid of an r.m.s. voltmeter.

Two Main Switches

It is well to have the device permit access to a receiver, and while this service, plus switching of the correct meter connections, may be done with a single switch, that switch would require about twenty-two different settings, sometimes more, and the wiring is exceedingly complicated. It therefore is simpler and incidentally much less expensive to do the work with two separate switches, and types of these, not nearly so expensive as other types, are limited to nine different connections. One of the switches is of the multiple type, with four decks, and an insulated circuit opener, renine different positions, accounting for two decks, and an insulated circuit?opener, requiring no connections to the opener itself but only to contact points on the switch represented by lug positions, opening circuits otherwise closed. This combination of uses makes for the utmost simplicity in getting access to receiver circuits in which current is read, for then the meter has to be put between the opened circuits, thus really closing them, the current flowing through the meter.

Choice Made

Since the switch for affording access to the socket connections of a receiver is limited to nine different positions, and as we shall have to contend with as many as eight different elements in a tube (counting heater as one in the 7-prong special tubes now being marketed), let us make the choice right away. For current values we may select the plate, screen and cathode circuits. Then we have left six voltages and we may measure plate, screen, suppressor, cathode, filament and grid voltage. In only one present instance will the grid voltage be of any considerable importance, that of the seven-pin tubes, as the normal control grids in other type tubes is picked up either by the lead from the standard G post of UX and UX base tubes, except in the instance of screen grid tubes, when an extra lead is utilized, for the normal G lead is of course serving another purpose, likely screen grid voltage.

The current readings not obtainable are those infrequently required and usually of such small value as to produce little deflection on a 0-1 milliammeter.

Seven-Pin Tubes

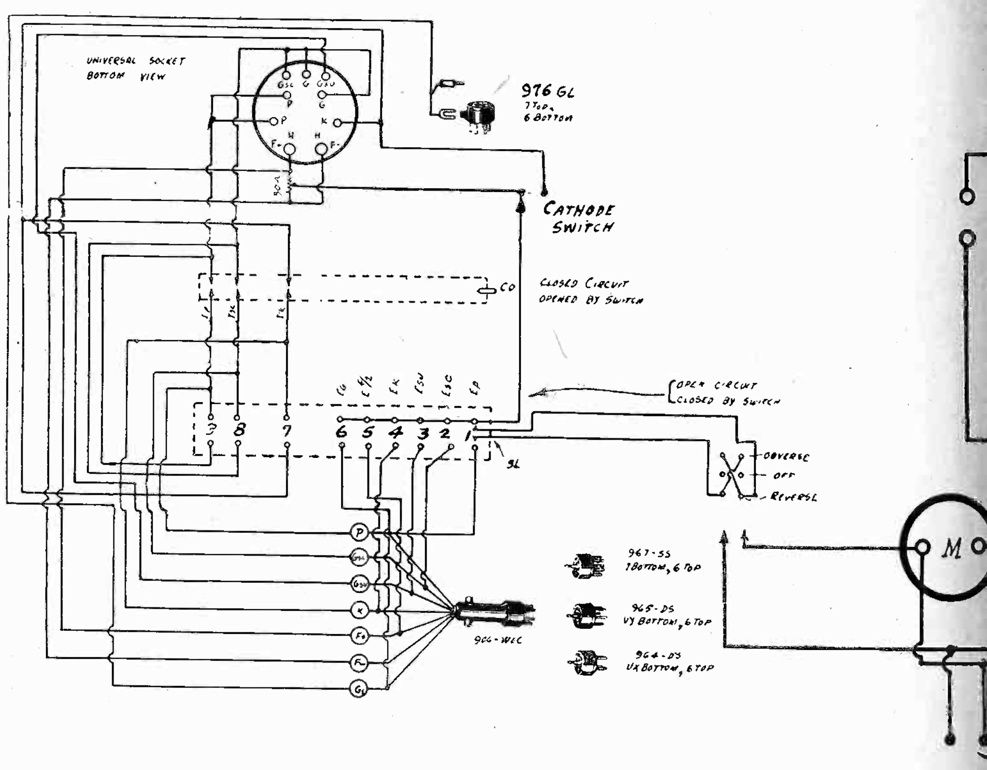
So at the nine positions the multiple switch that serves the dual purpose of closing and opening, all at one operation, gives us, by this method, about all that we can expect. Now, we need sockets in the tester, but a universal socket will take care of all the UX, UY and six-pin tubes, and an adapter, 976-GL, insertable in the 6-pin accommodation of the universal socket, affording a seven-hole top, so that seven-pin tubes may be inserted in the adapter that is in the six-hole socket.

Since 7-pin tubes are to be tested, there must be seven leads in the cable running from the tester to the receiver socket. Six of these are taken care of by the leads from the analyzer plug that is to be put into the receiver socket and that coincide with socket holes or analyzer pins. The seventh lead is an extra wire connected to a grid cap insert in the analyzer plug and also connecting with a bayonet or stud th protrudes from the top of the adapt (967-SS) that goes into the seven-p socket. In this way the seventh connecti is communicated to the tester, the sa lead being utilized that serves for cont grid connection of screen grid tubes, a which lead for the seven-pin tubes utiliz a tip phone that fits into a jack on the si pin-bottom, seven-hole-top adapter.

These considerations were discuss along somewhat the same line last we (issue of October 8th), but the prese tester is one that affords not only acce to the receiver, but also resistance, volta and current readings, including low valu of a-c voltage, and calibrated oscillatio A 57 tube is used as rectifier, and as plate current will cut off at close to volts negative bias, the actual amount voltage that may be read will not be mu in excess, although some grid current m flow, and positive bias be used due to larg input voltage than normally expected, pr viding the voltage is not radio frequenc For alternating current in the audio ran grid current will not upset the apple ca

Meter Built In

In the present instance the meter is bu into the tester, and therefore no outlet required, except for use when measuri

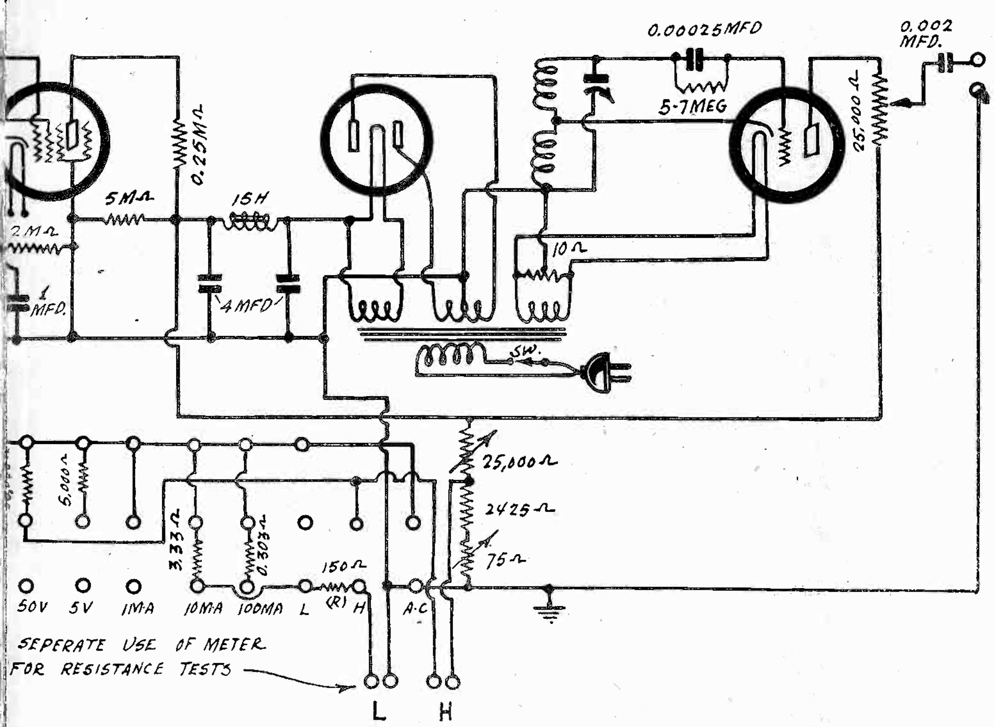


The values of resistances for the tester are given 30-ohm m

AL ANALYZER

tch Meter—Oscillator Included

Forbes



e diagram for a 0-1 ma. Shunt values are given for coil resistance.

esistance, and also except when it is de-ired to use the meter independently for easurements of external factors.

A calibrated oscillator is included because iere are probably almost as many instances hen the use of an oscillator is required s there are instances when a-c voltages re to be read. The oscillator is of the implest type, being on the order of the ne described in early pages of this issue, xcept that the voltage on the plate is d-c, nd the modulation is not the hum fre-uency of the line, but the grid blocking requency, and is introduced by using a igh value of grid leak in conjunction with ie 56 tube. Also, an attenuator is pro-ided, and this is of the type that has the mallest effect on frequency, practically one, since the resistance of the tube is be-ween the tuned circuit and the output.

Leak Change

If desired, a switch may be used to hange the leak value from the high one uggested to a low one, say, 50,000 or 00,000 ohms, so that the choice of modu-ated and unmodulated accommodation may e enjoyed, but as most service men have se only for the modulated type, this switch s omitted. It may be single pole single hrow, by putting it across the high resist-nce and not across the low resistance.

Modulation has to be provided some way, and this simple one was selected because the resultant note is of such a high pitch that it is not easily mistaken. There is a B supply built in, as you see, and as this is filtered, it is not desirable to introduce the a-c again. The B supply not only furnishes B power to the meter rectifier tube and the oscillator tube, but also voltage for resistance measurements.

Resistance Measurement

Division of the voltage is very easy, if one remembers that the principal concern is to see that the used high voltage is what it should be, and that a rheostat of more than the needed value for establishing the lower voltage is adjusted to correct value. The lower is such a small percentage of the higher that the lower should be watched particularly. If the higher voltage is 50 volts and the lower is to be 1.5 volts, then the resistance distribution may be as shown, although it is unnecessary to adhere to these values of resistances, for any other distribution that will give the desired voltages will be all right, with the single proviso that at least 20 ma should flow in the bleeder circuit. Then the resistors need not exceed 10 watts.

It is not necessary here to use multiples of 1.5 volts, as we are not dealing with batteries composed of 1.5-volt dry cells. Indeed, we may select 1 volt, if we prefer, and even 100 ma, although then the drain is considerably beyond what we at first intended. Nevertheless, it can be done, and since the resistance readings are to be calibrated anyway, the changing voltage due to changing current through the external or bleeder circuit can be taken into account, in the calibration, for these changes would be very large. Also, the voltage of resistors has to be multiplied by five, or lower resistor values used. In fact, if any current through the meter is to be much more than 1 ma maximum, the same general situaation obtains, therefore lower voltage will be used by some for low resistance readings, at 1 ma meter current, using, say, 0.5 volt and 500 ohms limiting resistor.

Question of Accuracy

As with batteries used for voltage source in resistance-measuring circuits, so with the B voltage supply, we check up on the actual voltage before each test, measuring with the very meter we have.

The only strictly accurate way of determining resistance value is to measure the current carefully, and compute the resistance on the basis of the known or ascertained voltage, or to use a decade box or other bridge circuit with highly accurate resistance banks. The calibrated scale method is never very accurate, but it is not necessary to have a high degree of accuracy in radio service work, in determination of resistance values, except for the low resistances through which filament current flows, and the testing of battery sets can be done satisfactorily with regard paid to the voltage only, since if that is correct, at the filament terminals, then the current is correct.

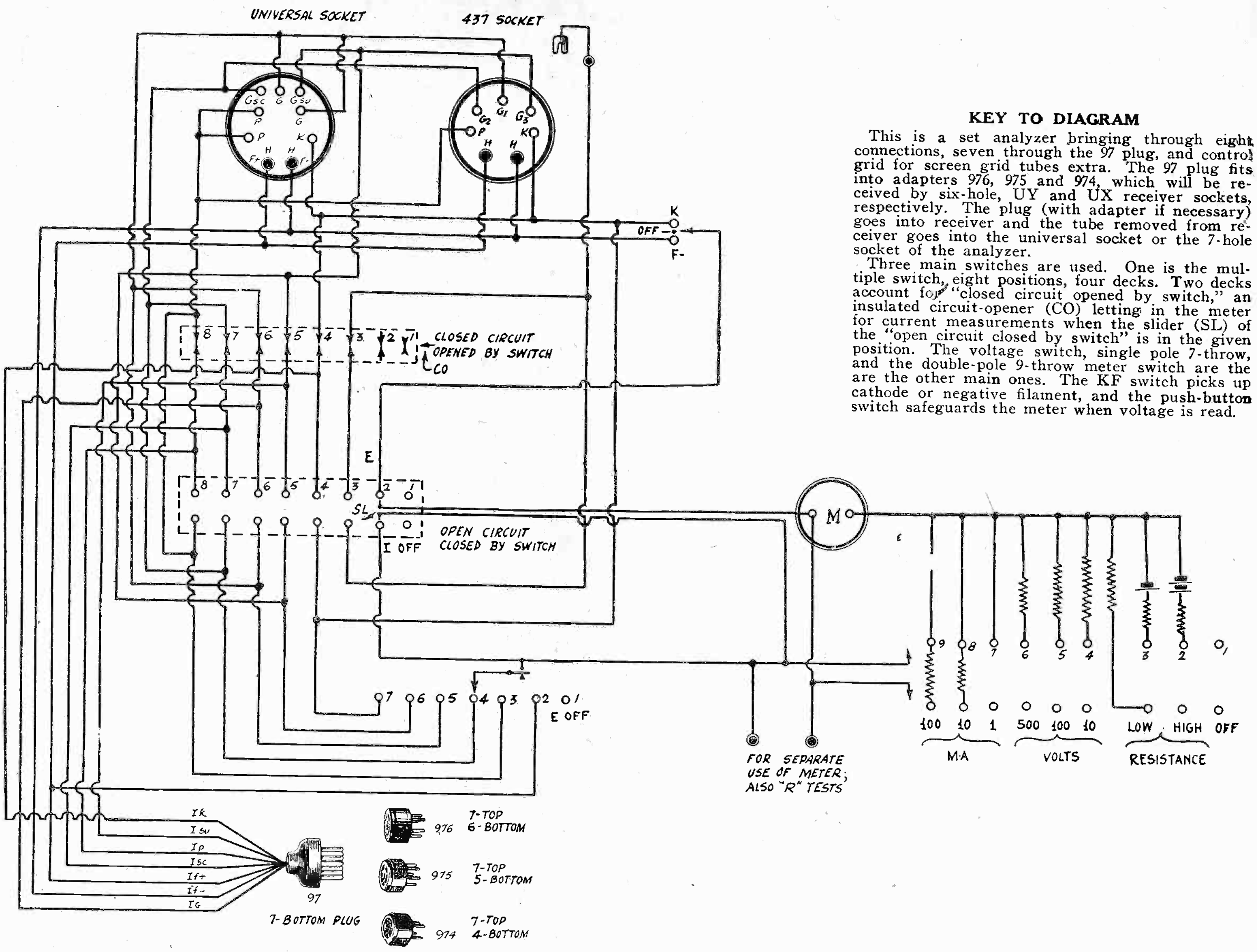
Chassis Data

The device can be built on a chassis top 10¾ x 8¾ inches, and if a metal chassis is used, it may be 2¼ inches high, overall, or if a wooden box is to be used, its inside depth, top to bottom, should be no less than the 2¼ inches. However, since an oscillator is herein contained, and some extra pains are to be taken (with additional expense of course) to produce a shielded oscillator, the metal idea is more attractive, as a wooden box would have to be metal-lined anyway.

The reason is that safeguard is to be made against oscillator output going to tubes after the input tube of a set, for instance, to detector direct, or, in superheterodynes, to the second detector rather than output of the first detector, which situation may obtain when a strong oscillator is used in unshielded fashion, the coupling by induction being great enough to strike detectors without any greater effect on the antecedent tubes. This is not really a difficulty of any great practical kind in service work, but the extra precaution, on the basis of theoretical considerations, may be taken with advantage, particularly as finer work than merely testing or lining up receivers may be attempted later on, when a shielded oscillator would be vital.

(*Continued on next page*)

Rigidly Economical Set Analyzer



KEY TO DIAGRAM

This is a set analyzer bringing through eight connections, seven through the 97 plug, and control grid for screen grid tubes extra. The 97 plug fits into adapters 976, 975 and 974, which will be received by six-hole, UY and UX receiver sockets, respectively. The plug (with adapter if necessary) goes into receiver and the tube removed from receiver goes into the universal socket or the 7-hole socket of the analyzer.

Three main switches are used. One is the multiple switch, eight positions, four decks. Two decks account for "closed circuit opened by switch," an insulated circuit-opener (CO) letting in the meter for current measurements when the slider (SL) of the "open circuit closed by switch" is in the given position. The voltage switch, single pole 7-throw, and the double-pole 9-throw meter switch are the are the other main ones. The KF switch picks up cathode or negative filament, and the push-button switch safeguards the meter when voltage is read.

(Continued from preceding page)

As to sockets: one is the universal socket, another the '80 rectifier socket, another the small a-c voltage rectifier (57) and the last the 56 oscillator tube. The power transformer would be at center rear. Binding posts as desired may be arranged at left and right rear.

The Two Sides

It is optional whether the seven-lead cable is permanently soldered to the destination points in the tester, or whether these points are connected to a seven-pin socket, a (437) into which a seven-bottom six-top adapter (967-SS) with stud connector fits. As explained, the seventh connection is made to the cable via the stud.

If the extra parts are included as just discussed, then the cable may be disconnected from the tester, and the annoyance of the cable dangling about, and sometimes getting into one's way when no use is had for it, is avoided. The other side of the picture shows the danger of possibly forgetting to bring the cable along on a job, and the theory that the a-c cable is no less a nuisance. So take your choice.

True Plate Voltage

The meter is at left center, the dial is at center, and at right, in line with the meter, would be the multiple switch with the key lines (giving information as to what is read at particular settings). Below this switch would be the two-deck, nine-position switch for the setting the meter to read what is desired (as distinguished from selecting what circuit in the set is to be tested). The switch for reversing, and for "off" position, also may be used for changing from cathode to filament center, as for some types of tubes the true applied plate or screen voltage is that between cathode and B plus, while for most battery-type tubes, in fact, all filament types, a-c or d-c, the voltage is that between negative filament or filament center and applied voltage. No matter which is which, the true voltage can be ascertained, though the present tester reads half the filament or heater voltage, requiring that the reading be doubled to obtain the true value. Since the filament voltage is read thus, the plate voltage will be actually less than the reading for plate voltage by the amount of half the filament voltage, a subtraction not too difficult to make!

The oscillator dial at center normally would have a 0-100 or a 100-0 numerical scale, but there if there is room on the margin the frequencies may be written in as the calibration discloses them, or possibly another scale prepared, translucent or transparent, and put over the numerical one, so that both numerical settings and frequencies may be read. However, a plan that is quite easy to follow is to prepare a scale of your own from the calibration, by drawing a line for each 100 kc of the broadcast band, and also other lines for the intermediate frequencies desired to be registered, and putting down the frequencies. Then the numerical scale may be removed, as there is scarcely any use for it.

A STILL less expensive set analyzer and resistance meter, not only because of the omission of the oscillator but also because more economical methods have been followed throughout, may be built by using three main switches and more or less improvising the plug-in arrangement yourself.

The circuit diagram for this is shown in Fig. 2. Unfortunately, the switches can not well be shown pictorially, because it is impossible to show all planes at once and co-ordinate the wiring of the switches. However, any who intend to build any of these devices, and who will obtain the switches, will find that after studying the switch, in conjunction with reading the diagram, the method of connections will be perfectly clear.

The only confusing point to those who have not done any analyzer wiring is the multiple switch, shown at left, divided into two sections, the "closed circuit opened by switch" and the "open circuit closed by switch." Regarding the diagram as to top and bottom positions of these two segments, read the diagram as if any one switch position controls the operation of both sections of this four-deck, eight-position switch. If the switch has nine different positions leave the ninth one blank, so that both ninth and eighth will represent "off", and then you have one extra position for any special use that may prove valuable in the future.

Grid Lead Extra

Let us give the diagram the "once over" from top to bottom. We use two sockets in the analyzer, one of the "universal" type, into which UX, UY and six-pin tubes fit correctly without necessity of any reflection by the operator, and the other a seven-pin socket, as there is no universal socket at present that accommodates the seven-pin type base and other tubes without an adapter.

Since there are seven socket connections there must be at least a seven-lead cable. While at present no seven-pin base tube exists that also has a grid cap at top, some day one probably will appear, so why not provide for the future? Eight leads would be necessary, but the eighth one may be a flexible wire run separately from the grid cap of such a tube (when the tube exists) to the grid clip in the set, while the seven socket connections are communicated through the plug. Also the grid cap connection may be used in this fashion for present screen grid tubes. It is not the handiest thing in the world to have the grid cap lead separate from the cable, and it is not done that way in the Fig. 1 circuit, but the present manner costs less money.

The bottom views of the two sockets are shown, and the wiring should take that into consideration. So the plate to left of the heater or filament and cathode to right should not be taken as an error.

Let us follow the plate lead, see where it goes and what happens.

Following Through

The plug is inserted in the receiver socket, the tube taken from that socket is put into the analyzer socket, and therefore we must discover whether continuity is established when needed, broken when required, or, rather, that something else is put in to keep the otherwise broken line continuous.

The lead may be followed backwards probably with greater facility, so start with the analyzer socket. Plate is led down through special wiring to one side of the switch section marked "closed circuit opened by switch." This lead also goes to the bottom of the switch section marked "open circuit closed by switch." The lower part of the upper switch section is joined to the upper part of the lower switch section. On analysis this proves to be a case of the two switch sections being in parallel. The plate lead to the analyzer plug is connected to the plate lead common to both switch sections.

What has happened in operating the switch connected this way?

The plate has been led to a closed circuit switch that opens at this position. The necessity for such action arises from the fact that to read current a meter has to be in series with the line through which the current is flowing. Also it is necessary that when the plate reading purpose is fulfilled that the circuit be closed, so that the tube will get plate voltage. The reason for opening the circuit is simply to put the meter between the two otherwise closed points. It is the meter that keeps the circuit closed though the switch points are open, for as the two switch operations are in parallel, the opening of the switch above is accompanied by the closing of the switch below. The lower switch is connected to the meter.

Interrupted by Meter

Therefore, operating in the other direction, the current from the receiver does not go directly to the socket of the analyzer and the tube in that socket but goes through the switch to the tube in such a manner as to interpose the meter in series.

Six different current readings are provided for, and that means that every circuit, except only the filament or heater, may have its current read, providing the current is d.c., as the intended meter is only of the d-c type. No greater variety of use for current measurements could be provided by an analyzer, for even the current through each of the two plates of a full-wave rectifier may be read separately, also the suppressor current even if suppressor is not tied to cathode, and also any other current due to the tubes in question not being of the 57 and 58 types one usually has in mind. For instance, the 55 has the equivalent suppressor and screen grid connections of the 57 and 58 serving as separate anodes, and each anode's current may be read independently, provided the meter is sensitive enough, or the current is high enough.

The next to the last right-hand position is for voltage readings, while the right-hand extreme is "off". Wherever possible an "off" position has been provided, as when one is finished using an analyzer he should leave it in as inoperative condition as possible, so that he will have to use his head before he can get any reading the next time, and thus the likelihood of mistake, with consequent meter damage, is reduced. There is no universal corrective for the possibility of error, and it is possible to burn out a meter by a mistaken connection in virtually any analyzer, even those with small fuses in them, as the fuses are effective at from 10 milliamperes up, hence are useless in so sensitive an instrument as the 0-1 milliammeter here intended.

A Little Ingenuity

Now, there is no standard use for the circuit-opening section of the multiple switch at the voltage position, but we shall find an ingenious one for it. If the meter is set for current and the multiple switch for voltage there would be one more meter to be sent to the factory for repair. While for current readings the meter itself is to be picked up directly, for voltage readings it should not be picked up directly, for the multipliers, which not only provide the voltage-reading basis but also incidentally thus protect the meter by limiting the current through it, have to be selected, one at a time, as needed. Therefore we want to get rid of the direct connections to meter terminals as fast as possible, and we do it instantly by using the circuit-opener to remove the direct connection to one side of the meter (upper section of switch in diagram) while the single-pole seven-throw switch at bottom is connected to the multiplier-shunt slider of the third or meter control switch.

Let us pause a moment to review the number of switches accounted for: (1) the multiple switch, for current readings; (2), the voltage selector switch that controls the points picked up from the receiver; (3), the meter control switch, to make the meter handle more current (by shunts) or read voltages (by series multipliers). And then, too, there is another switch, (4), to switch the voltage readings from negative filament to cathode, which also dispenses with the necessity of a reversing switch. Battery type tubes should have their bias and plate voltages read from negative filament. For a-c filament type tubes one side of the filament is as good as the other or as center, while for indirectly heated tubes ('27, '24, 57, 58, etc.) the plate voltage is truly read from cathode to plate return (applied voltage) or cathode to plate itself (the effective voltage).

We come across two posts. These are for connection of the unknown in measuring resistance values, also for independent use of the meter, as for external measurements. One side of the meter selector switch is tied permanently to one of these posts. This connection also goes to the voltage switch (single pole, seven throw). The other slider of the meter selector switch never picks up any shunts or 0-1 ma without depression of key, and therefore when set-analyzing you cannot connect shunts or 0-1 ma to voltage positions and destroy the meter in consequence, provided the multiple switch is at "E" (voltage position) or off, either once, and key automatically open.

The simplest way to handle the resistance problem is to use an extra shunt for the low resistance readings, and this avoids complicating the switching, and also avoids extra binding posts being brought out for resistance measurements.

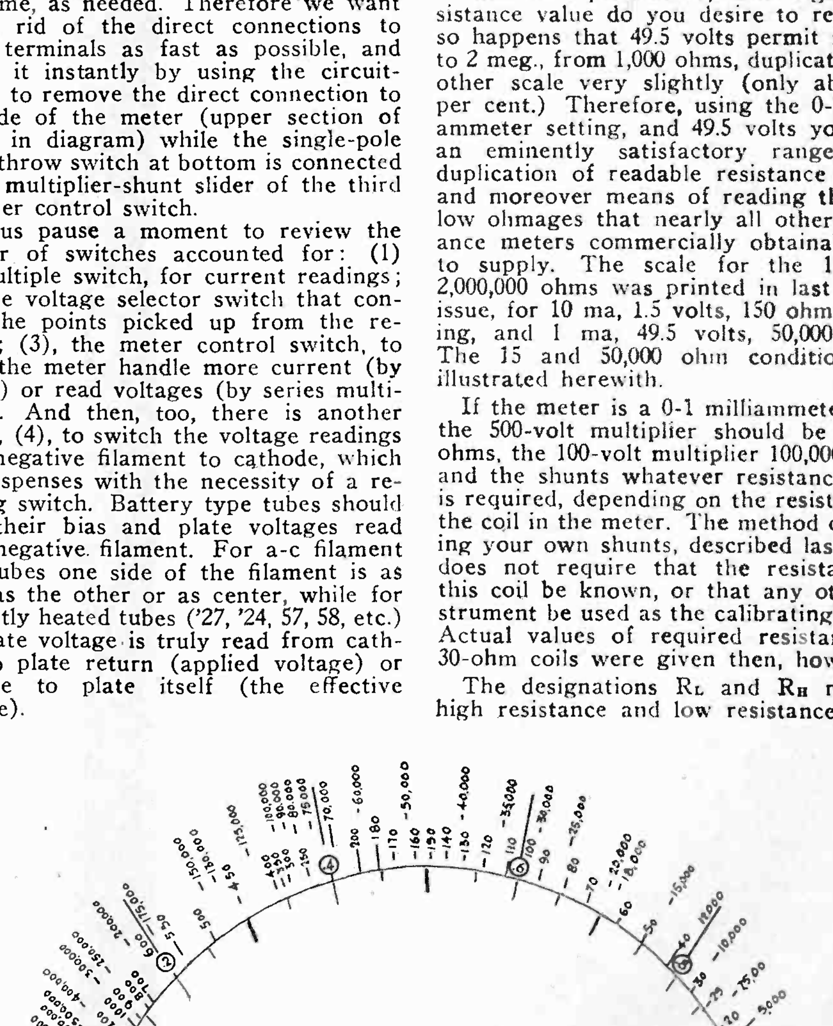
It is not known what demands the constructor may put on the resistance measuring device, but if most builders are of the same mind as the writer of these lines they will provide a No. 6 dry cell to furnish 1.5 volts, use a 15 ohm-series limiting resistor, and use the meter shunted for 100 ma, whereby very low resistance values may be read. Much current must flow if low resistance values are to be read, and the situation just outlined enables readings from 1 ohm to 5,000 ohms. The scale was printed last week, issue of October 15th, on page 11, in an article that also told how you may make your own shunts very easily.

How High?

The next question is, how high a resistance value do you desire to read? It so happens that 49.5 volts permit reading to 2 meg., from 1,000 ohms, duplicating the other scale very slightly (only about 15 per cent.) Therefore, using the 0-1 milliammeter setting, and 49.5 volts you have an eminently satisfactory range, little duplication of readable resistance values, and moreover means of reading the very low ohmages that nearly all other resistance meters commercially obtainable fail to supply. The scale for the 1,000 to 2,000,000 ohms was printed in last week's issue, for 10 ma, 1.5 volts, 150 ohms limiting, and 1 ma, 49.5 volts, 50,000 ohms. The 15 and 50,000 ohm conditions are illustrated herewith.

If the meter is a 0-1 milliammeter, then the 500-volt multiplier should be 500,000 ohms, the 100-volt multiplier 100,000 ohms, and the shunts whatever resistance value is required, depending on the resistance of the coil in the meter. The method of making your own shunts, described last week, does not require that the resistance of this coil be known, or that any other instrument be used as the calibrating device. Actual values of required resistance for 30-ohm coils were given then, however.

The designations R_L and R_H refer to high resistance and low resistance.



This resistance scale, 1 to 5,000 ohms, for 0-100 ma, 1.5-volt No. 6 dry cell, and 15 ohms limiting resistor, and 1,000 to 2,000,000 ohms, 0-1 ma, 49.5 volts, 50,000 ohms limiting resistor, will fit directly above popular type meters.

Radio University

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Tapped Coils

WOULD IT be possible to cover other than broadcast frequencies on a small a-c set, using switching device? The broadcast results must be good, and the short-wave results at least fair.—C. V., Tampa, Florida.

Yes, you may use the switching device shown in Fig. 1033. This is one of the best methods, in that there is no short-circuiting of the coil and no dead-ending, both of which introduce heavy losses. The objection to this system is that it does not switch the primaries, hence there might be some oscillation in the r-f amplifier on short wavelengths, and the corrective would be either exact resonance (at which there is no feedback) or some detuning, which reduces the amplification. For 125-turn secondaries on 1-inch diameter, No. 30 wire taps might be 100th, 117th and 122d turns.

* * *

Short-wave Selection

HAVING DECIDED to build a short-wave set at minimum expense, please let me know if tuned radio frequency coils will be all right for the intermediate frequency, what frequency to use, and also whether I should put a manual trimmer across the oscillator as well as across the modulator.—P. L. R., Boston, Mass.

You may use the t-r-f coils. If the receiver is to be for short waves only, then we suggest that you use a high intermediate frequency, two stages (three intermediate coils), selecting such frequency as is suitable at your location. About 1,550 kc may be tried. The coils may be the type commonly used for 0.0005 mfd. tuning, but instead of large tuning condensers across them, of course use small ones, such as equalizing condensers, of not more than 35 mmfd. maximum capacity. You may put a manual trimmer across either modulator or oscillator, but hardly across both. If the manual adjusting condenser is across modulator the receiver may be calibrated, otherwise the benefit of calibration (with that condenser across oscillator) will be sacrificed. For such a high intermediate frequency of course separate main tuning condensers are preferable from the viewpoint of results, as it becomes too difficult to compensate for the first and second wave bands (lower frequencies) and padding is to be discouraged under such circumstances. The reason is the considerable difference then between the modulator and the oscillator frequencies. If you use a lower intermediate frequency (400 to 465 kc), use standard 0.00035 mfd. coils and tune the secondary with the 350-450 mmfd. condensers normally used for padding. Then, too, the circuit may be padded tolerably well, and especially well if the manual trimming condenser is across the modulator. Also, the oscillator secondary need have only a few less turns than the modulator secondary for the first (low frequency) band, while the other secondaries may be equal.

* * *

Meter Safety

IN BUILDING a tester please let me know how I can safeguard my meter against damage. I desire particularly to avoid cutting in the meter when as a current meter when the tester is for voltage setting.—O. P., Beloit, Wisc.

A fuse would be the only way to insure absolute protection of the meter, but as fuses are not generally obtainable for less than 10 ma they would be useless on a meter of the sensitivity of 1 milliampere or so. There is no other absolutely certain way of protecting the meter, because it would be possible always to use a current setting for the meter and at the same time have the tester at a voltage setting. If a pilot lamp is put in parallel with the line from the meter to the tester, and a closing switch put on the meter, all tests at first to be made with meter shorted (switch closed), then the lamp would burn out on such a short as you describe (current meter at voltage setting). At least after some lamps were destroyed this way, at only 10c. each, you'd become familiar with the caution necessary. Then in wiring the tester you could provide for all current readings at the high current setting of the current meter (say, 100 ma or more), lower current readings obtainable only by depressing a key. This is relative protection in addition to the foregoing. Just as a meter you hold in your hand may be incorrectly connected, so as to be ruined, so may the same result obtain in a tester.

* * *

Oscillator Protection

FOR PROTECTION of the line fuse in my home please let me know how to construct an oscillator that uses a-c on the plate, and thus has cathode connected to one side of the a-c line. If this happens to be the hot side (as picked up by the wall plug, to which no particular polarity attention is usually paid), then if a ground wire touches the chassis, condenser, etc., there'd be a short of the line, if the line were grounded, as I believe it is.—T. W. E., Roanoke, Va.

You might fuse the oscillator with a 2 ampere fuse of the automobile cartridge type, and also put the oscillator in a wooden box, using an insulated dial. If the dial is of the type that requires an escutcheon, take care that this escutcheon is not conductive to the chassis potential, as then the dreaded shorting might take place at the escutcheon.

* * *

Wave Behavior

DO RADIO WAVES pass through metal, as well as through everything else? Is vacuum a better conductor of radio waves than is the air? What is the ether? Please give its constants.—T. W. S., New Rochelle, N. Y.

Yes, waves pass through practically everything, but since the determination as to whether there is penetration or not is relative, depending on how much penetration is supposed, an unclear line of demarcation exists. Thus we would say that radio waves do not pass through steel walls that are erected, but they go right through the human body, through water, earth, wood etc. The best conductors of direct current are usually the best shields against penetration by radio waves. Vacuum is a better conductor of radio waves than is the air. It is not regarded as strictly safe to refer to the air as the conducting medium, for one reason because even more freedom of conduction results when the air is removed. So the medium through which the waves pass is conveniently referred to as "the ether," nobody knowing exactly what that is, so we can not give you its constants.

* * *

Phono Connection

IN CONNECTING my phonograph pickup to my receiver, may I put it across the audio grid leak? Will this have any bad effect?—U. S., Aurora, Ill.

The connection you suggest is all right. However, there should be more than one stage of audio following, that is, at least two tubes, rather than only one, should amplify the output of the phonograph pickup.

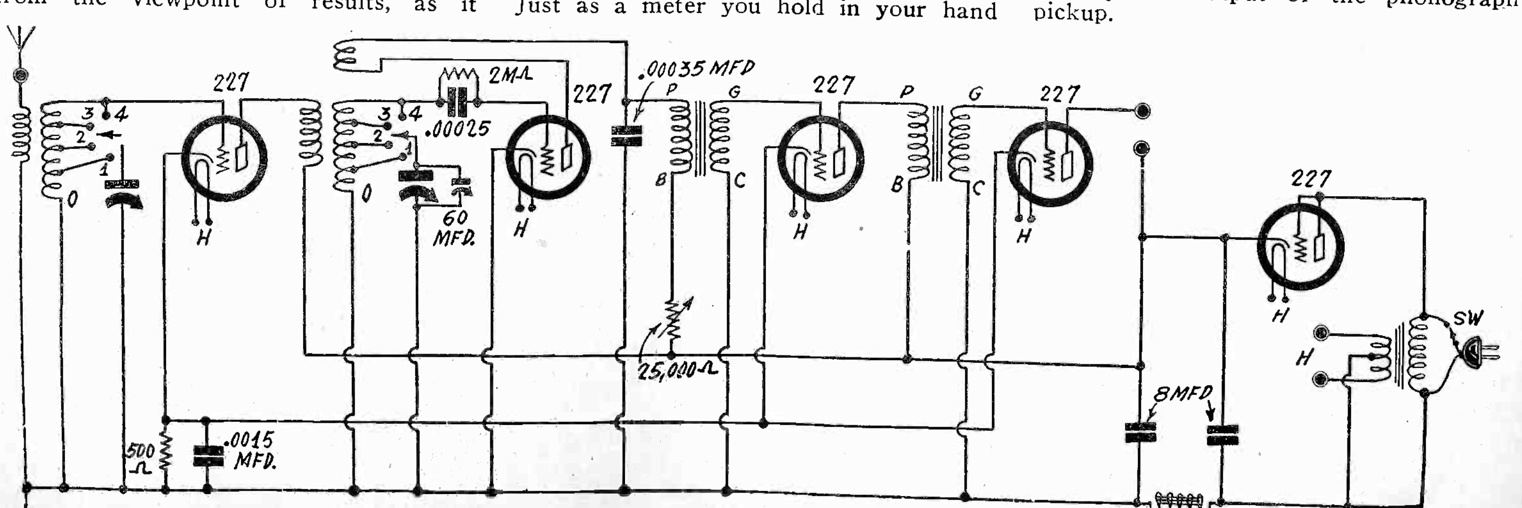


FIG. 1033.

Tapped coils used in a broadcast receiver to bring in short waves fairly well.

Battery Set

PLEASE LET ME KNOW whether a potentiometer with grounded pointer may be used as well as a volume control, and show how it is done; also show diagram of a battery t-r-f set using this.—O. P., Salt Lake City, Utah.

Five tubes are used in the diagrammed receiver, Fig. 1034. The volume control is as you request, and it is an acceptable method, although we know of no completely satisfactory volume control. Screen grid tubes are used for r-f amplification, general purpose tubes for detection and audio amplification, and a power tube as output. The filament resistence value will depend on the tubes used, but for 232, 230 and 231 R2 should be 2.7 ohm. This value can be attained by a chassis-mounted 6-ohm rheostat, which also can be adjusted from time to time (weeks apart) as tube and battery conditions change, so as to keep the filament voltage at 2 volts. R should be more than 5,000 ohms, C6, C7 and C8 are 1 mfd., and C5 is 0.001 mfd. The voltages are imprinted.

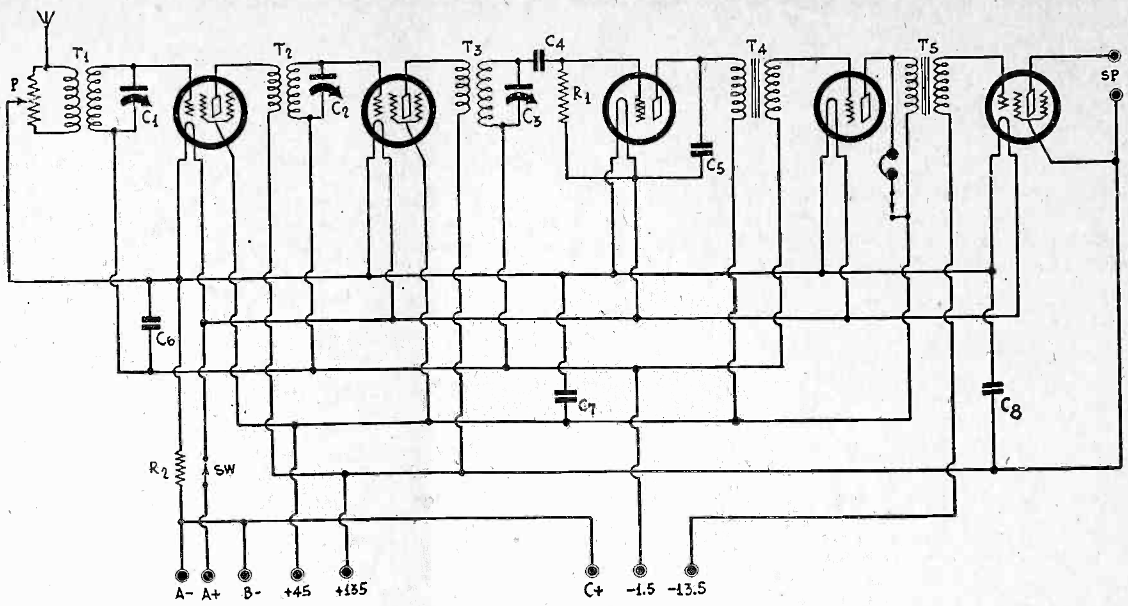


FIG. 1034.
Battery-operated receiver with a potentiometer volume control with pointer grounded.

* * *

Question of Law

IF A MAN PLAYS his radio so loud that passersby can hear the signals, and these happen to be police alarms, would that constitute a violation of the radio law respecting the disclosure of point-to-point communications?—Y. W., Kearney, N. J.

We can not undertake to construe such legal effect, as it is a legal rather than a technical radio problem. However, it is our opinion that such action would be construed as constituting the passersby as original listeners who themselves are bound by the secrecy rule, as they seem to be in the same category as would be guests in the radio owner's home. We suggest that you address your communication to the Legal Department of the Federal Radio Commission, Washington, D. C.

* * *

Resistor Choice

IS IT PREFERABLE to use an inductive or a non-inductive resistor for broadcast frequencies, in the cathode and other biasing circuits of radio frequency amplifiers and detectors?—T. R., Delta, La.

For broadcast frequencies it makes little difference if the resistor is inductive or non-inductive, such an example of the latter being a metallized resistor. For short waves, however, including any frequencies above the highest of the broadcast band, the preference is strongly for non-inductive resistors, even though there are large bypass condensers in these biasing circuits.

* * *

Ohm's Law

OF COURSE I am asking you to do something that you've done perhaps many times before, but as I am a beginner I would like you to give me a simple statement of Ohm's law for direct currents. I promise you in return to learn it thoroughly and not to bother you about it again.—H. C. M., Belle Harbor, N. Y.

We are glad to state Ohm's law for the nth time. It is something every beginner should learn just as soon as possible. Every one is the merest beginner until he has learned it, and since it is so simple nobody can complain it is too hard for him. That would be a sad confession indeed. So here goes. Ohm's law relates the resistance, voltage and current in a direct current circuit. The usual recommendation is that the values be expressed in amperes, volts and ohms, hence fractional values would be expressed as decimals. The resistance in ohms is equal to the voltage in volts divided by the current in amperes. What is the resistance when the current through it is 10 milliamperes and the voltage drop across it is 2 volts? The unknown resistance, R, is equal to 2 divided by 0.01, or 200 ohms. The current in amperes is equal to the voltage in volts divided by the resistance in ohms. What current flows through 18 ohms when the voltage is 6 volts? E (the symbol of I current) equals 6 divided by 15, or 0.4 ampere. The voltage in volts equals the resistance in ohms multiplied by the current in amperes. What is the voltage when the resistance is 24 ohms and the current is 5 amperes? E (the symbol of voltage) equals 120 volts. When Ohm's law is known, volt current meters can be calibrated by computation, when the voltage and resistance are known, as they always are, because provided by the experimenter, or because he can readily ascertain either.

* * *

Tracking Condensers

DO MANY receivers use tracking condensers (that is, oscillator tuning condenser of inherently correct capacity), instead of the padding method, and if not, why not?—T. D., Butte, Mont.

No, not many receivers use the tracking condenser. The reason may be the restriction placed upon the inductance of the oscillator's tuned winding, as this would have to be held very close, hence it may be a coil problem. In other words, it seems it is easier to adjust capacity (as by the padding method) than to adjust inductance (by the tracking condenser method). Still, there is little leeway as to inductance even when, by the padding method, the capacity may be adjusted.

* * *

Grid Leak Values

WILL YOU PLEASE let me know what has become of the theory that the grid leak should have some definite value in respect to the stopping condenser in resistance-coupled amplifiers, and that the higher the leak value the better the low-note response? I ask this in the light of recommendations of tube manufacturers that certain tubes be used with low values of leaks. For instance, the pentodes usually should have not more than 0.5 meg., and one new tube is supposed to be limited to 10,000 ohms as maximum grid leak value.—T. W. Q., Danbury, Conn.

The requirement of the leak value in respect to the stopping condenser takes into account only the circuit formed by these two adjuncts, and does not include the effect of grid current and of audio frequency feedback. Thus if there is considerable grid current likely, then the leak value has to be as low as the lowest limit you expressed, and moreover if there is motorboating, a form of a-f feedback, then regenerative effects on the low frequencies have to be considered, and the leak value made low enough to stop the audio oscillation. There is no good reason why the low leak value should not be tolerated under such circumstances, because just below the point of oscillation the low-note response will be as strong as the system permits without oscillation, and that is the limit of all systems. With single stage resistance audio, the most frequently used pentodes will stand leak values in the order of megohms.

* * *

Use of Odd Multipliers

AT PRESENT I have quite an accumulation of multiplier resistors of the accurate wire-wound type, but not suitable for meters that I have. Since I am desirous of making resistance measurements, and indeed of making a set tester on the resistance measurement principle, how may I press some of these multipliers in service?—J. O. P., Canton, China.

If you will build a small B supply you may use these multipliers. Standard multipliers are made for voltages of 1.5 volts or multiples thereof. However since from a B supply you may obtain any voltage, you may select the voltage that suits the purpose and the multiplier, which is now used as a series limiting resistor. For instance, if you have a multiplier of 1,200 ohms, and a 0-1 ma, you may use 1.2 volts, and with terminals for the unknown shorted, the meter would read full-scale deflection. It is necessary to know the full-scale deflection current of the meter. If it is a 0-1 ma then the full-scale deflection is 1 ma and the resistance of the meter used as voltmeter is reckoned as 1,000 ohms per volt. If the meter is 0-1.5 ma it has 666.67 ohms per volt, if 0-2 ma, 500 ohms per volt, etc. Hence for every volt applied, for full-scale deflection, there would have to be 1,000, 666.67, 500 ohms etc., in the multiplier.

A THOUGHT FOR THE WEEK

"CAUGHT WITH THE GOODS!" is the way the authorities expressed it recently when they arrested several stock salesmen in a room in a Chicago hotel. These men were accused of selling stock in a television concern, and using high-pressure methods in so doing.

RADIO WORLD *has frequently warned its readers about buying television stock at this time when television is very far from being a commercial success, although technically it has made vast strides toward ultimate utility. We still advise our many thousands of readers to consult their bankers before investing in stock in any television company; let us repeat—BEFORE investing! The smartest banker can't help you after you've taken the fatal step.*

RADIO WORLD

The First and Only National Radio Weekly

Eleventh Year

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

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

Education by Air

EDUCATION by radio is admittedly experimental, and the educators are striving hard to accomplish as much as possible under most difficult circumstances. Time on the air was one problem, but really only a small one. Educators may feel that advertising programs occupy too great a percentage of the broadcasting hours, and moreover leave the less desirable hours for the educators' purposes, but without a suitable financial foundation there would be no radio, hence no education by radio. Surveys have been financed by philanthropists to determine what the situation is and how best to promote educational ends, and besides money has been provided for buying time on the air for educational programs. These efforts are in line with the continuation of the experiment, rather than with the present discovery of the solution.

Vast though the financial problem is, there is still a greater problem. It concerns the very worth of the programs intended to be educational, when weighed by the degree of success with which the avowed purpose is met. Classroom and laboratory instruction, with examinations, are the best that the educational system has been able to provide so far, but all the formal processes of education, save curriculum and in some instances laboratory work, are admissions of shortcomings of civilization. Formal education is as much a concession to absence of will power or the faculty of concentration as it is a curtsey to the diploma as an evidence of knowledge.

Take the school of any grade above that of the primary and its basis of existence is classroom instruction. For the successful completion of specified courses diplomas are awarded. In the world at large the diplomas pass somewhat as recommendations required by many who have jobs to give.

There is very little indeed taught in the secondary and the collegiate courses that can not be learned from books, without school attendance. The quest for knowledge is not sufficient unto itself, for there must be some curriculum, consisting not only of choice of subjects but also of an order of procedure and the appraisal of the goal, and of such assistance even home study is in full need. Beyond that the book can outdo the classroom, for nothing that is said or pictured in the classroom can not be set down in a book as a fact or an illustration. Aside from curriculum, there must be something that requires the classroom instruction, and that something must be the lack of will power to derive the information from a book alone.

The fact of such a low order of will power and ability at concentration requires that the educational system be predicated upon it, hence parents must finance the shortcomings of their progeny long after the children have learned to read and write and have arrived at an age when they could broaden their knowledge by their own efforts alone were those efforts intense enough.

Since the entire educational structure, aside from the early teachings in childhood, and the laboratory courses later on that can not be duplicated in the home because of the great expense of the equipment, is predicated on a tacit acknowledgment of a low order of attentiveness, concentration and determination, it is hard to imagine the radio as a means of education equalling the achievements of the classroom. Teachers perform their important work in classrooms before groups of pupils or students largely reluctant, and thus do a good share of the work of the students themselves. The student is after a diploma and the teacher has to do too much of the work of earning it for him.

That classroom study is not altogether imperative (except to obtain the coveted degrees) is proved sufficiently by the growth of correspondence schools. These courses are virtually full proof of the acquisition of knowledge from books, as the correspondence schools have their teaching books and no classrooms, and thus the student can lean less heavily on the faculty. The student himself must learn to do a greater percentage of the work to earn whatever diploma is coming to him.

It simmers down to a gradation of the amount of work the student is anxious to do, or the amount of enthusiastic determination with which he invests his objective, plus application and patience. What the student lacks of these the teacher must make up, and therefore the more difficult the course, the disproportionately larger the burden on the teacher, as the student's contribution is about the same independent of the nature of the course. Besides, the teacher must take up the slack due to student ineptitude for some subjects, which by the exclusively bookish method would have to be contributed only by the student, in terms of still greater concentration and stiffer application.

Therefore if the most advanced system of education is a concession to the failings and quasi-indifference of students, many of whom are obeying the parents' wishes or compulsory attendance laws, rather than their own desire, how much can be expected of a system of education by radio, where listening may be done under circumstances rather distracting than consuming, where the continuity of listening is by no means assured, and where, perhaps most important of all, there is no check-up on whether the aim has been achieved by the educator? Merely sending out the program and dismissing the subject from mind and memory is not education but sheer adventure. Where is the broadcast educational program that has its concomitant of examination of all the students to determine whether the lessons have been learned? The undertaking would be so vast that the very foundation of success—a true measuring rod—is dismissed as impractical.

To meet this situation in part some branches of education work by radio look to the reception of the programs in classrooms of formal schools, and examinations conducted by the class teacher, but this is education by radio only in the narrow sense that radio has brought the voice and personality of the teacher to the classroom. It is not education by radio in its larger sense of teaching persons in their homes, and more particularly teaching adults, since the attendance schools serve the minors.

Compare, then, compulsory attendance with voluntary listening-in; rigid written and oral examination as against no examinations whatsoever; the discipline of school life as against the varying environment of the home; the private philanthrophy or advertising sponsorship of education by radio as against the public tax-financed elementary schools and the privately endowed and parent-financed colleges and universities.

It becomes increasingly obvious that for education by radio to be the success that it deserves a vast new system of education, based on new methods, with auxiliary home study from books on a far larger scale than at present. The sheer enormity of such an enterprise at once suggests that private undertakings can not be expected to cope with such a project, and therefore if education by radio is to be a reality commensurate with the older systems of education it, too, must be similarly financed.

Price Mention

THE mention of price in sponsored advertising on radio programs has done no violence whatever to the broadcasting structure, as the amount of time devoted to sales talks, and the frequency and even chronology of price mention, are well controlled by the two large chains that caused a surprise when they allowed such mention at all.

Radio comes so close to the people that no matter what change is instituted there is always opposition, although if the change is a wholesome one the opposition wears itself out.

It is hard to understand, however, on what particular ground objection is voiced to the frank mention of price, as compared with the suggestive method that prevailed in the past. That a product costs no more than "an ordinary package of cigarettes" or "a ride on the subway" leaves nothing to the imagination, and why there must be circumlocution to convey the ideas of fifteen cents and five cents is quite mysterious.

Certainly it is more wholesome to have the price stated as a price, rather than to have the price wear a thin disguise. It is better to do a thing and acknowledge the doing of it, rather than to do it in a manner shackled with the pretense of not having done it. Prices are not uninteresting to listeners, and so long as there is no more to the price mention than now prevails on the two big chains the situation is well met.

More Colonies!

OUR own domestic conferees, in one form or another, have enough difficulty agreeing on anything. For instance, even political conventions are marked by disagreement, and one is surprised sometimes that any candidate at all is named. Therefore it is not so surprising that the delegates to the International Radio Conference at Madrid found themselves at loggerheads over the distribution of voting strength. The United States and most of the other nations wanted one vote to be counted for each nation, but Great Britain, France and Holland demanded one vote for each of the colonies.

If any rule is permanently adopted whereby the number of colonies directly determines the number of votes, we are in favor of the United States acquiring for itself a nice stack of colonies somewhere, for, come what may, our voting strength at the radio conferences simply must be great enough to win for us practically everything that we want. Otherwise what happens to our much-vaunted leadership in radio, and what will our delegates tell the folk at home when they return from a long series of parliamentary defeats at the hands of multi-colonied countries?

STATION SPARKS
By Alice Remsen

A Friend

For "The Voice of Experience" WOR, every week-day at noon.

Because I am blessed with a friend,
This world is a wonderful place.
My troubles and cares seem to end,
Whenever I look on his face.
The sky is a lovelier blue,
The sun shines much brighter each day;
Life takes on a rosier hue,
Since he has come singing my way.

Our innermost thoughts are the same,
We each read them just like a book.
We don't have to call things by name,
We know by a smile and a look.
I think of all riches and power,
Or honor which this world may send,
Whatever our guerdon or dower,
There's nothing so great as a friend.
—A. R.

* * *

AND IF YOU LISTEN IN TO "THE VOICE OF EXPERIENCE," you will feel that you have found a friend. He is a man with an all-embracing friendliness. If you have troubles, write to him and he will help you solve your problems. His advice is always sound and good, logical and philosophical.

* * *

The Radio Rialto

It may or may not interest my readers to know that Fall has come to New York. . . . Woke up this morning with a chilly old rain pouring in the window. Oh, gosh! . . . Makes no difference; must don the rubber galoshes and hie me to the city. . . . Just to be mean I'll take you right along with me, rain or no rain. . . . Well, here we are on a nice, sloppy rialto, but, do you know, there's something about this weather I like—it reminds me of dear ol' Lunnon'. . . . First person we meet is Irving Conn, the maestro of Arrowhead Inn, whose sweet music is heard three times a week over WOR. . . . Irving is a nice lad; he stands in the rain long enough to tell me that there were big doings up at Arrowhead on October 9th. Two hundred of the most beautiful girls in the world, and a half hundred European and American stars, feted Earl Carroll—the occasion, the tenth anniversary of his "Vanities." And ain't that sumpin'! . . . We trudge along and almost fall into the arms of Billie Dauscha, the tall willowy gal with the big brown eyes. Billie is doing good work with Andy Sanella on WJZ, Wednesday nights. . . .

Well, let's go up and see Irving Bibo, the nice little songsmith. . . . There he is, seated at a piano. . . . "What's doing, Irving?" . . . A new song. . . . Sounds good. . . . Not quite finished. . . . You'll hear it on the air in a couple of weeks. . . Title, "It's Tremendous." Listen for it. . . . From Irving's we go down two flights of stairs—I'm wrong, it's only one flight . . . to Ager and Bornstein's. . . . There we find Milton Ager. He's concentrating wildly, trying to write some catch lines for a new song. . . . Little Jack Little is giving him encouragement and so is Ben Bornstein. . . . Jack, as you probably know, is featured over WABC every day except Sunday at 9:00 a.m. and also Fridays at 10:30 p.m. Jack is a clever lad; he sings and accompanies himself, he writes songs, too, and has a new one with Irving Berlin, written in collaboration with Freddie Coots; title, "I Wouldn't Trade the Silver in My Mother's Hair for All the Gold in the World;" very nice sentiment, eh, what! . . . S'posin' we hop a cab over to WABC. . . . There in a jiffy. . . . Plenty of news flying around here. . . . First of all, Jim Doane, Morton Downey's pilot, informs us that Morton has returned to radio; he may be heard every Friday at 9:30 p.m., as the star of the weekly program "To the Ladies," with Leon Belasco's orchestra. . . . There's Eddie Wolf, who tells us that Vaughn de Leath, "the original radio girl," now has an augmented schedule which includes two periods for children; if you like Vaughn's work, and I'm sure you do, you may hear her sing popular songs, Mondays, at 6:30 p.m.; Fridays, at 7:15 p.m.; and Saturdays, at 10:45 p.m. Her juvenile listeners may hear her sing those cute little childish songs on Wednesdays, at 6:00 p.m.; and Thursdays at 5:45 p.m. . . . We also hear that the Canada Dry program, with Jack Benny as featured attraction, is switching over to Columbia, but up to the present writing name of band has not been divulged; rumor has it that Ted Weems will be brought into town. . . . Date of premier, Sunday, October 30th, program will be heard twice a week, Thursdays at 8:15-8:45 p.m., and Sundays at 10:00-10:30 p.m.

The mysterious X Sisters made their debut over WABC last week. . . . New to American listeners, but plenty "mike-proof;" they gained their experience over in Europe. Their identities are to remain a secret, but I'm not breaking faith when I tell you they are easy to look at; one is a redhead, another is a brunette and the third has light brown hair. . . . While I'm in the neighborhood, might as well tell you that I listened again to the "Evening in Paris Mysteries," and must say, in all fairness to Mr. McKnight, author of the series, that they have improved a great deal. I'm sure if you're fond of thrills and listened last week, your hair must have stood up straight when Patricia and her escort discovered the "Cat." . . . Everyone along the Radio Rialto is sorry to hear that Jack Foster has resigned from the Radio Editorship of the New York "World-Telegram." . . . He was an unbiased critic, with a whimsical sense of humor, which often cropped out in his column. Jack had been fed up with radio for a long time and will probably be happier in his new job, that of Feature Editor on same paper. James Cannon, who used to cover Broadway for the W-T, takes over the radio chores. . . . Somebody relieved Elsie Hitz, (who plays Patricia Barlow on the Evening in Paris Mysteries) of twenty dollars the other day; it was taken out of her purse; I ventured the suggestion that "The Octopus" was the miscreant, and Elsie laughed that delightfully throaty gurgle of hers, and said she'd get "Cy" to find out.

Think we'll slip over to 711 and see whats' doing over there. . . . Want to come along? . . . Righto! . . . Here we are! . . . Always meet someone of consequence in the elevator at NBC. . . . Mr. Aylesworth nods "Hello" and Frank Luther grins. . . . By the way; the latter young man was ordained a minister some years ago. . . . Off at the thirteenth floor; no, we're not superstitious . . . and right away someone tells us the story about Madame Sylvia, GE Circle artist: It seems that a celebrated New York actress had grown a little heavy during vacation; she telephoned Madame Sylvia and asked how much money she wanted for taking off fifteen pounds in three weeks. "One thousand dollars for ten treatments," replied Sylvia. There was dead silence for a moment, then in carefully measured tones the actress replied: "Never mind, Madame Sylvia, I've lost ten pounds already." . . . If you want to know where the clever Georgia Backus has been hiding herself, she is at NBC; just this minute she passed by; and if you'd like to hear her, tune in on the Big Ben Dream Dramas, WEAF, Sundays at 5:30 p.m. . . . Another story comes our way. . . . Ed Wynn, Texaco's Fire Chief, goes to bed every night with a roll of bills under his pillow; he says it's so nice to know that he always has money to retire on. . . . Everybody around here seems to be glad that the Sherlock Holmes dramas have returned to the air; the majority of radio artists are Sherlock Holmes fans. Leigh Lovel's and Richard Gordon's speaking voices are very fascinating. . . . And I must tell you that Edith Meiser, who dramatizes all the Sherlock dramas, is also preparing the Dromedary Caravan series of Arabian desert romances. Joseph Bell, the Sherlock director, is acting in that same capacity for Dromedary, and Lucille Wall, well-known to radio audiences as "Bibs," "Polly Preston" and "Barbara Wayne," plays the young American girl; Alfred Shirley plays her lover; and H. Cooper-Cliffe, a woman-hating Englishman gone native. These romances may be heard each Monday, Wednesday and Friday, at 5:15 p.m. over WJZ. . . . There's John Fogarty, the romantic looking Irish tenor, who tells us that he has resumed those "Sweetheart" programs with Ruth Jordan, sponsored by the Manhattan Soap Company, each Wednesday, 11:45 a.m. WJZ. . . . Don't you think we've gathered enough news? . . . Out into the rain again;—but guess what we have in store—a nice hot mess of Octavia's Irish stew, so we should worry about a little rain.

* * *

Biographical Brevities

ABOUT BILLY HUGHES

Billy Hughes, formerly known as Billy Hillpot, was born in Redbank, New Jersey, in 1904. . . . In high school, Billy attacked and conquered the banjo, ukulele, and guitar. He organized a band to play at local socials. Then he went to Rutgers, made the Varsity baseball teams; organized the Rutgers Jazz Band; discovered he had what sounded like a voice and then starred in the Glee Club. . . . Billy had every intention of becoming a wolf of Wall Street, but his Glee Club performances won the attention of an advertising agent, and the ensuing radio performances drew him to the attention of Ben Bernie; the Old Maestro proffered a contract and Billy accepted; thus he was drawn seriously into the entertainment world and has never yet succeeded in extricating himself. . . . Billy did vocals, played banjo and acted as "my decoy" for the Old Maestro. He is one of the tallest baritones in captivity, and is one of the oldest, yet youngest, stars of the radio, for at the age of 28 he has seven years of microphone experience behind him.

When he first became acquainted with the theatre, Billy knew nothing of tradition and whistled in dressing rooms without a qualm; now, after eighteen talking shorts, the Follies, and innumerable radio programs, he knows better. . . . He played a farmer boy opposite the Boswell Sisters in "Close Farmany," and explains that Martha was so terrified at the squealing assortment of pigs, ducks, and chickens that she would occasionally give way and jump on the piano.

One of Billy's most treasured memories is of Knute Rockne. Whenever the Notre Dame team came East, he and Knute would stay up half the night singing. Billy accompanied Knute on the guitar. . . . Billy is hearty and athletic. . . . Is an epicure. . . . Wears what he calls "silent colors," grey and blue; positively no stripes. . . . Lives in the country because he likes to wake up and see trees. . . . Hates rainy days. . . . Owns no animals or wives. . . . Good-looking? Oh, yes! Very . . . Strong, but not exactly silent. . . . That's Billy Hughes.

Ten Years Ago This Week

The October 21st issue of RADIO WORLD ten years ago contained the following:

Front cover illustration: The reproduction of a photograph showing Raymond F. Guy, of WJZ, before a bank of 50-watt transmitting tubes. In one hand he held one of these large tubes and in the other hand a small receiving tube. The caption stated that the transmitting tubes cost $120 apiece.

An editorial announcement, occupying the first text page in full, suggested National Radio Week, for November 26th to December 2nd, 1922. This was the first suggestion for such an event, and eventually the event became an annual eventuality.

How to improve existing radio sets, as compared to vexations over designing entirely new circuits, was discussed by Charles White, while Fred Charles Ehlert had an article on how to make the very best sort of a ground and connection thereto.

The Aesthetic Side

A woman writer came forward to tell how a set was installed in her home, thus showing the early evidences of the aesthetic side of radio, its part in interior decoration and the intimate surroundings of family life. These wide phrases are our own, and we're not so sure they mean much, yet they fit in well with radio aestheticism, we believe.

"One-Tube Regenerator Hookup for Loud Sigs," by Harold Day, had nothing to do with smoking, but presented a variometer-variocoupler set in conjunction with a vacuum tube circuit; plenty of binding posts, a rheostat or two and the inevitable tap switch.

As if in the vein of the present department, there was a photograph showing F. Clinton and W. Guillet (names as taken from the caption), one holding a receiver variocoupler of the day, the other "a loose coupler of twelve years ago." That meant there was some loose coupler work going on in 1910.

"Compactness is the watchword in radio as in all other up-to-date matters," the readers were informed in the caption. Then the old massive loose coupler and by comparison the "modern vario coupler" were mentioned with the same air of haughtiness with which we now mention the affairs and utterances of a decade ago.

Where the Compactness?

But what we do not understand is the "compactness" that was supposed to be the watchword of the day, when all over the pages of the issues of ten years ago were photographs and diagrams of receivers, showing front panels sometimes as much as six feet long, and often installations that consisted of (a) a tuner; (b) an audio amplifier; (c) a storage battery, three B batteries and a C battery; and (d) a charging device. We have told in previous reviews about some of these, one of which had twenty-seven gadgets on the front panel.

Carl H. Butman reported from Washington that broadcasting was up 500 per cent. in a year, on the basis of number of stations, and there were then stations in every State of the Union.

Reliability of range of radio signals was discussed by John Kent, and, believe it or not, "the importance of a good aerial" was stressed.

"The Radio Primer" set forth information in definition form principally, while an article dealt with "The Theory of Radio Communication," telling how waves are sent and received, which we could reprint today without changing a line, and may do surreptiously some time when copy is scarce.

The Illustrations

A page of hookups adorned another page, or rather it was the same page that the hookups were on, while the center spread had reproductions of photographs showing a fellow testing a storage battery with an hydrometer, "the only positive and yet the simplest method of determining the condition"; the U. S. Langley, first radio-equipped airplane carrier; and the usual assortment of pictures of men and boys turning dials, looking at the rear inside views of receivers and wearing earphones.

"New circuit for experimenters" was a caption over one diagram, thus showing that in those good days even the most industrious writing experimenters did not have time to try out all the hookups that came to mind, and thus wrote about experimental circuits.

Many advertisements, some publicity notices and a half-page back cover advertisement consisting of only seven words, no more, no less—"Be a Booster for National Radio Week"—made up the rest of the issue.

It must have been just as exciting to get out the issues in those days as it is to get out the present issues in which the reports concern a much better stabilized industry, include no more trick circuits and only a few diagramatic errors at no extra charge, and far more greatly detailed accounts of what are deemed the more important of the subject-matters that cross the managing editor's desk and mind—mostly desk.

Literature Wanted

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

R. R. Smith, 4902 Broadway, Indianapolis, Ind.
Kenneth McDaniel (Service Man), 1108 Hodges St., Lake Charles, La.
Elvin F. La Salle, Box 708, Chesterville, Ont., Canada.
H. C. Johnston, Box 23A, State College, Miss.
I. C. Stickley, Radio Repair Shop, 1908 So. Elm., Pittsburg, Kansas.
F. G. Taylor, Box 186, Covington, Tenn.
Wm. Gordon, Route No. 1, Yakima, Wash.
Fehr Kellner, 703 Rubel Ave., Louisville, Ky.
R. L. Hegg, 1816 N. Mayfield Ave., Chicago, Ill.
C. E. Neff, 36 Paterboro Street, Detroit, Mich.
J. N. A. Hawkins, 19th Ave. and Sloat Blvd., San Francisco, Calif.
C. M. Henderson, Box 1102, Carmel, Calif.
A. B. Hanke, Carmel, Calif.
James W. Turner, 100 Highland Ave., Tuckahoe, N. Y.
Arthur Remme, Kenneth, Minn.
Wm. De Mosh, 60 Park Ave., Albany, N. Y.
Mike Celenza, 2114 So. 8th St., Philadelphia, Pa.
O. L. Casto, Box 365, Sta. B, Charleston, W. Va.
Carl Rader, 1702-5th Ave., Charleston, W. Va.
Gordon R. Coston, Butterfield, Ark.
B. B. Turner, 1526 Des Moines Ave., Portsmouth, Virginia.
Jose J. Lopez, Cine Arco, Bacolod Occ. Negros, Philippine Islands.
Olin G. Humphries, 622 Gibson Street, Austin, Texas.
Magtangol F. Santos, 300 Nebraska Street, Manila, Philippine Islands.
Carl Holmes, 27 Park Ave., Monticello, N. Y.
W. E. Blain, 702 Maple St., Johnson City, Tenn.
G. Raccanyi, 5031 Fischer Ave., Detroit, Mich.
Carl J. Childers, 2134 Simmons Ave., Abilene, Texas.
Alfred Howard, 1500½ First St., Moundsville, W. Va.
Robert Kemp, 25 Riverside Pl., Walpole, Mass.
Roger Shannon, New Albany, Miss.

SHORT-WAVE CLUB

Kenneth L. Sargent, 3717-74th St., Jackson Heights, L. I., N. Y.
Harold McCullen, 1923 Madison Street, Saginaw, West Side, Mich.

Fine Displays Seen as Amplifiers Are in the Foreground

Laboratories that specialize in power amplifier systems in and around New York are showing some very fine equipment to fill almost any requirement at very attractive prices. One shown was a 3-stage 250 power amplifier of about 11-watt output, which will handle six to eight speakers and take care of an audience of over 4,000 for auditorium work. Another fine outfit of about 10-watt output and handling six speakers will take care of audiences up to say 3,000. A smaller outfit, of about four watts, is sufficient for stores, clubs and lodges, and consists of a 3-stage 245, to take care of 800 if need be.

There are types of great variety and to take care of every and all conditions. The thing to do is to learn just what you want to accomplish and send your requirements to a reliable establishment, and state if for a permanent installation. It might be well to know if you are limited by a price or if you mainly require a first-class job. When you know your conditions these establishments can supply you with the engineering data. A sketch or blueprint of the hall, lodge, or auditorium, with measurements and seating capacity if for indoor work, should be sent. There are a number of standard outfits of various capacities, ample to take care of all conditions. Circulars or booklets will give ample information and should prove very helpful to service men interested in public address systems or who want to increase their income. This is a branch of the radio industry that will pay rich rewards and one that has hardly been touched. The prospects in any town are practically unlimited.

—J. Murray Barron.

'PROGRAM VIGIL GOVERNMENT'S DUTY'—LAFOUNT

Washington

The suggestion that "some person" should be appointed to a United States Government post "to devote attention to the character of programs" was made by Federal Radio Commissioner Lafount. He gave out the following as representing his views, according to "The United States Daily":

The technical features of broadcasting have held sway. The time has now come to consider just what use this highly perfected system of communication should be put to in the public interest. The Government sets up requirements for equipment of a certain design which has to be put into operation, it requires broadcasters to maintain a frequency with an accuracy heretofore unheard of, and regulates the establishment of transmitters and their location. In short, from a technical point of view, it imposes requirements in great detail, and has a corps of supervisors engaged to see that the regulations are obeyed.

Not Attentive Enough

Yet the Government does not consider the use of this great instrumentality other than that it be used in the public interest. When educators are in a position to broadcast programs, the use of radio for this purpose is not at all clear. Even they themselves have no accepted formula. The whole question of the use has yet to be defined.

One of the reasons that little has been accomplished in this direction is due to the fact that there has not been developed a proper coordination of the various interests involved. This is an inescapable problem of the future. It might at some future time seem reasonable for Congress to consider the educational aspects of broadcasting.

Through the United States Office of Education, a system of coordination with States and localities might be developed. All the forces could be brought together and something tangible worked out as educational and the method of presenting set forth.

New Job Suggested

Commercial stations have taken care of entertainment and they have sponsored many educational programs of inestimable value. They are usually cooperative in broadcasting some educational programs, but few know what is in the public interest and how to present it. If some person could be appointed in the Federal Government to devote attention to the character of programs, then the solution of this increasing problem would be near.

GROWTH OF MARINE RADIO

It was a treat to listen in 1922, bad as the reception was. Today it is commonplace, good as the reception is. Perhaps too commonplace. But the sponsors don't think so.

Marine radio was growing in importance, although in its infancy. Ships were being guided over their courses by radio aid, and of course more and more ships were being equipped with sending and receiving apparatus, for emergencies.

Three Sisters, Husband in Family are "Hams"

Kathleen and Nancy Kirby, sisters, maintain home amateur stations at Douglas St., Balclutha, New Zealand. Their call letters are, respectively, ZL4DT and ZL4FN. Their sister, Mrs. Peggy Cameron, operates her station ZL4CL at 40 Cargill St., Dunedin. Her husband, Ewen Cameron, ZL4BJ, is one of New Zealand's best-known amateurs.

It was his enthusiasm that first induced his wife to become a licensed amateur in May, 1931. Her example was followed by Kathleen in January, 1932, and by Nancy in July. All three are members of the Rag Chewer's Club, a unique band of radio comrades who have qualified for membership by holding conversations of several hours duration with existing members.

A younger brother does not have his own station as yet, being forced to learn his dots and dashes under big sisters' tutelage.

POST ON BOARD STILL VACANT

Washington.

A policy of not filling vacancies, in instances where the activities of the Government will not suffer greatly, is expected to be followed by President Hoover in regard to one of the Federal Radio Commissionerships. Nearly two months ago the chairman of the commission, Maj.-Gen. Charles McK. Saltzman, resigned, but no one has been appointed to fill the vacancy.

The Radio Law authorizes a Commission of five, but there are only four Commissioners now functioning, due to the resignation. Moreover, early next year the term of Eugene O. Sykes, one of the four, expires, and it is possible the President will not appoint a successor in that instance, either. Recently the Shipping Board, authorized strength seven Commissioners, was reduced to five, so it is believed the Federal Radio Commission will be reduced from the authorized five to three.

The power to institute reduction of personnel was given to the President in the economy bill passed by the last session of Congress.

WRHM Opposes Sharing With College Stations

Washington

During arguments on the application of WRHM, Minnesota Broadcasting Corporation, for extension of facilities, the Federal Radio Commission was told that the station should not be compelled to share a channel with exclusively educational stations because their interests are incompatible and the requirement itself discriminatory and inequitable. WRHM is trying to divorce itself from three college stations, namely, WCAL, St. Olaf College, Northfield, Minn., KFMX, Carleton College, Northfield, Minn., and WLB-WGMS, University of Minnesota, Minneapolis.

The colleges, through counsel, argued that WRHM already utilized 80 per cent. of the time and that they could not extend their educational programs unless their time was increased to 29 per cent.

NEW PROPOSAL FOR SETTLING TRUST CHARGES

Washington

The suit of the Department of Justice against the Radio Corporation of America, the General Electric Company, the Westinghouse Electric and Manufacturing Company, the American Telephone and Telegraph Company, the Western Electric Company, Inc., RCA Photophone, Inc., the RCA Radiotron Company, the RCA-Victor Company, Inc., the General Motors Corporation, the General Motors Radio Corporation, the National Broadcasting Company, the RCA Communications, Inc., the International General Electric Company, and the Westinghouse Electric International Company, has been adjourned for two weeks or more to give the representatives of the defendant companies and the Government time to come to an amicable settlement out of court.

The point at issue is the cross-licensing agreements among the companies by which the Radio Corporation of America obtained patent rights. The Government contends that these are in violation of the anti-trust laws. A basis of compromise is being sought and the defendant companies have indicated how far they are willing to go.

Great secrecy is maintained in the case both at the Department of Justice and at the headquarters of the various companies involved in the suit. It has been rumored in radio circles that an entirely new method of solving the problems occasioned by the scattered ownership of essential radio patents has been proposed, and that this new method is along the lines acceptable to the Government.

Longer License Periods Proposed for Stability

Washington.

An extension of the terms of station licenses has been proposed by Commissioner Harold A. Lafount to the legal division of the Federal Radio Commission. He proposes that broadcast licenses be extended from the present six months to one full year, commercial licenses from one year to two years, and amateur licenses from one year to three years. This change, Mr. Lafount believes, would have a salutary effect on the radio industry and would stabilize broadcasting. Moreover, it would bring about a large reduction in the routine functions of the Commission's staff.

Mr. Lafount said:

"I believe the time is at hand when we should give stability to broadcasting by issuing licenses for at least one year. It would have a very salutary effect upon the entire radio industry. This action would bring about a commensurate reduction in the routine functions of the Commission's staff."

ANSWER TO CORRESPONDENTS

JAMES MINIUM, Oil City, Penn.—Freddie Martin's orchestra is now playing at the Post Lodge on Boston Post Road. . . . Terry Shand is the pianist with Martin; he was born in Texas. Has just completed a song called "Broadway Moon," published by Famous Music Corporation.

ANNUAL TRADE REPORT SHOWS A BIG DECLINE

Washington

Radio apparatus and phonographs valued at $194,313,602 were made last year in the United States, a decrease of 59.8 per cent. as compared with the $476,041,054 reported for 1929. The Census of Manufactures made available by the Department of Commerce included the following information:

The more important items which contributed to the total for 1931 are as follows: Radio receiving sets for the home (excluding batteries), except combination radio and phonograph units, 3,647,499, valued at $113,214,421; all other receiving sets (including automobile and aircraft sets), valued at $4,347,037; combination radio and phonograph units, 73,603, valued at $6,310,442; receiving tubes for initial equipment, 24,944,796, valued at $13,263,520; receiving tubes for replacement, 24,317,552, valued at $13,712,552; phonographs, not including dictating machines, 48,276, valued at 1,74,010; records and blanks, valued at 7,946,355.

Scope of Industry

This industry, as defined for census purposes, embraces establishments engaged wholly or principally in the manufacture of radio apparatus, phonographs, and parts and accessories for either or for both.

Prior to 1931 the manufacture of phonographs was treated as a separate industry, but the increasing production of radio apparatus by the manufacturers of phonographs and the introduction of the combination radio-phonograph unit made it desirable to establish the present classification.

As manufacturers of radio apparatus were formerly classified in the "Electrical machinery, apparatus, and supplies" industry, the schedule for which did not call for detailed data on this class of products, comparable statistics for years prior to 1931 can not be given except for certain items.

214 Establishments

The number of establishments in the industry last year was 214, with an average of 36,330 wage earners for the year and wages totalling 35,031,461.

The cost of materials, fuel and purchased electric energy amounted to $88,-280,906 and the value added by manufacture to $104,044,265.

Jolson to Be Heard Weekly Over Chain

Al Jolson returns to radio November 18 as a weekly star of a new series of broadcasts for Chevrolet over networks of the National Broadcasting Company.

The programs will be heard over NBC-WEAF networks on Friday nights from 10 to 10:30 p.m., E.S.T.

Jolson became a Broadway institution when he was signed by the Shuberts for their new Winter Garden in 1911. His first shows were "Bow Sing" and "La Belle Paree." Thereafter, Jolson kept the Winter Garden packed and became an entertainer of almost unprecedented popularity.

Some of Jolson's outstanding stage hits of the early years were "The Whirl of Society," "The Review of Reviews" and "Vera Violetta." In 1913 he shared honors with the late Gaby Deslys in "The Honeymoon Express" and in 1914 was featured alone in "Dancing Around."

Tradiograms

By J. Murray Barron

Radio Progresses

IT will be hard for many in the radio business in this country, including of course the licensed receiver manufacturers, virtually all of whom are reported to be losing money, to realize that radio has been making steady advances right through the depression. Information that such progress has been going on is furnished by the Department of Commerce, but it should be remembered that the report is based on world conditions. Besides, financial features are by no means the ones controlling the report, for technical and program advances are included. Therefore many who have been disappointed with the radio business for nearly three years may assume that the advances are mostly of the ethical rather than the financial kind.

Although the field of important improvements is narrowing, according to the Department of Commerce, invention and research have continued to prove their worth to radio. Even atmospheric conditions and climatic limitations have been yielding to engineering, and the number of receiving sets in use is constantly growing, says the report.

With this increase in sets applicable to the United States as well as to most foreign countries, it is clear that set manufacturers who are losing money are subsidizing their customers at least to the extent of the amount of the loss. Cheaper and cheaper sets are being made, some manufacturers considering this the solution, but as money is lost on these sets also, palpably the remedy lies in another direction. An even greater limitation of output, to make it more nearly commensurate with actual sales conditions, and the pricing of sets at modest enough figures, but still to yield a profit, seems to be the far better way.

* * *

The presidential campaign and election afford an opportunity to cash in on the public address system. Countless communities all over the United States, from the smallest hamlet to the largest city, will have crowds anxious to listen in for the election returns.

Clubs, lodges, places of amusements, restaurants and even main thoroughfares and public squares, as well as other places of public assembly are real live prospects for public address systems. The idea has no doubt been sold to many prospective users, or at least they appreciate in a measure the advertising value of a public address system. Many will instal a system sooner or later, but need just such an event as the election to bring home forcibly the big value of being in a position to address such large numbers.

Practically any serviceman can find plenty of excellent customers in his own community who are waiting for someone to take their order. Servicemen should not let this opportunity slip by. Regardless of the literature you may have sent in the past or calls you have made, once again the fact must be brought home to the prospect.

* * *

Cleveland's Radio World's Fair will be held October 22nd to 29th, inclusive. It will be held in the Higbee Building, Euclid Avenue and East 13th Street. This location is central and in the heart of the theatre and retail district. This show is made possible through the co-operation of the Cleveland Electric Illuminating Co., local broadcasting stations, a group of radio distributors and three daily newspapers. All indications point to a fine show.

VICTOR TO USE RECORDINGS ON 263 STATIONS

The RCA-Victor Company, RCA subsidiary, is about to inaugurate an extensive advertising campaign by radio, using electrical transcriptions. Two of the reasons are economy, due to the avoidance of expensive telephone line charges, and the practicability of having distributors and jobbers in local territories get their own message before the listeners, and thus provide "local color." Some of the larger distributors are believed to have agreed with the radio receiver manufacturing company to defray part of the cost.

It is said that approximately 263 stations will be used and that the broadcasts will be spread over a period of three months or so.

The early opposition to recordings of this type has been declining, due to improved tonal results. The science of recording has been a difficult one, amplification itself being easy, but since RCA-Victor Company is an expert in the recording field, it is believed that it hopes to pave the way for much more extensive similar broadcasts by other companies. In that way RCA-Victor would improve its own recording business, also.

The recordings for such work are on larger records than those familiar to phonograph users, and are driven by a motor that revolves the turntable 33 1/3 times a minute, instead of 8 r.p.m.

Several large stations have recently gone in for sponsored recordings, particularly since the two large chains lifted the restriction previously imposed on stations they controlled. However, it is still necessary to identify the transcriptions as such, and thus to inform the public they are not listening to a program originating at the time in a studio.

Thor's Counter Bigger

Thor's Radio Basement, 167 Greenwich Street, N. Y. City, is again making extensive counter alterations for small parts. This is necessary better to serve the serviceman and experimenter in this department and to take care of the increased business.

New Incorporations

Broadcast Publishing Corp., New York City—Attys., Twyeffort & De Bois, Graybar Bldg., New York City.

Poly Amplifying Systems, Brooklyn, N. Y., radio appliances—Atty., A. H. Smith, 132 Nassau St., New York City.

Bob Radio Corp., New York City—Attys., Attorney's Albany Service Co., 315 Broadway, New York City.

WSAN, Inc., Allentown, Penna., broadcasting stations—Attys., Corporation Service Co., Dover, Del.

Howard Sound Products Corp., New York City, telephone, telegraph business—Attys., Hyman & Hayman, 103 East 125th St., New York City.

Household Refrigerator Sales, Newark, N. J., electric refrigerators—Attys., Greenburg & Wilensky, Passaic, N. J.

Ozonator, New York City, electrical devices—Atty., A. L. Gellich, 521 Fifth Avenue, New York City.

American Electrical Transcriptions, New York City, radio broadcasting—Attys., Grossman & Combs, 521 Fifth Ave., New York City.

CORPORATE CHANGES

Capital Reductions

Superior Music, Manhattan, New York City, $5,000 to $3,000.

Name Changes

Raymond Music Co., New York City, to Superior Music.

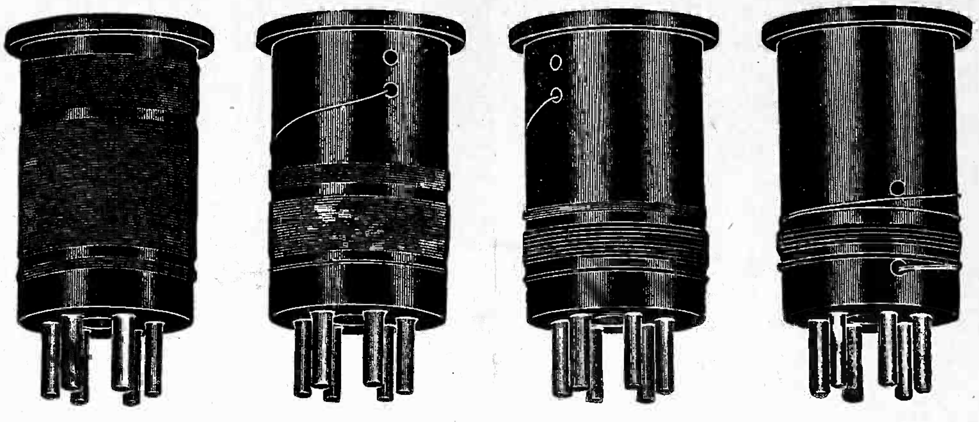
Receivers Appointed

B. P. N. Auto and Radio Supply Stores, Inc., 108 Canal St., Stapleton, and 243 Richmond Ave., Port Richmond, S. I., N. Y.—Judge Byers has appointed Frank C. Mebane, Jr., 149 Broadway, Manhattan, New York City, receiver in bond of $1,000.

6-Pin Plug-In Coils

200 to 15 Meters with 0.00014 mfd.

SHORT - WAVE plug - in coils with three separate windings for detector circuit produce best results as they avoid the broadness of plate-circuit tuning or the losses of r-f choke load on plate circuit due to damping. The lower winding is for r-f plate circuit, if t-r-f is used, or for aerial otherwise, the center winding is the tuned secondary, while the top winding is for feedback. The coils are accurately wound on 1.25 inch diameter Bakelite and have a 1/16-inch flange for gripping. Thus the actual winding need never be touched when you're handling the coils, and they are suitable for calibration.



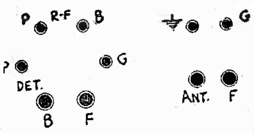
Cat. SWB—Four plug-in coils, 6-pin base; primary, secondary, fixed tickler..............................$1.70
Cat. SZ—Six-spring wafer socket for use as coil receptacle for six-pin coils..............................11c
Cat. SWA—Four plug-in coils, UX base, primary and secondary; primary may be used for feedback if condenser connects serial to grid..............................$1.35
Cat. SX—Four-spring (UX) wafer socket for use as coil receptacle for four-pin coils..............................10c
Cat. H-14—Hammarlund junior midline 0.00014 mfd. condenser with Isolantite insulation..............................$1.20
Cat. H-20—Hammarlund junior midline 0.0002 mfd. condenser with Isolantite insulation. Used as feedback control..............................$1.35

THE secondary is to be tuned with 0.00014 mfd. capacity. Using four coils, there will be sufficient overlapping of bands, also assured coverage to above 200 and below 15 meters. Also, 0.00015 mfd. may be used instead for tuning, with slightly greater overlap. Regeneration may be controlled by a 0.0002 mfd. variable condenser from detector plate to ground, or by a plate voltage rheostat or other means. The standard six-pin tube socket may be used for coil receptacle.

For antenna stage tuning only two windings are needed, where no stage of t-r-f is included, when use SWA.

HOW TO USE THE COILS FOR HIGHEST EFFICIENCY AND SMOOTHEST OPERATION

In building short-wave receivers using our plug-in coils be careful to locate the coils so that the centers of their cores are at least 6 inches apart, otherwise in sets with t-r-f- the r-f tube may oscillate. Even if a volume control in the r-f stage controls any oscillation present the recommended separation should be maintained, otherwise a critical circuit results.



The connections to make are diagrammed herewith. Bottom views of sockets are shown. For the 6-pin coil P-B RF goes to aerial and ground if there is no r-f. Standard UX and 6-pin sockets serve as coil receptacles.

HIGH-GAIN SHIELDED-COILS FOR T-R-F

DIRECTIONS FOR BEST RESULTS

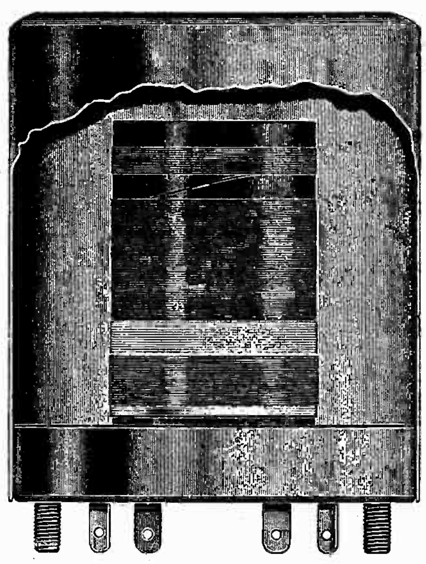
THE shielded coils for tuned radio frequency sets are supplied in matched sets of three or four, with secondary inductance equalized (plus or minus 0.6 microhenry). Thus any lack of sensitivity due to mismatched secondaries is avoided. As inductive discrepancies could not be compensated for by parallel capacity trimming, this high degree of inductive accuracy is important. Complete coverage of the wave band with the specified capacity condensers is absolutely guaranteed.

The coils may be used (set of three) for t-r-f, and with minimum value of negative bias for r-f tubes may oscillate a little at the very highest frequencies, say 1500 to 1580 kc, as they will be tuned below the broadcast band about that much. The negative bias should be increased until oscillation completely stops. Thus also selectivity is improved by heightened permanent or limiting bias.

In using four coils (three stages of t-r-f and tuned detector) each screen and plate lead should be carefully filtered, using 300-turn honeycomb coils and 0.002 mfd. or higher capacity in the filter, and the coil centers placed at least 4 inches apart.

The diameter of the form is 1 inch, the aluminum shield 2⅛ inch diameter, 2½ inches high. The shield has a small protected opening at top so the lead for the grid cap may be brought through. The opening is bevelled. This constitutes the protection against fraying the insulation of leadout wire to grid cap.

In the four-coil system, reversing connections to primary of second coil often stops oscillation in poorly filtered sets.



Cat. No. 1—Three t-r-f coils for 0.00035 mfd., 80-meter tap..............................$1.35
Cat. No. 1-F—Four coils, 0.00035 mfd.....$1.80
Cat. No. 3—Three t-r-f coils for 0.0005 mfd., 80-meter tap..............................$1.35
Cat. No. 3-F—Four coils, 0.00035 mfd......$1.80
Cat. DCH—Diode r-f choke, center-tapped..$ .40
Cat. 3DS—Three-deck long switch for above coils, to utilize 80-meter tap............$2.50

80-METER TAP PROVIDED

EACH coil for the t-r-f sets has secondary tapped, so that if desired a long switch may be used to shift the tuning condenser stators to extreme of winding (200-555 meters) or to tap (80-200 meters). The tap is represented by a ground symbol stamped on the shield base. Please note ground is not to be connected to ground symbol. Grid return is the side lug inside the shield. P, B represent primary, G and side lug secondary.

The 80-meter tap does not have to be used, but is advantageous to those desiring to tune in television, amateurs, police calls, some relay broadcasting and other interesting transmissions in a band of frequencies replete with novelties for the usual broadcast listener.

High impedance primaries are used, the number of turns chosen so that the same coils may be used for antenna coupler and interstage couplers.

For diode t-r-f circuits, either full-wave or half-wave detector, a diode choke may be inserted inside the detector form. This choke has three terminals, with outleads: two extremes and center. For full-wave use two extremes to anodes of 55 or 85, center to cathode resistor. For half-wave use two extremes and ignore center tap.

Except in rare hookups the diode circuit requires an input free from grounding, and as the tuning condenser rotor and frame are grounded the choke pickup affords any potential output.

T-R-F sets using the 55 or 85 should have three stages of resistance audio, e.g., first stage the triode unit of the 55 or 85, second stage screen grid audio, third stage power tube or tubes (output).

COILS FOR 4-TUBE DIAMOND (CAT. DP) @ 90c—COILS FOR 5-TUBE DIAMOND (CAT. DT) @ $1.35

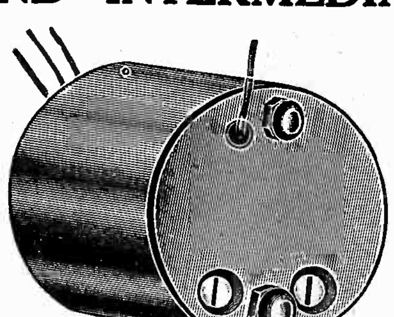
MIXER AND INTERMEDIATE TRANSFORMERS

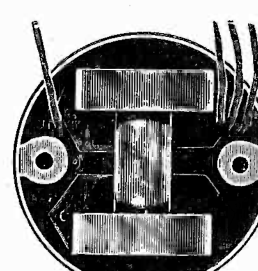
PADDED SETS

For circuits using 175 kc. or 400 kc. intermediate frequency we have two coils for a stage of t-r-f and first detector, and accurately chosen inductance for the padded oscillator for these intermediate frequencies. There is no 80-meter tap provided on these mixer coils.

The coils are of the same type of mechanical construction as the t-r-f coils. Since there is no secondary tap, the code for connecting the t-r-f coils of the superheterodyne combination is different: P and B, primary; G and ground symbol, secondary. P would go to plate or antenna, G to grid cap, while B and ground symbol are the returns.

The oscillator has a smaller inductance secondary, for padding, and moreover is a three-winding coil. The three windings are: pickup, secondary and tickler. The pickup winding consists of 10 turns, and is brought out to two side lugs. The polarity of its connections unusually is of no importance. The secondary is represented by G and ground symbol. G going to grid and ground symbol to grid return, usually ground. The tickler connections for oscillation usually require that the lug at B be conected not to B plus but to plate, hence the P lug goes to B plus. In any case, if no oscillation results, reverse the tickler connections.





Cat. No. 4—Three mixer coils, for 0.00035 mfd. Intermediate frequency intended, 175 kc. Price includes padding condenser, 700-1000 mfd.......$1.80
Cat. No. 5—The mixer coils for 0.0005 mfd., 175 kc., 700-100 padder....$1.80
Cat. No. 7—Three mixer coils, for 400 kc; padding condenser included is 350-450 mfd..............................$1.80

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INTERMEDIATE TRANSFORMERS

The intermediate transformers consist of two honeycomb coils, wound with low resistance wire, coils spaced 1 inch apart, and thus affording loose coupling, stability and high selectivity. Primary and secondary tuned.

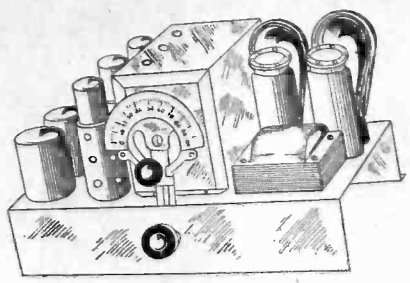
Cat. FF-175—Shielded intermediate frequency transformer. 175 kc.......$1.10
Cat. FF-175CT—Same as above, center-tapped secondary, for full-wave diode detector..............................$1.25
Cat. FF-450—Shielded intermediate frequency transformer, affording choice by condenser adjustment of frequencies from 380 to 480 kc...............$1.30
Cat. FF-450CT—Same as above, center-tapped secondary...............$1.45

Padding Condensers @ 45c Each

Cat. PC-710—For 175 kc intermediate. Put in series with oscillating tuning condenser. Capacity 700-1000 mmfd. Hammarlund, Isolantite base.
Cat. PC-3545—Same as above, except 350-450 mmfd. for 380-480 kc intermediate.

Cat. CH-300—A 300-turn r-f choke, inductance 1.3 millihenries $0.30
Cat. CH-800—An 800-turn r-f choke, inductance 10 millihenries..........$0.35

5-TUBE DIAMOND



Coils, tubes and tuning condenser in the Five-Tube Diamond are fully shielded.

A TUNED radio frequency set, two stages of t-r-f (58 tubes) and tuned detector input (57 tube). One stage of audio ('47) and rectifier ('80). For 105-120 v. a-c, 50-60 cycles. Extremely high sensitivity for a t-r-f set —10 microvolts per meter at 1,000 kc. Brings in the high wavelength stations with tremendous volume, as well as the low wavelength stations. One knob for dial, one for volume control-switch. Selectivity to meet modern needs. Tone of the first quality.

COMPLETE KIT (Less Tubes and Cabinet)........$15.69

The 5-Tube Diamond uses a three-gang tuning condenser with a midline tuning characteristic and affords a coverage of from 1520 to 500 kc (below 200 meters, to 600 meters). This affords excellent quiet spots past either extreme of the broadcast band for operation with short-wave converters.

Precision shielded coils are used in the circuit, matched to plus or minus 0.6 microhenry. The vernier dial, travelling light type, has 1-to-5 ratio, for close tuning.

The complete parts—chassis, Rola 8" speaker, power transformer—everything except tubes and cabinet, is Cat. D5CK @...........$15.69

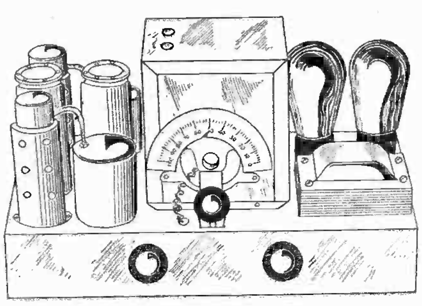
FOUNDATION UNIT............................$6.19

Drilled metal subpanel, 13¾ x 8⅝ x 2¼", cadmium plated, with mounting flap at rear......$0.92
Three-gang Scovill 0.00035 mfd. condenser, midline tuning, brass plates, trimmers built in, ⅜-inch diameter shaft at both ends; full shield.. 1.95
Three special tube shields for the 58 and 57 tubes.. .33
Six sockets (one for speaker plug).. .66
Two Polymet 8 mfd. wet electrolytic condensers, inverted type; insulators; lugs............ .98
One set of three shielded coils (antenna coupler and two interstage transformers).......... 1.35

Foundation Unit (Cat. D5FU)..$6.19

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

4-TUBE DIAMOND



Excellent parts and an original circuit make the 4-Tube Diamond remarkable.

HOW much can be accomplished in an a-c set on only four tubes was revealed when the 4-Tube Diamond was announced and demonstrated recently. This remarkable circuit has the utmost in tone, and all that can be obtained in selectivity and sensitivity from a 4-tube design. It is heartily recommended and will give enduring satisfaction. The chief praise heard of the circuit concerns its tone. The other qualties are not deficient, however.

Complete Kit (Less Tubes, Less Cabinet) **$13.58**

All the parts, except cabinet and tubes, are supplied in the official kit, including Rola 8" dynamic, chassis, shielded condenser, dial, etc.

Kit of four Eveready-Raytheon tubes for this circuit, Cat. D4TK.......$3.89

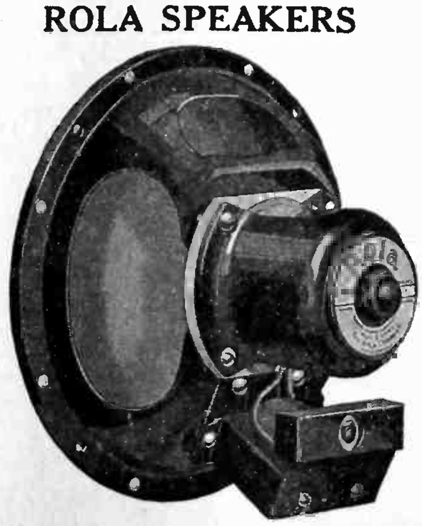
FOUNDATION UNIT $5.48

Drilled metal plated subpanel 13¾ x 2½ x 7"; cadmium plated, with mounting flap at rear..$ .85
Two-gang 0.00035 mfd. SFL condenser, brass plates, 2½" long shaft; full shield............ 1.39
Two special tube shields for 58-57.. .22
Center-tapped 200-turn honeycomb coil.. .40
Five sockets (one for speaker plug).. .55
Two Polymet 8 mfd. electrolytics; insulators; lugs.. .98
One pair of r-f coils, consisting of impedance antenna coil and interstage transformer...... .90
20-100 mmfd. Hammarlund equalizer for use as antenna series condenser.................... .19

Cat. D4FU @ $5.48

8 MFD.

ROLA SPEAKERS



The Rola Series F speakers with 1800-ohm field coil tapped at 300 ohms are now standard in the 4-Tube and the 5-Tube Diamonds. The list of parts specifies the 8" diameter speaker, but larger diameters may be used, to fit any particular console. The small model is intended for mantel set installations.

The Rola speakers are supplied with 5-lead cable and plug. The output transformer built in is matched to the impedance of a single '47.

8" diameter (Cat. RO-8)....$3.83
10.5" diameter (Cat. RO.-105) 4.27
12" diameter (Cat. RO-12).. 5.35

8 mfd. Polymet wet electrolytic condenser, inverted mounting, insulating washers (Cat. POLY-8) $0.49

POWER TRANSFORMERS } **4-Tube Diamond (Cat. D4PT) . $1.49**
5-Tube Diamond (Cat. D5PT) . 2.16

Travelling light vernier dial, 5-to-1 (0-100 for 5-tube, 100-0 for 4-tube); lamp; escutcheon; knob. Same dial takes either ¼ or ⅜" shafts..$0.91

DIRECT RADIO CO., 143 West 45th Street, New York City

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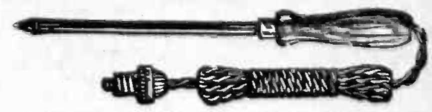

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FULL SCALE PICTURE DIAGRAM OF 4-TUBE DIAMOND

This full scale diagram, together with an accompanying article on wiring, adjusting and operating the Four-Tube Diamond, appeared in Radio World dated Sept. 17. Sent for 15c a copy. First and Second installments of article on the 4-Tube Diamond appeared in issues of RADIO WORLD, dated Sept. 3 and 10. The three copies sent for 45c. Or send $1.50 for a three months' subscription and receive these three numbers free.

Also full scale picture diagram of the 5-tube Diamond. This appeared in Radio World of Oct. 8, 15c a copy. Other issues containing information about the 5-tube Diamond are dated Sept. 24 and Oct. 1. These 3 copies, including full scale picture diagrams, mailed on receipt of 45c, or sent free with a $1.50 subscription for three months.

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