FEB. 21st

1931

RADIO WORLD

REG. U.S. PAT. OFF.

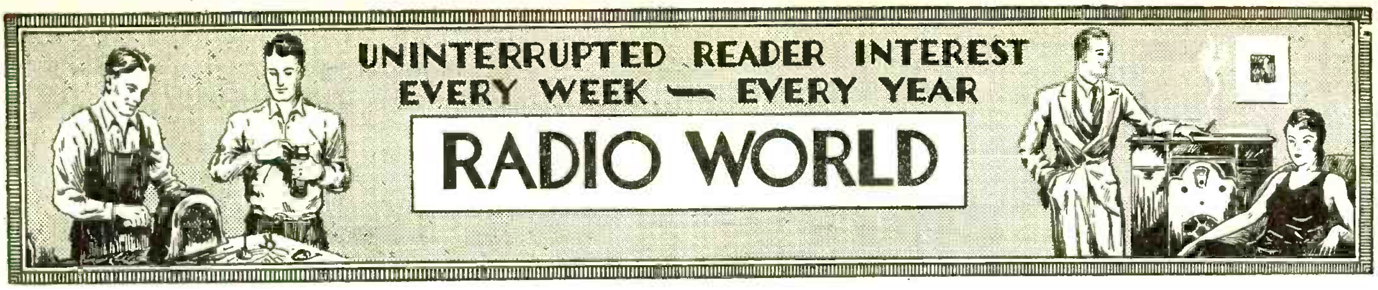
The First and Only National Radio Weekly

465th Consecutive Issue—NINTH YEAR

PRICE 15¢ PER COPY

HOW BAND PASS FILTER CIRCUITS WORK

RADIO WORLD, Published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.



Vol. XVIII. No. 23 Whole No. 465
February 21st, 1931
[Entered as second-class matter, March 1922, at the Post Office at New York, N. Y., under act of March, 1879]
15c per Copy, $6.00 per Year

NINTH YEAR
Technical Accuracy Second to None
Latest Circuits and News

A Weekly Paper published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y.
(Just East of Broadway)
Telephone, BRyant 9-0558 and 9-0559

RADIO WORLD, 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, business manager and managing editor; J. E. Anderson, technical editor.

More Volume Achieved in Stable Resistance Audio

By Herman Bernard

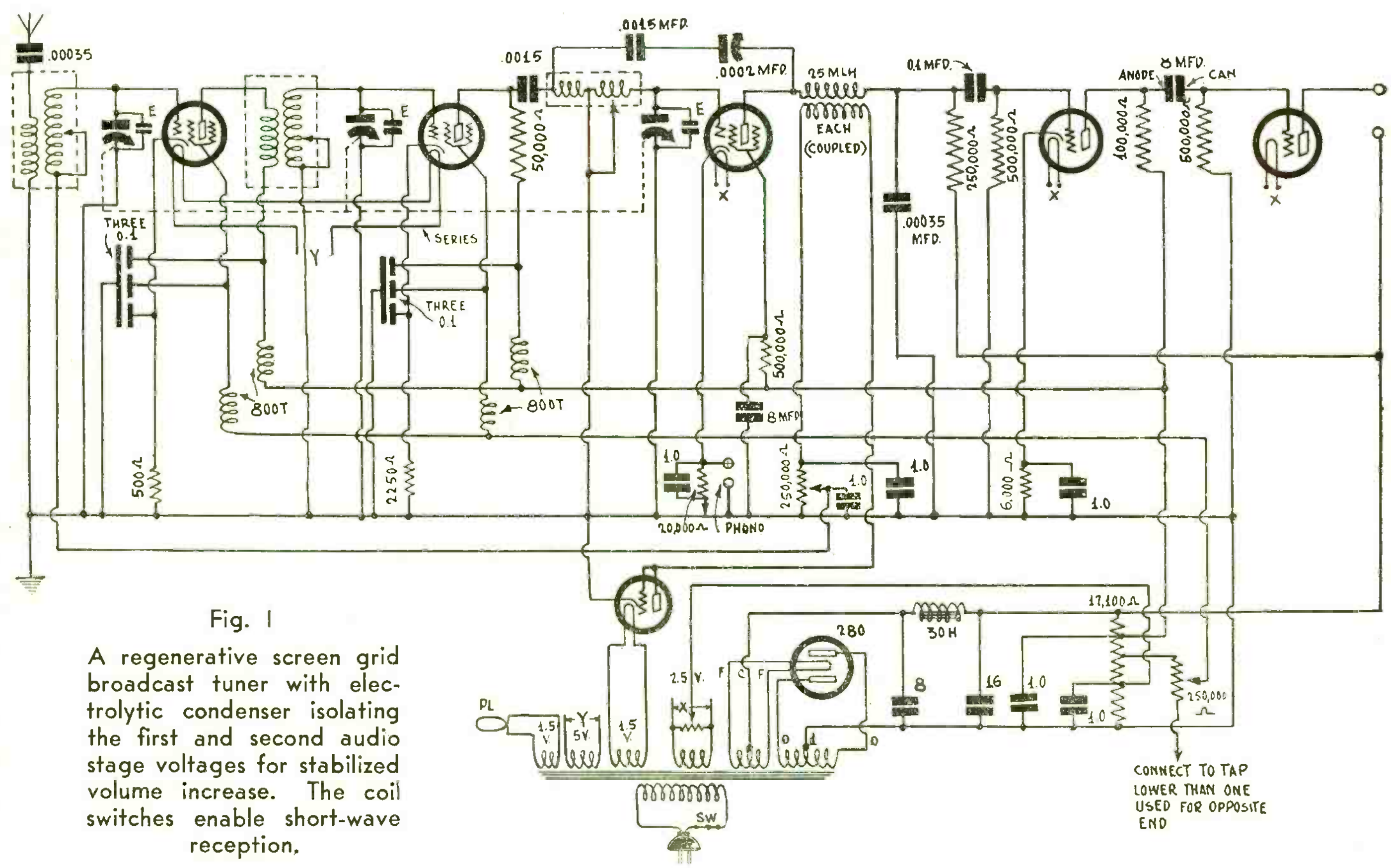


Fig. 1

A regenerative screen grid broadcast tuner with electrolytic condenser isolating the first and second audio stage voltages for stabilized volume increase. The coil switches enable short-wave reception.

GAIN in the radio frequency amplifier is being pressed farther and farther as new circuits appear for pit construction and for commercial production, with reduction in the amount of audio-frequency amplification. So we see factory-made sets with one stage of audio to work a loudspeaker, and these include even tuned radio frequency receivers. The last stage (which is the only audio stage), may be even push-pull, as the detector is worked at a high bias, and the radio frequency amplitude is built up so greatly by the RF amplifier that a screen grid detector's output will be enough to load up the push-pull pair.

Proper Load for Plate

Experimenters with resistance-coupled audio frequency amplification know that the gain with the system is likely to be less than when transformer coupling is used. However, it is a fact that the screen grid tube, worked with a resistive plate load, can produce as much amplification as a general purpose tube, such as the 227, and a 1-to-5 ratio transformer.

The next step to consider is whether to use the screen grid tube as the first audio amplifier, to feed a 245 output tube. The sensitivity of the screen grid tube as a power detector is good, partly because the tube's mu, i.e., amplification factor, is high. Capitalization of this high mu is attained only by use of a high impedance plate load, which is more conveniently a resistor, although a choke coil of enormous inductance, around 1,000 henries, also would provide good amplification. Nevertheless, the tonal characteristics when a resistor is used are likely to be superior to those attained when a choke coil is the plate load.

The same advantage of high amplification is present when the screen grid tube is used as an audio amplifier, so the gain

(*Continued on next page*)

Large Isolating Capacity Up

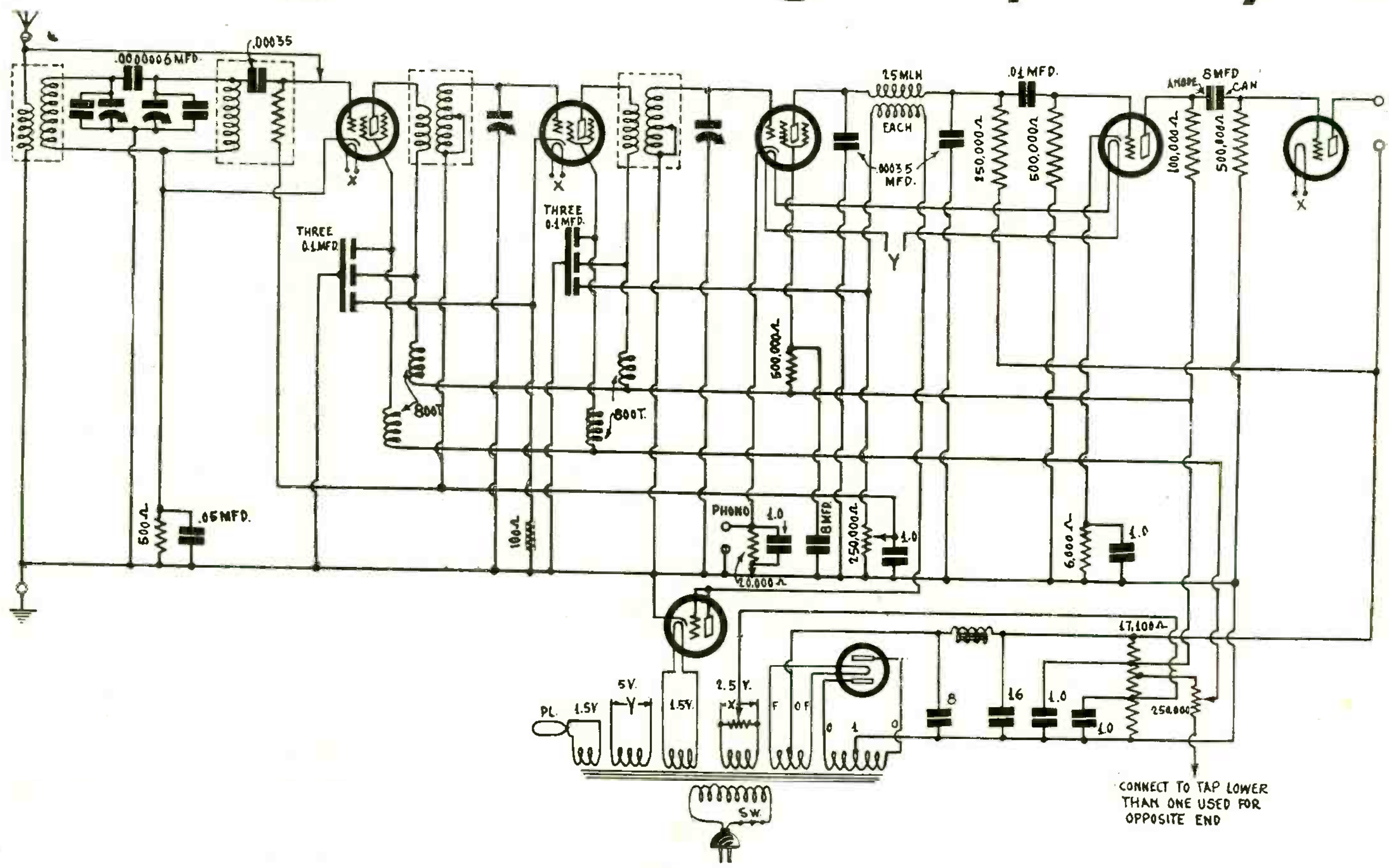


Fig. 2
A bandpass filter tuner with the new method of boosting volume in a resistance-coupled audio amplifier. This audio amplifier, the same as that in Fig. 1, positively does not motor boat.

(*Continued from preceding page*)
will be greater than if a 227 were used in this position, since the gain is comparable to the working mu of the tubes. In the case of the screen grid tube it would be around 60, in general practice, and for the 227, around 7.

This is quite a substantial difference, but the moment the two-stage resistance-coupled amplifier is worked as a high-gain system, dangers arise that would be absent from a similar circuit with a 227 for first-stage audio amplification.

One of the problems is motorboating. This may evidence itself as a put-put sound that wholly destroys all semblance of tone quality, and makes listening unbearable. Then one might be prompted to wonder where resistance coupling acquires all its vaunted graces.

Cures for this evil include the use of enormous filter and by-pass capacities, in voltage circuits serving the audio tubes. One such amplifier, with screen grid tube in the first stage, was built, and it motorboated. Capacity was added, until finally there was a total capacity of 108 mfd. across the voltage divider. Only then did motorboating stop. The condensers cost $13.

Another consideration is the negative grid bias that the tubes require. For the 224 the bias might be 3 or 4 volts, and the signal amplitude at this point might be great enough, on several stations, to overload the first audio tube. The effective plate voltage is relatively low, as a 250,000 ohm plate resistor would be used, so that less than 1 milliampere of plate-screen current would flow, and the biasing resistor would be around

Bias for the 227 Tube

The recommended value of the plate resistor, if a 227 is used, is 100,000 ohms, largely for support of high audio frequency response that would be attenuated by a larger resistor, due to the increased input capacity, effective as bypassing these high frequencies.

So, with 100,000 ohms in the plate circuit, the voltage drop in the resistor, at 1 ma plate current, would be 100 volts, and since the applied plate voltage is 180 volts, there will be 80 volts effective on the plate. Yet the negative grid bias may be the same as if there were no drop in the plate resistor, since the mu of the 227 tube does not depend on the plate voltage, whereas with the screen grid tube change in plate voltage does change the mu, the screen voltage normally not being changed. It is assumed that adequate plate voltage is applied.

Therefore we may use 10 volts negative bias, theoretically, for the 227 tube, although in actual practice it has been found that the tube amplifies a little better when the bias is somewhat lower than the theoretical value. At 1 ma of plate current, a 6,000 ohm resistor in the cathode B minus lead would provide 6 volts negative bias, the practical amplification would be about 7, so a swing of 84 volts on the power tube stage would be accommodated pro-rata by the first audio tube without overloading, which is satsisfactory.

More Amplification Desired

This is represented approximately by the negative bias on the output tube, which is 50 volts, the peak swing being 100 volts, measuring the points of highest amplitude in the alterations of signal voltage. The doubling of the negative bias value to attain the peak load value arises from the fact that an alternation is half a cycle.

For the higher bias reason alone it is preferable to use the 227 as first audio amplifier, although the ready solution of the motorboating problem is no slight advantage either, nor is the economy feature, which enables use of smaller filter and bypass capacities.

It has been said the amplification is less, but since excellent tonal characteristics prevail, the benefit endures, only in another form. Two stages of resistance coupling are inexpensive and easily accommodated in small space, which are incidental advantages. The only point about the system that runs somewhat counter to popular demand is the fact that push-pull can not be instituted, as this requires a coil of some kind, to constitute an effective and reliable push-pull circuit. Methods of using resistance coupling by phase-shifting tubes and similar devices are not very reliable.

It can be seen, therefore, that the two stages may be built with great satisfaction, to serve a high-gain radio frequency amplifier, and yet there is every reason to look forward to a two-stage resistance-coupled audio amplifier that safely will provide even greater gain, to do justice to a modest tuner.

There is a method of accomplishing this, and it is represented in the schematic diagrams of two circuits herewith. Fig. 1, a two-stage RF amplifier, regenerative detector and two-stage resistance-coupled audio amplifier, and Fig. 2, a band pass filter two-stage radio frequency amplifier, detector and two-stage resistance-coupled audio amplifier, are the examples.

If the capacity between the plate of the first audio tube and the grid of the second audio tube is made large, the effect is one of positive feedback at audio frequencies, a highly substantial gain, and yet without introducing any instability. The first discovery of this secret occurred when a 72 mfd. electrolytic

sets Theory in Resistance AF

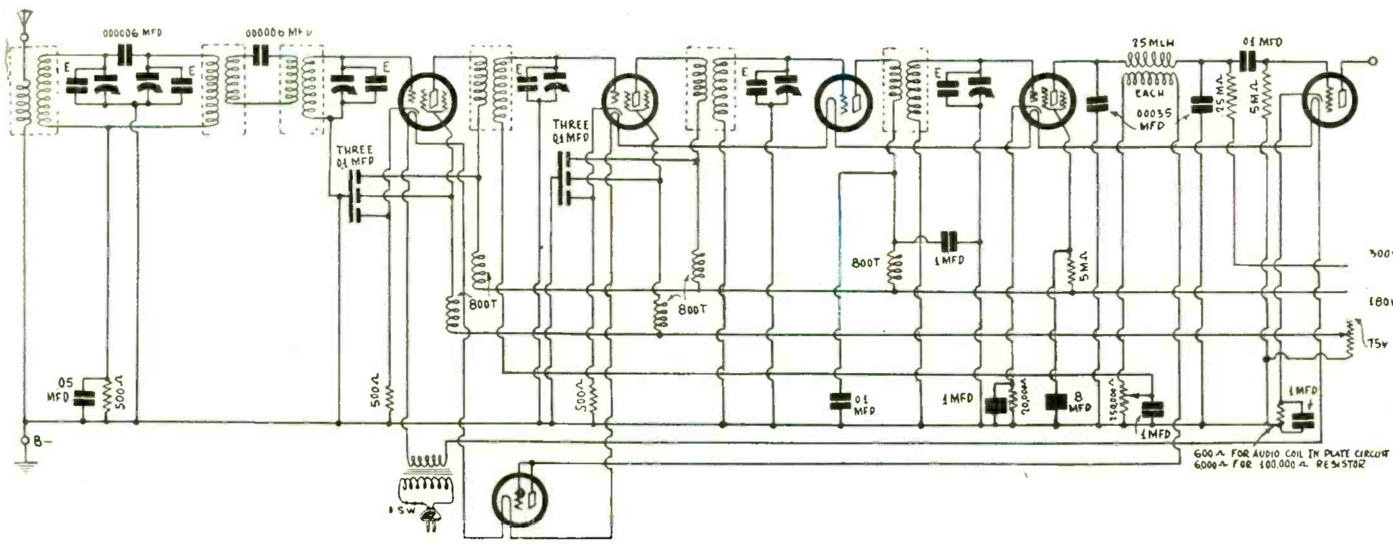


Fig. 3
A band pass filter six-circuit tuner, with screen grid detector and built-in filament supply. The heaters are in series across the secondary of the power transformer.

condenser was cut in between these positions, across an .01 mfd. condenser. The volume was four times as loud with the 72 mfd. in circuit, as when only the .01 mfd. was used. The total volume from the audio amplifier compared favorably with that of a two-stage transformer-coupled channel with push-pull output, so here was a circuit suitable for even modest tuners.

It was supposed that the volume could be built up with four-fold gain once more, by using a large condenser from plate of the detector to grid of the first audio tube, but volume declined. So .01 mfd. was retained as the isolating capacity in the first stage and finally 8 mfd. of electrolytic condenser used from plate of first audio stage to grid of the output tube, since the ear disclosed no volume difference between 72 mfd. and 8 mfd.

A Gratifying Result

The overall result was most gratifying, even though in some respects baffling. It had been supposed that the larger the capacity isolating the circuits, providing the grid resistors were held constant, the greater the tendency toward motorboating. In fact, in the first stage this well-accepted theory or fact was authenticated, for even when the capacity used was 0.3 mfd., with 8 mfd. in the next stage, motorboating did exist. It was not of the type plainly audible, but it did injure tone quality.

The motorboating could be "seen" in a milliammeter in the power tube's plate circuit. The needle wiggled greatly on both sides of the position for steady current value, in fact, hit both extremes of the meter scale. The frequency was 6 cycles.

When the first capacity was reduced to .01 mfd. the motorboating stopped.

One theory advanced for the gain accomplished by using 8 mfd. to the grid of the output tube was that the amplification of that tube was increased. However, when the effect on the preceding stage was one of reduction of amplification, it was assumed the principal cause was feedback, that in the one instance it turned out to be positive, and increased amplification, while in the other it proved to be negative, and reduced the amplification.

Good Low-Frequency AF Response

An incidental, but still valuable, advantage of the improved gain at audio frequencies was a new opportunity to work the radio frequency amplifier with stability. The limit of the radio frequency amplifier is, in general, the squealing point. A tuner that squealed at the higher radio frequencies, under conditions purposely introduced so that the lower radio frequency channels would come in strong, with these conditions removed now could be made perfectly stable at any point on the dial, without the trace of a squeal, and yet with satisfactory response throughout.

The two-stage resistance-coupled amplifiers included in Figs. 1 and 2 are stable. The resistor values should not differ from specifications. It is true that 1 meg. may be used in the last grid circuit instead of 0.5 meg., but the amplifier, while generally good, will be of the "trigger" type, whereby it may start to motorboat after the set has been played for an hour or two. Touching an audio grid lead may start this audio oscillation, or sudden tuning in of a strong signal may do it. Hence the amplifier would be like the trigger of a gun, likely to cause the gun to "go off" under the slightest shock.

The shock-proof audio amplifier is due to the values of the resistors and the isolating condensers, and to the bypass capacities. The grid leaks are 0.5 meg. each, and still support most excellent low audio frequency response.

Screen Grid Tube As Detector

It is because amplifiers build up low audio frequencies too pronouncedly that motorboating of the put-put-put type exists, so there can be no good reason for using only so much amplification in this region as the amplifier and associated equipment will stand and stay stable. It is in principle the same operation as neutralizing a tuner, since the cause of oscillation at over-amplified frequencies is removed. Besides, if an audio system amplifies some frequencies to a much greater degree than it does other frequencies, it is discriminatory, i.e., distorting.

The electrolytic condenser should be connected with anode (cap with screw on it) to plate of first audio tube and lug on container to grid of first audio tube. If a metal panel is used, insulate the condenser can.

Direct current will flow through the condenser. This will reduce the bias on the last audio tube, so the filament connection to this tube should go to a higher point on the voltage divider. The proper position on a Multi-Tap Voltage Divider is shown on the diagrams Figs. 1 and 2.

The screen grid tube is used as a detector in Figs. 1, 2 and 3. By the way, Fig. 3 represents a six-circuit band-pass filter tuner, with filament supply. One stage of audio is included, so that there will be no mistake about the proper load for the detector tube. Otherwise there would be the possibility of builders putting the primary of a transformer in the detector plate circuit, whereas no commercial transformer has a sufficiently high inductance for this purpose.

Circuit Pointers

Fig. 3 should be worked with an audio power amplifier.

The values in the screen grid detector circuit are: A 20,000 ohm biasing resistor, across which a bypass capacity of 1.0 mfd. is sufficient; a 250,000 ohm plate load resistor, to which are applied the full 300 volts of a 245 B supply, and 500,000 ohms from screen to B plus 180 volts. This puts about 150 volts on the screen, in the interest of stability, but a somewhat larger response may be obtained by using 1.0 meg. here. If motorboating is present, the smaller value of resistor may be put in this position. However, no matter which value of resistor is used, the bypass capacity must be high, so a capacity of 8 mfd. is recommended.

The audio amplifier, as shown in the first two diagrams, is assuredly stable, utterly free from motorboating, and will give you tonal volume results that will joyfully surprise you.

Figs. 1 and 2 include an automatic volume control tube. The theory of operation of this tube was explained in last week's issue, February 14th. An increase in signal amplitude increases the negative bias, hence decreasing the amplification of the controlled tube or tubes. The potentiometer (in the RF choke coil circuit), is set once, and left in the desired position.

Facts About Ba

By J. E.

SIMPLE band pass filters as used in modern radio tuners are of three general types. In the most common at this time the two tuned circuits are coupled with a condenser, that is, a condenser is common to the two circuits. In the second type the two circuits are coupled by means of a small inductance, and in the third they are coupled by means of mutual inductance. The inductively and the mutually coupled circuits may be reduced to one type. The three circuits are illustrated in Fig. 1. A is the capacitively coupled circuit, B the inductively coupled, C the mutually coupled, and D the equivalent of C. It will be noticed that D is of exactly the same type as B, so that B, C, and D are equivalent as far as type is concerned. The value of L in B is not the same as that of L in D, but L in B is equal to L—M in D, and Lm in B is equal ot 2M in D. That is, these equalities hold if the passed bands are to be the same both in width and location.

Theory of Filters

The theory of all these filters is the same and the two maxima may be determined by the same equation by making the proper substitution for the impedances. One maximum is determined by the circuit disregarding the coupling device. For example, in A the first maximum is determined by the two inductances L connected in series and the two capacities C connected in series. The circuit then consists of L, L, C, and C. The resonance point determined by these four impedances is exactly the same as that determined by one L and one C. The reason for this is that the inductance of the two coils in series is twice the inductance of either coil and the capacity of the two condensers in series is equal to one-half the capacity of either.

This also holds for the first resonance in circuit B, in which Lm does not enter. Circuit C is first reduced to its equivalent form D and then the same principle holds for the first resonance. That is, the first resonance is determined by L—M, L—M, C, and C connected in series, or by what amounts to the same thing, by L—M and C connected in series.

The Second Maximum

The second resonance, or maximum, is determined by each half of the circuit, in which the common or coupling impedance enters. For example, in A the resonance is determined by L, C, and Cm, and in B by L, C, and Lm. In C and D the second resonance is determined by L—M, C, and 2M.

We can generalize these conditions for the maxima by two equations. The first is $Z = 0$ and the second $Z + 2Zm = 0$, in which Z stands for the impedance of L and C and Zm the common impedance of the two circuits. The generalized circuit is given in E. This circuit shows that the signal voltage is introduced in series with the left circuit. In practice this means that the voltage is introduced into the left hand coil in circuits A, B and D. Ordinarily it is not so introduced in C, and therefore not in D, because the plate circuit of the tube ahead is connected across the coil and the condenser in the left hand circuit. This changes the characteristics of the filter but not enough to invalidate the theory. The signal voltage is taken from the filter either by coupling another coil to the second L or by connecting the grid circuit across either the right hand coil or the right hand condenser.

Applying the General Equation

Applying the first general equation $Z = 0$ to the circuit in A we have:

$$Lw - 1/Cw = 0$$

is which w is 6.2832 times the frequency. Solving this equation we have for the first resonance point w equals the square root of 1/LC. We get exactly the same if we apply the equation to B. If we apply it to D, which includes C, we get w equals the square root of 1/(L—M)C. It will be remembered that the L in A and B is not the same as that in C and D.

If we apply the second equation to A we have:

$$Lw - 1/Cw - 2/Cmw = 0$$

Solving this equation we have w equals the square root of (1/LC + 2/LCm). Applying the equation to B we have·

$$Lw - 1/Cw + 2Lmw = 0$$

Solving this we have w equals the square root of 1/(L + 2Lm)C. Similarly, if we apply the equation to D and solve it we get w equals the square root of 1/(L+M)C. In two cases the first resonance point is independent of the coupling impedance between the two circuits and in each case the second resonance is dependent on the coupling impedance, as well as on the other impedances. The width of the band passed is therefore dependent on the value of the common impedance, or rather on the ratio of the common impedance to the other impedances.

Comparing Resonance Points

The first resonance point for circuit A is obtained by setting the 2 pi frequency to the square root of 1/LC and the second is obtained by setting it equal to the square root of (1/LC + 2/LCm). It will be observed that the first of these expressions is contained in the second and we may substitute.

Let us deal with the squares of the frequencies rather than the frequencies themselves in order to simplify the work. Let the first frequency be w1 and the second w2. Then $(w1)^2 = 1/LC$, and the second resonance point may be written:

$$(w2)^2 = (w1)^2 + 2/LCm$$

making the substitution suggested above. Put both frequencies on the same side of the equation and we have:

$$(w2)^2 - (w1)^2 = 2/LCm$$

The first side of this equation may be factored and the two factors are the sum and the difference of the two frequencies. But the difference is the band width, or the difference in frequency between the two resonance points. Moreover, the two frequencies are so large compared with their difference that we may put the sum equal to 2w, where w is the mean of the two frequencies, or either of the two frequencies, just as we choose. The error in any case will be negligible for narrow bands.

Let dw represent the band width. Then we have $dw = 1/LCmw$. This is a simple expression for the width of the band. It will be noted that, since L and Cm are constant, the band width is inversely proportional to the frequency. In designing a band pass filter we usually have to determine the value of the coupling impedance to give a definite band width. For this purpose we set $Cm = 1/Lwdw$. Suppose, then, that we wish a band width of 10,000 cycles, or 62,832 radians, at 930 kc. The inductance of the coil may be taken at 160 microhenries, on the assumption that the capacity of the tuning condenser is .0005 mfd. Substituting these values we have Cm equals .017 mfd. when the capacity of the coupling condenser is .04 mfd. the band width is 4,260 cycles, the other values remaining the same.

Band Width With Inductance Coupling

For the inductively coupled filter we got the two expressions

$$(w1)^2 = 1/LC \text{ and } (w2)^2 = 1/(L+2Lm)C$$

for the squares of the two resonance frequencies, and here, too, one is contained in the other and therefore we may simplify by substitution. We get $dw = wLm/(L+2Lm)$ for the band width, using the same approximations and definitions as previously.

Since Lm and L are constants, we note that the band width is directly proportional to the frequency w. The band width is also directly proportional to the inductance of the coupling coil if L and w are kept constant. In practice we are interested to know how large the coupling coil should be to give a definite band width at a particular frequency. For this purpose we

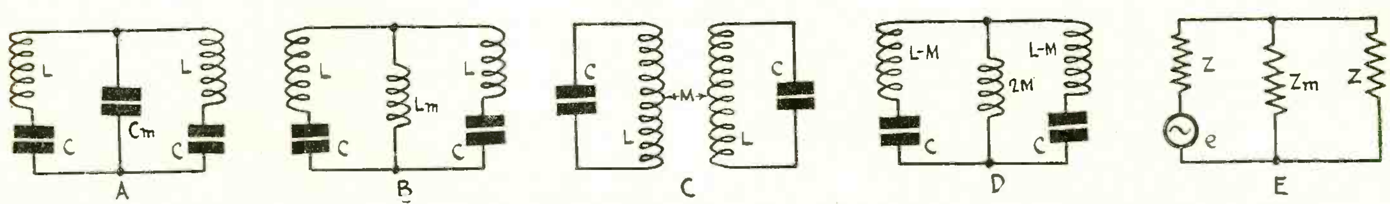


FIG. 1

Three different band pass filter circuits, A, B, and C, with the equivalent D of C and a generalized circuit E.

nd Pass Filters

Anderson

write Lm=Ldw/w. Let the desired band width be 10,000 cycles, the inductance 160 microhenries, and the frequency at which we desire the 10,000 cycle width 930 kc. We can use kilocycles just as well as radians since in this case we have a ratio of two frequencies. Then Lm=.00016x10/930, 1.72 microhenries. At 550 kc the band in this case is only 5,910 cycles wide.

The formula for Lm assumes that 2Lm is very small compared with L. With the accurate formula Lm turns out to be 1.758.

Mutually Coupled Circuits

The circuit in D yields the same results as that in B provided that the impedances are suitably interpreted. The impedance of 2M should be 1.72 microhenries, and this makes the mutual inductance between the two coils in C equal to .86 microhenries.

It should be remembered that if the frequency at which the specified band is taken is different, the common impedance will also be different, since for a given band width and given inductance in the circuit, the common impedance is inversely proportional to the frequency. At 550 kc the common inductance would be larger in the proportion of the frequencies, that is, it would be greater by the factor 930/550. If a larger tuning coil, and hence a smaller condenser, were used, the common inductance would also be larger, and in direct proportion to the inductance.

Disadvantages of Filters

The fact that the width of the transmission band of a filter varies with the frequency is a serious disadvantage because if the band is specified at one end of the broadcast band it will either be too narrow or too wide at the other end, depending on which type of filter is used. This situation is not changed by specifying the width of the band in the middle, say at 930 kc. However, if the band is specified at a given value at the upper frequency in the case of the inductively coupled filter the band will be narrowed as the frequency is reduced and the transmission characteristic will approach that of a simple tuner. Since many receivers contain simple tuned circuits and give good response, one containing a filter of this kind would be no worse.

The capacitively coupled filter has one advantage in that the band width increases toward the low frequency end of the tuning range, where a somewhat wider transmission band is desired for equal transmission of the side frequencies. This is undoubtedly the principal reason why this type of filter is used in most commercial receivers that use band passing at all. Another reason for its use is that it is somewhat simpler, especially as compared with the common coil coupled filter.

Use in Superheterodynes

In a superheterodyne intermediate frequency tuner any of the filters discussed above may be used. The question of frequency variation of the band width does not enter because the frequency is the same all the time. Hence in such circuits the simplest of the filters will be used, and the simplest one is the tuned primary, tuned secondary type. To insure the proper band-pass effect it is only necessary to make the two circuits the same both with respect to inductances and capacities and to make the coupling between the circuits loose. In commercial superheterodynes the primary and the secondary coils are so far apart that it would seem there is no coupling at all between them. However, the distance has been adjusted very carefully to yield a definite and predetermined transmission band.

Let us apply the formulas derived to the determination of the mutual inductance in a special case. Suppose the intermediate frequency is 175 kc and the desired band width is 10 kc. If the capacity of the tuning condensers is 100 mmfd., the inductance L should be 8.28 millihenries. If the band is to be 10 kc wide one resonance point must fall at 170 kc and the other at 180 kc. For the lower frequency we use L + M and for the higher L — M. For both the capacity is 100 mmfd. and L, 8.28 millihenries. This is enough to enable us to compute required value of M. We get M equals .565 millihenry.

Involved Circuits

As has been emphasized, a simple band pass filter has a band transmission characteristic because two resonant circuits are coupled together. The voltage is introduced into one of the circuits by means of a generator of some kind and the voltage is transferred to the other circuit by means of the coupling impedance. If the circuit is complex so that there is also a voltage introduced into the other circuit from an external source, the characteristic is altogether different and the combination can no longer be called a band pass filter. This is also true if a voltage is introduced into the coupling impedance from some external source.

An illustration of a complex circuit is that when the first LC is in the input of one tube and the second LC in the input of the next tube in an amplifier and when Cm is a condenser across a common bias resistor. Due to the amplification in the tube there is a voltage introduced into the second tuned circuit which does not get there by virtue of the coupling impedance. This voltage is proportional to the voltage that would be introduced in the simple tuned circuit, but it is many times greater. The simple relationships no longer hold, and just what relationship does exist is not easy to determine for the circuit becomes very complex. It becomes still further involved from the fact that a voltage is introduced into the common condenser from an external source. It is called external because it is not introduced in the proper direction but rather in the reverse direction. When circuits are so arranged they should not be called coupled circuits but entangled circuits.

Modulation

Many suppose that there is some kind of modulation involved in filter circuits. There is none whatever. There is only coupling of two circuits and the degree of coupling determines the width of the transmission band. When two equal circuits are coupled, the two being tuned to the same frequency when one is away from the influence of the other, there are two resonance peaks in the combined circuit. One of these resonance points is higher by a certain amount than the resonance

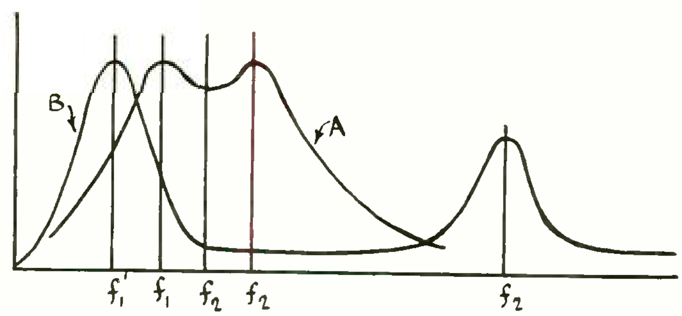


FIG. 2
Curves illustrating the effect of varying the coupling between the two resonant circuits in a band pass filter such as that in C of Fig. 1.

frequency of either alone, and the other is lower by the same amount. The distance, in frequency, between the two peaks depends on the degree of coupling.

The statement that one resonance peak is higher and the other lower than the resonance frequency of either alone seems to violate the principles discussed above, since in A and B one of the resonance points was determined by the inductance and capacity in either circuit. There is no discrepancy, however, if we use the proper inductance and capacity in each case. In D of Fig. 1 the statement is obviously true. Here the inductance in the simple circuit has been expressed correctly. What is true of D is also true of C since they are equivalent.

Analysis of Circuit Peaks

A and B in Fig. 1 are suitable for analyzing the circuits qualitatively to see what happens to the transmission band when the common impedance is varied. No matter what the value of the common impedance one of the resonance points is determined by L and C, as these are defined in this case. Hence this point remains fixed as the common impedance is varied. The other point is determined in part by the common impedance. Let us consider circuit A. As Cm is decreased the coupling between the two circuits increases and Cm exerts a greater and greater influence on the frequency of the second resonance point. If it is zero it alone determines the frequency. That is, C does not exert any influence. Since the resonance frequency of a coil of finite inductance and a zero condenser is infinite, the band width continually increases as Cm is decreased by pushing the second resonance point to higher and higher frequencies. When the coupling condenser is zero there is only one resonance point for all practical purposes.

When Cm is increased the second resonance point moves in the other direction, that is, toward the first. When Cm is infinite, again, there is only one resonant point, or there are two coincident points, which amounts to the same thing. But then there is no coupling and no voltage gets into the second circuit and of course the filter does not serve as a coupler.

When Coupling Is Inductive

Let us now consider circuit B. As before the first resonance point is determined by L and C and it remains in the same place no matter what the degree of coupling. The second resonance point depends on Lm in the same manner as on L. Suppose now that Lm increases. The total inductance in either circuit increases and the frequency is lowered. When Lm is infinite the resonance frequency is zero. Thus in this case the transmission band widens by pushing the second resonance point toward zero away from the first point. When Lm is infinite

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A "Flat Top" Characteristic

Transmission Band Does Not Stop the Outside Frequencies

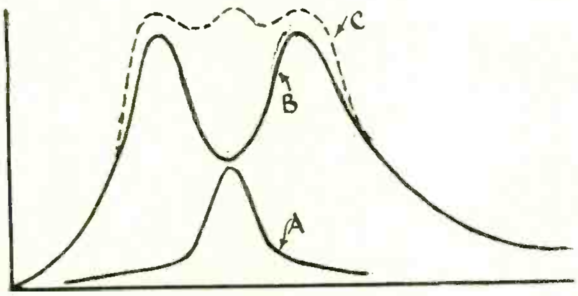


FIG. 3
Curves illustrating the effect of combining a band pass filter with a simple tuner and adjusting the constants so as to get a flat top charatceristic.

there is therefore only one resonance point, that determined by L and C.

As Lm decreases the second resonance point moves in the opposite direction toward the first, but it cannot go beyond this point for when Lm is zero it can have no effect on the circuit. There is then no coupling between the circuit and the filter is not a coupling device.

Case of Mutual Coupling

Circuit D can be treated exactly the same as circuit B where 2M takes the place of Lm and L—M takes the place of L. As 2M decreases M of course also decreases. Therefore as the coupling between the two coils decreases the resonance frequency decreases toward that determined by L and C, and we have the case when the two circuits in C, Fig. 2, are very far apart. There is no coupling between the coils and the circuit is useless as a coupling device in a circuit.

Since M is a mutual inductance between two equal coils, M cannot have a value greater than L, which occurs when the coupling is unity. When this is the case L—M equals zero and 2M equals 2L. Hence the inductance in either half of the circuit is 2L. The frequency is therefore determined by 2L and C. As the lower peak moves to this value the other moves to infinity because L—M equals zero, for a finite condenser and a zero coil resonate at an infinitely high frequency.

Why Less Capacity

The fact that the finite resonance point moves to the value determined by 2LC explains why the capacity of the tuning condenser must be reduced to maintain the resonance at a given frequency when the coupling increases. When the coupling is unity the condenser should be only one half as great as when the coupling is zero for the effective value of the inductance is twice as great. The LC value must be constant for a given frequency.

Misconception of Transmission Band

There is a common misconception about the nature of the transmission band. It is believed by many that inside the transmission band every frequency passes without any attenuation and that outside nothing can get through at all. The fact is that in some cases there may be no transmission inside the band, while there may be considerable transmission outside. The meaning of the transmission band is nothing more than the difference in frequency between the two maxima, or peaks. If the peaks are far apart there may be practically no transmission inside the band, say half way between the two peaks. Yet there may be considerable transmission just outside the peaks.

Consider Fig. 2, for example. There are two cases represented, A for moderate coupling between the two circuits, and C for close coupling. In both cases the resonance of either circuit alone falls at f. Curve A shows two peaks, one at f1 and another at f2. At f there is less transmission than at either peak, but not much less because the coupling is moderate. B also shows two peaks, but they are far apart because the coupling is close. At f the transmission is nearly zero. At f'1 it is great while at f'2 it is less but still much greater than at f. It is the f'2 peak that moves on to infinity as the coupling increases while f'1 moves to that value determined by 2LC.

Optimum Coupling

The best coupling, perhaps, is that which is called the critical. It is that coupling at which the hollow at f just disappears. This is determined largely by the resistance in the two circuits for it is the resistance which determines how deep the hollow is for a given separation between the two peaks.

In some cases, however, a little dip in the center can be tolerated and may be advantageous. If f is the carrier frequency and the circuit is so adjusted that it falls exactly at the deepest part, the low notes will not be amplified so much as the higher and there will be some compensation for excessive selectivity elsewhere in the receiver.

Combination Circuit

It is possible to combine a circuit having a band pass characteristic like that in A, Fig. 2 and one having a single peak, that is, a simple tuned circuit, so that the top of the combined curve is practically flat. It will really have three peaks, but the constants are so proportioned that they are equally high. The hollows between any two adjacent peaks will then be negligible. This is illustrated in Fig. 3. The band pass filter curve B is combined with the simple tuner curve A to form the band pass curve C.

Users Confused by DC and AC

RADIO dealers throughout the country are constantly called upon to explain the difference between direct and alternating current sets. The answer to this question involves the history and development of electricity over half a century, according to Frank Aiken, chief radio engineer of the Atwater Kent Manufacturing Company, Philadelphia.

"A direct current of electricity," said Mr. Aiken, "might perhaps be compared to water in a river flowing constantly in one direction. Alternating current would be the tide moving alternately in and out of a coastal bay or inlet. As with the two forms of water movement, both forms of electric current possess power and require somewhat different means to extract this power.

First Worked on DC

"It so happened that the engineers worked first with direct current on a considerable commercial scale. The early direct current installations, chiefly used at that time for lighting, were called Edison networks. For some time the direct current was accepted as the one and only system, and in a considerable number of the larger cities Edison systems were installed.

"A little later its commercial rival, the alternating current, was brought forward through the work of Nikola Tesla, B. G. Lamme, William Stanley and other scientists and engineers. It has turned out that for general commercial application a very large proportion of electrical power developed and used in the world today is of the alternating current variety; direct current has fallen back to more or less special uses.

"Alternating current apparatus of a rugged and reliable character, and in very large sizes, can be built more cheaply and operated more easily than can direct current machinery.

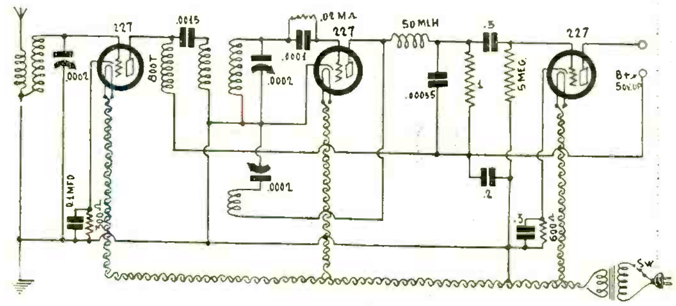
"The direct current system has economic limitations in the delivery of power at any considerable distance, whereas alternating current can be raised to a very high voltage for efficient transmission, and then stepped down to service pressures.

"On the other hand, direct current motors will give finely divided speed graduations of value for work requiring exacting and flexible speed variations, such as the drive of electric trolley cars, elevators and printing presses. Direct current is also essential to electroplating, and is preferred for electric welding."

A Midget Short-Wave Set

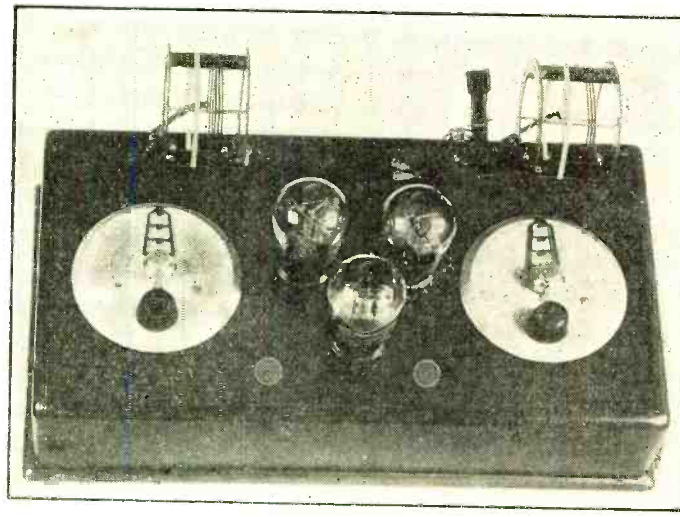
It May Be Used as Receiver or as An Adapter

[In last week's issue, February 14th, was published an article describing two battery-model short-wave receivers which may be used also as adapters, the tubes being three 227s with heaters in series, in one instance, and three 230's in the other, while the third model, Fig. 3 last week, was that of an A circuit. The list of parts for the AC circuit is published herewith, together with the schematic diagram and a view of the finished product.—EDITOR.]



THE AC model combination short-wave receiver and adapter has a built-in filament transformer, to supply the parallel-connected heaters. Essentially the circuit is the same as that of the battery models, and the performance is the same as to all three models.

The circuit, if used as a receiver, enables earphone reception of short waves, using two tuned circuits, and providing adequate selectivity, with high sensitivity. If speaker volume is desired, the plate of the last tube may be connected to the plate prong of a detector socket in a broadcast receiver, from which socket the detector tube has been removed.



The knob to the right of the front tube is for the regeneration condenser, which is connected between the tickler coil and ground, while the knob to the left of this tube is for the AC switch, which is of the shaft type.

Precision type plug-in coils are used, there being a total of six coils to plug in, or three pairs, while if the tickler winding that is built on the receptacle s considered as an extra coil, there are, all told, seven coils. The wave range is from 15 to 150 meters.

Sharp tuning prevails on the right-hand dial, while there is somewhat greater leeway on the left-hand dial, except when very weak signals are received, when the setting of both dials is somewhat critical, but to overcome any difficulty ultra-vernier dials are used that have a reduction ratio of 20-to-1.

LIST OF PARTS—

FOR FIG. 3—

Coils

One set of precision de luxe coils (six coils and one tickler, total 7 coils; no base receptacle needed, as it is on panel).
One 800-turn duolateral wound radio frequency choke coil.
One 50. mlh. RF choke coil.
One Polo 2½ volt filament transformer.

Condensers

Three Hammarlund .0002 mfd. short-wave midline junior tuning condensers.
Three fixed condenser blocks, three condensers of 0.1 mfd. in each block.
One Hammarlund equalizer (100 mmfd.).
One .00035 mfd. fixed condenser.

Resistors

One 300 ohm Electrad flexible biasing wire-wound resistor.
One 600 ohm Frost wire-wound resistor.
One Lynch .02 meg. pigtail metallized resistor.
One Lynch 0.1 meg. pigtail metallized resistor.
One Lynch 5.0 meg. pigtail metallized resistor.

Other Parts

One Hart & Hegeman shaft type switch.
Two knobs for switch and feedback condenser.
Two Ultra-Vernier REL dials.
One 7x14-inch bakelite drilled panel.
One walnut-finish midget cabinet to fit.
Three five-prong sockets.
Two wire leads for antenna and ground.
One wire lead for B plus.
One twin assembly for plugging in phones.
One dozen small nickel-plated 6/32 nuts, and one dozen ½-inch nickel plated round-head 6/32 machine screws.

Testing for Opens and Shorts

THE radio experimenter often wishes to find out whether there is a break in a circuit or an instrument, or whether there is a direct connection where non is wanted, called a short-circuit.

A simple device to employ for testing in these cases may be made up of a dry cell and a voltmeter, preferably of the high-resistance type. One wire from the voltmeter is connected to one terminal of the battery. A length of wire is then connected to the other terminal of the battery. This wire and the remaining lead from the meter become the two test leads. If these two wires are touched together the voltmeter will register. Similarly, if they are touched to any two points in the radio set between which there is a metallic contact, the meter will register.

A diagram of the receiver, showing all the connections, is a worth-while preliminary. Any batteries in the set should be disconnected, or if it is an AC set, turn the set off. Care must be taken to note whether there are any external circuits such as through the ground, through the filaments of the tubes, etc., which would affect the tests which it is intended to make.

Suppose you wish to test a fixed condenser for a short. The test leads are touched to opposite terminals of the condenser. A momentary movement of the meter may be noted, due to electricity from the battery charging the condenser. No permanent reading is noted, however, where there is no short or internal break in the condenser.

In testing for a break, the test wires are touched to two points between which the diagram indicates a metallic connection. If no reading is seen, a break is indicated.

The primary or secondary winding of an audio transformer may be tested in this manner, although the reading of the meter will be less than that of the battery because of the high resistance of the fine wire used to wind the transformer.

A pair of headphones may be employed in place of the voltmeter, although care must be taken not to be misled by clicks caused by the capacity of condensers or other parts of the set. A definite connection is indicated by a very strong click as the connection is made and again as it is broken.

A Precision Type V

By Bruns

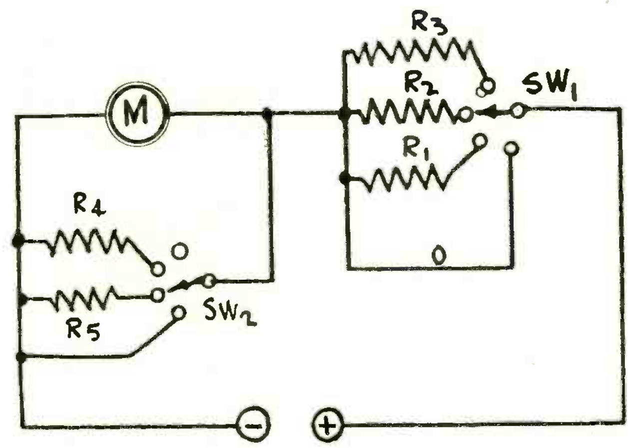


Fig. 1
The circuit of a volt-ammeter with three voltage and three current ranges made with a 0-1 milliammeter.

ALL radio service men and most fans want some kind of testing device for tubes and receivers. This device must be cheap, accurate, and widely applicable. There are on the market devices which meet the requirements of accuracy and applicability, but these are expensive and they are not as flexible as they should be to enable the user to make tests on different receivers.

Is it not possible to combine these requirements in a single testing device, that is in one device that will be cheap, accurate, and flexible? It is. But in order to keep down the cost we are confined to a single meter. To be accurate it is necessary that this meter be of high quality, and to be flexible the single meter must be available for both current and voltage measurements in many different positions. This means that the meter must be more or less independent of the test circuit, that is, it should not be tied to a particular function in a particular place in the test circuit.

It is possible by means of a multiplicity of switches of different type to throw the single meter into almost any position in the circuit and to convert it to a voltmeter or current meter as the case may require, and at the same time have many ranges in each function. But a multiplicity of switches complicates the circuit so that it is difficult to learn its many applications and in the process of learning there is danger of causing damage to the meter. Moreover, the switches add to the cost so that the device is no cheaper than if several meters were used.

The most flexible device is a meter that may be used either as current meter and that is in no way connected to anything except when it is to be used for a particular measurement. We might illustrate this with an analogy. A steel tape graduated in inches and feet is applicable to the measurement of lengths everywhere and anywhere. But suppose that steel tape is riveted to a machine for measuring a certain dimension of that machine. The rule is then no longer useful for measuring any other length, at least not directly. It is the same with a meter that is tied in a circuit in a particular place.

Practically all that is needed in a test set is a means whereby the various leads in a receiver are made available for measurement with an independent meter. There is no reason at all for tying the meter to anything until a particular measurement is to be made. It is with this idea in mind that we shall describe a really flexible test set.

A suitable meter for a tester of this type is a 0-1 milliammeter. With suitable multipliers this will make a 1,000-ohms-per-volt meter of any desired range. Also, with suitable shunts it may be used for measuring currents from about 50 microamperes to 100 milliamperes, or higher. These ranges will cover practically all conditions that may be met in a receiver.

For voltage three ranges are sufficient. These might be 0-10, 0-100, and 0-500 volts. Accordingly, three multipliers are necessary, R1, 10,000 ohms, R2, 10,000 ohms, and R3. 500,000 ohms. (See Fig. 2.) Only good wirewound multipliers should be used and those which are guaranteed to be accurate to at least one per cent. Such resistances are made by several resistor manufacturers.

In Fig. 1 there is a switch Swl for selecting the desired multiplier. This has four points, or stops, one for each of the multipliers and one for zero resistance. The zero resistance stop is used when the meter is to be used as milliammeter and must never be used when voltage is to be measured for it would be disastrous to the meter.

The current ranges when the meter is used as a milliammeter should be 0-1, 0-10, and 0-100 milliamperes. The first requires no shunt, for the meter itself is a 0-1 milliammeter. Hence the first stop on switch Sw2 is a blank. This blank stop, by the way, should always be used when voltages are measured for otherwise the instrument will not be a 1,000-ohms-per-volt instrument. The first shunt, connected to the second stop, is for 0-10 milliamperes, and the second shunt, connected to the third stop, is for 0-100 milliamperes. The values of these shunts depend entirely on the internal resistance of the meter and therefore they cannot be specified without reservation.

However, we can determine their values in terms of the internal resistance of the meter. Suppose this resistance is R. At full scale the current through the meter, and hence through R, is 1 milliampere. But since the total current is to be 10 milliamperes, the shunt resistance must be such that 9 milliamperes flow through it when 1 milliampere flows through the meter. Since the voltage drop in the meter and in the shunt is the same we have the relation R=9R4, and the value of the shunt should be one-ninth of the resistance of the meter. In the Weston 301 instrument the internal resistance is 40 ohms. Therefore the 0-10 milliampere shunt should be 40/9 ohms, that is, 4.444 ohms.

For the 0-100 milliampere shunt we have by the same reasoning, R=99R5, or R5 should be R/99. If the meter is the Weston, the 0-100 milliampere shunt should be .404 ohm. It requires very careful adjustment to get to proper value of shunt due to the fact that the values are so small. Heavy resistance wire should be used or it will be almost impossible to effect the adjustment. It may even be necessary to use copper wire, in which case fine wire may be used.

Protection of Meter

On switch Sw2 there is also a stop to which a dead short is connected. This is mainly for the protection of the meter. If Sw2 is set on the short-circuit point no damage can take place to the meter even if Swl should be set on the zero point when a high voltage is applied. The damage will happen to the voltage source or to the leads.

Two binding posts are provided for the meter for making any desired connections. Binding posts are suggested in place of the more common flexible leads used in testers because leads may break, when it becomes necessary to open up the instrument for making repairs. When binding posts are used it is only necessary to put in other leads, which may be simple wires.

There is a double check on the meter to protect it, whether it is used for voltage or current measurements. Switch Swl should always be set on R3 and Sw2 on the short-circuit shunt at the beginning. For voltage measurements the shunt switch

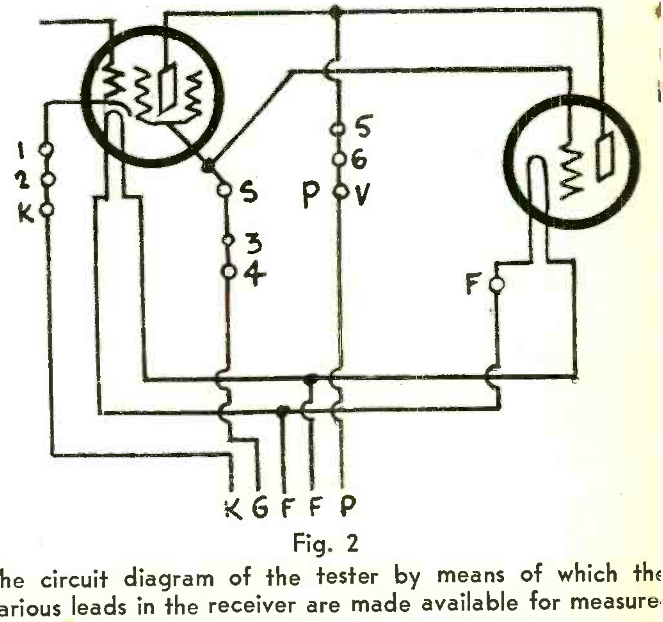


Fig. 2
The circuit diagram of the tester by means of which the various leads in the receiver are made available for measurements.

/olt-Ammeter-Tester

ten Brunn

should be moved gradually over to the open stop before Sw1 is moved from R3. Then when Sw2 is on the open stop Sw1 should be moved gradually to the correct point. But make a step only when it is ascertained that it is safe to do so. For example, if the reading on the meter is more than one-fifth scale when the switch is on R3 it is not safe to move it to R2. If the reading is less than one-fifth scale the switch should be moved to R2. If now the reading is more than one-tenth scale it is not safe to go to R1, but if it is less than one-tenth the step should be taken. It is not safe to go to the zero stop if there is any reading at all on step R1.

Almost any lead in a receiver may be made accessible by means of an arrangement such as that depicted in Fig. 2. Two sockets are provided, one for UY tubes and another for UX tubes. A third UY socket can be provided for terminals. This will obviate the necessity of using a long cable permanently attached to the test assembly. This UY terminal socket may be used for both types of tubes provided that at the receiver end of the cable that is used an adapter is used so that it may be plugged into either type of socket.

On the circuit of Fig. 2 is a number of tip jacks making connections to the various leads. Some of these are for voltage and others for current. For measuring voltage the negative terminal of the meter in Fig. 1 is connected to ground of the receiver by means of a lead, or to B minus in case that is different from ground. A tube is taken from the set and put in the appropriate socket on the tester and the cable plug is inserted in the socket vacated by the tube. Now the positive terminal of the meter in Fig. 1 connected to one of the voltage tip jacks. If it is connected to K the voltmeter will read the grid bias on the UY tube whether this is a screen grid or a three-element heater, but only if the bias is obtained from the drop in a resistor. If the lead is connected to F the voltmeter will read the grid bias on the UX tube provided that the bias is obtained from the drop in a resistance. Either of these fails when the bias is obtained from a grid battery.

Measuring Plate Voltage

When the positive lead of the voltmeter is connected to S the screen voltage is obtained and when it is connected to P the plate voltage is obtained. If, however, there is any impedance in the screen lead the reading obtained will be too low, but nevertheless it gives a good indication. The voltage obtained at P is always too low because the plate load impedance is in the circuit. In the case of radio frequency amplifiers the voltage obtained is nearly the full value but in the case of resistance coupled amplifiers just a faint flicker may be obtained even when the applied voltage is as high as 300 volts. Just how much low the reading is depends on the value of the plate coupling resistance.

The screen and plate voltages obtained in this manner, assuming that the voltage drop in the load is negligible, is the sum of the plate and grid voltages. The screen voltage as measured should be subtracted from the screen and plate readings to get the effective applied voltages. But it may be that the error due to the load is greater than the screen voltage. All testers are subject to this error, but in this tester the error is small due to the fact that the meter is a 1,000 ohms per volt instrument. Even so, in resistance coupled circuits the reading must not be taken literally.

For the measurement of current it is necessary to cut the milliammeter in series with the lead the current in which is to be measured. But the circuit must be closed when the meter is not connected for taking a current. Thus a closed circuit jack is required for each lead. There are tip jacks of this type available and they are recommended. There are two tip jacks for each position, but only one of these need be of the closed circuit type. This is such that when the tip is inserted the original circuit is broken and the meter cut into the break.

Jack (1) and (2) are for the measurement of the sum of the plate and the screen currents, jacks (3) and (4) for the measurement of the screen current alone, and (5) and (6) for the measurement of the plate current alone.

When a UX tube is under measurement (1) and (2) will not yield a current for the circuit is open. When a 227 tube is in the socket no current will be obtained in (3) and (4), for they are then in the grid lead. Neither will the grid voltage be obtained at S with the meter connected as suggested. It will be necessary to reverse the terminals and put the negative at S and the positive on the ground of the set, or better to put the positive at K. When this measurement is made it must be kept in mind that there may be a high resistance in the grid circuit which will cause a lower reading than the bias on the tube.

When readings are taken on screen grid tubes the grid clip in the set must be connected to the cap on the tube in the tester. Otherwise the currents and voltages will not be correct, since the grid bias will be incorrect.

It will be noted that if the negative of the voltmeter be connected to F or K and the positive to P, the plate voltage alone is measured. This measurement is possible by virtue of the fact that the meter is independently available for connection anywhere. The use of F is allowable whether DC or AC is used on the filament, because the AC does not register on the DC voltmeter.

The instrument does not measure either filament voltage or current, but this does not matter much. If the filament current is up the plate current will be up, assuming normal values on the filament current or voltage. The most suitable voltmeter is one that measures the line voltage.

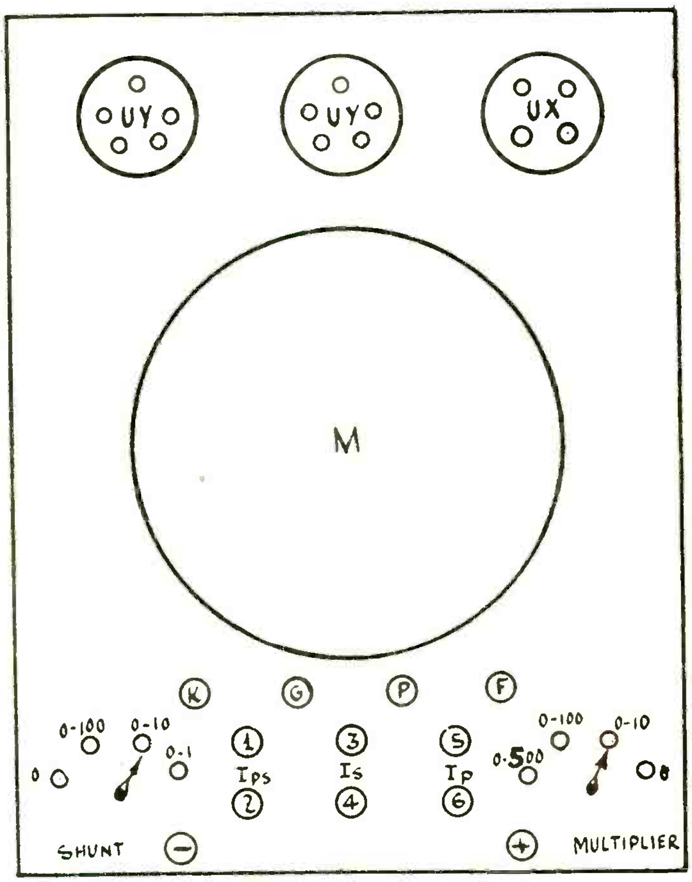


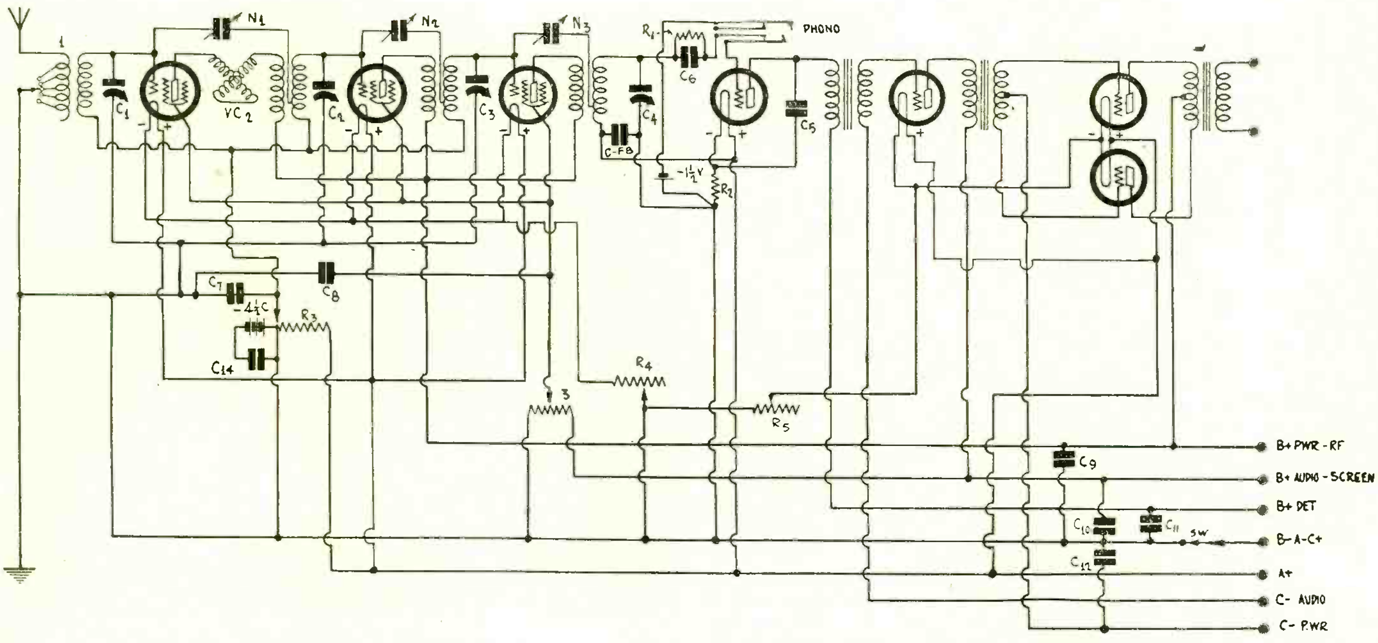
Fig. 3
A suggested layout of the tester.

LIST OF PARTS

R1—One 10,000 ohm wire wound resistor.
R2—One 100,000 ohm wire wound resistor.
R3—One 500,000 ohm wire wound resistor.
R4—One 4.444 ohm resistance.
R5—One .404 ohm resistor.
Sw1, Sw2—Two four-stop switch.
One 0-1 milliammeter.
Two binding posts.
Seven plain tip jacks.
Three closed circuit tip jacks.
Two UY sockets.
One UX socket.
One connecting cable with UY plug at each end.
One adapter for matching UY plug to UX socket.
One flexible lead for connecting grid clip in set to grid cap in tester.
Two short flexible leads for connecting meter to jacks.
One panel 5x6.5 inches.
One wooden box to match.

Remedies for the Two

By Henry



Some circuits have local-distance switch in the antenna circuit or elsewhere to atone for low response at high wavelengths. This circuit has a four-point switch, besides the aid of variometer regeneration.

TWO of the commonest troubles with radio receivers, and yet not given much attention in various trouble-shooting articles, are failure of wave band coverage, and decline in sensitivity on the higher wavelengths to the vanishing point.

Most articles deal with specific instances of trouble, whereby selectivity is poor, sensitivity low throughout, receiver totally dead (if you will forgive comparative degrees of death), motorboating, radio frequency oscillation, and current, resistance and voltage checkups. The ideas are presented from the viewpoint of a service man, to help him solve the material problems that arise in a day's work. But it is also within the scope of a service man's experience to find receivers that do not cover the wave band or that are low in sensitivity only at high wavelenghts, say, from 450 meters up, for the set may be very sensitive at the low wave end, and may even squeal then.

Verify the Complaint

On the question of wave band coverage, there is one solution that can be introduced always, although it is not a practical method, in the sense that the remedy may be applied quickly and at little expense. A new tuning condenser or gang condenser, of considerably higher maximum capacity than the one now in the set, may be substituted if the complaint was that the higher wavelength stations, say those above 526 meters, are beyond the tuning characteristic.

Even so, it is necessary first to verify the complaint. This does not consist of going to a notary, as no verified complaint in the legal sense is desired, but just a check-up to determine whether the condition complained of is due really to failure to cover the wave band with the tuning system, or whether failure to receive the higher wavelengths is due instead only to decreased sensitivity in that region, perhaps plus remoteness of all such stations from the point of reception.

As a pointed example, one man, living in New York City, admitted that he had a great set, except for one thing, the missing stations above 526 meters. In New York two stations, WMCA and WNYC, are on this frequency, one at a time, however, one must add thankfully. Therefore any stations that would be received above 526 meters would be distant stations.

"I don't know why the manufacturer made an expensive set that tunes only up to 526 meters," stated the semi-proud owner of the great set. "I'd give $25 to any one who would remedy the defect."

Service Man Smells a Rat

The service man, in a radio retail store, to whom these remarks were addressed, quite properly asked:

"At what setting on the dial does WMCA or WNYC come in?"

"Why, at 570," was the reply.

He had a set that was calibrated in kilocycles and 570 kc was simply the frequency of the two stations.

The service man then surmised the correct answer immediately. Any manufacturer who puts out a set with dial calibrated in frequencies must take precious good care that the readings at least approximate the frequencies stated. Moreover, any failure to cover the whole band would be advertised by such a calibrated dial, so it was assumptively a case of diminished sensitivity rendering reception impossible, not failure to cover the wave band.

"When you turn your dial, say from 600 kc in the direction of 570, can you turn it quite a distance farther, before reaching the end?" asked the professional.

"Yes," answered the customer, "but what good does it do me? The set does not tune any higher, even though I can rotate the small knob almost a quarter turn before reaching the end."

All Set for 25 Bucks

The "quarter-turn" of course, was accounted for by the reduction ratio of the vernier dial used. With a 5-to-1 reduction ratio, one full turn of the knob meant one-fifth the expanse of the dial, or 36 degrees of a circle, assuming a 180-degree total dial rotation or condenser roto swing, and one-quarter turn, 9 degrees.

"Well, aren't there numbers lower than 570?" asked the service man.

"Yes, the numbers run to 550," replied the customer.

When the service man visited the customer's home he was all prepared to increase the sensitivity at the high wavelengths and collect the $25. Now, what do you suppose he did to earn that money?

How He Got Away with It

First, he added 50 feet to the aerial length. Then he tested the set for practical selectivity. It was still good enough, despite the increased input to the first tube, and without cross-modulation. Two stations did come in at waves higher than 526 meters. It was found that the response below 400 meters was tremendous, and the falling off on the higher waves was gradual but quite obvious, until near the end of the dial it was bad.

Fortunately the set did not squeal at the lower wavelength or cross-modulate, so the service man "loosened" the shielding around the radio frequency coils, by putting 1½ inch high bushings under the shield mounting feet. Then the shield absorption was less, and the reduction of the damping effect improved the situation sufficiently to make the customer comply with his hasty offer and pay the $25.

It should be emphasized, however, that raising the shields above the coils usually has no effect at less than 1½ inches, while sometimes 2 inches or more are required.

"Pretty soft for you," remarked the customer, "collecting $25

Commonest Troubles

B. Herman

for half an hour's work, a few feet of wire, eight bushings and a few nuts and screws."

"Well," countered the beneficiary, "it was you who made it soft for me."

Manana, Was His Reply

"What would have been the normal charge for such service?" asked the specialist in post-mortems.

"I'll tell you that tomorrow."

And, sure enough, the next day the service man took the pains to telephone the customer that the normal charge would have been $2.50. The customer had paid ten times too much, yet he wasn't sorry, for the improvement was worth $25.

It is characteristic of tuned radio frequency that the amplification is less, the lower the frequency. This fact is generally well-known. But how to capitalize on that knowledge, as did this service man, is not so generally well-known. If circumstances permit easy remedies, such as a longer aerial and incomplete shielding, there's nothing to it, but if the set has a tendency to squeal at the higher frequencies, improving the radio frequency amplification by shield adjustment, will only make the squealing worse, and although lower waves will come in more strongly, the remedy will be worse than the ailment.

Therefore the squeal question is an important one in connection with the application of remedies.

Adding an Audio Stage

A certain degree of volume is required from the loudspeaker in the home. If the tuner squeals a little, even though the volume control will check this in regenerative control fashion, the aerial may be lengthened to build up the volume on high wavelengths, sections of a condenser gang relined so that resonance is established perfectly at a high wavelength instead of at some low wavelength, as is more frequent, and if practical means are present, a stage of low-gain audio frequency amplification may be added. Usually the best place is between the detector and the first audio stages, since then no trouble with push-pull reconnections is encountered.

The load on the detector may be made resistive, and a grid leak put in the next audio stage, as the material for resistance coupling including the isolating condenser of .01 mfd. or higher capacity, takes up little room indeed. If necessary, the push-pull stage may be made single-sided, to provide the extra socket, although a five-prong socket would have to be substituted in most instances, since a 227 tube would replace a 245.

A peaked radio frequency coupler to the detector is another method introducing an extra tube.

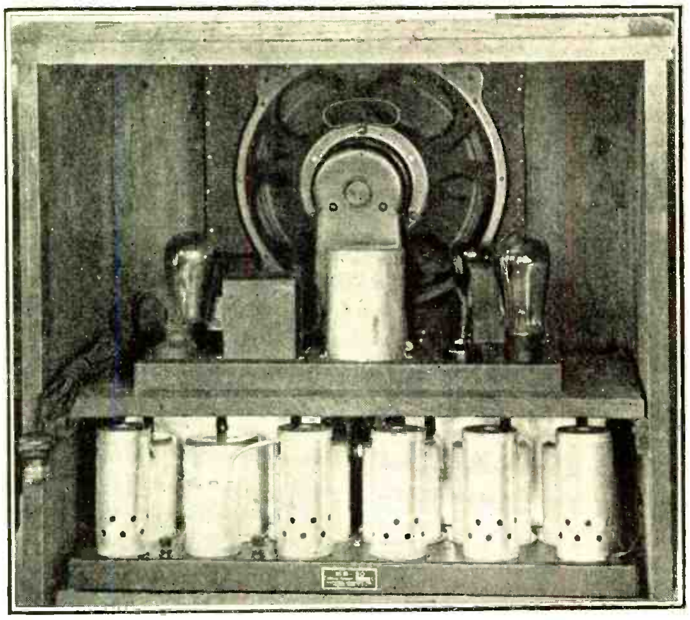
Effect of Shielding

The question of real failure to cover the wave band is one not so easy to solve. Apparent failure, due to insensitivity, may be remedied as outlined, but real failure requires either that larger shields be used than the ones now in the set, that these new shields be of aluminum or copper, if the present ones are tin (which is bad material indeed for radio frequency shielding), and even the coils themselves may have to be removed so that the secondary will be centered on the new shields. If the coil is nearer one wall than another, whether side, top or bottom, the losses pile up, and sensitivity is low.

A rather large capacity develops in the use of shielding, supplementing the drop in inductance due to energy absorption. A rough test may be made of a coil by tuning it outside a shield and then putting it in the shield to note the difference in dial settings. With a coil inside a shield less capacity would be needed from the tuning condenser to establish given resonance, were the added capacity effect of the shielding alone to be considered, but the inductance drop is likely to be considerable. So despite the capacity increment, much more capacity is needed of the tuning condenser for the resonant condition. In practice it works out just that way. Thus, if higher maximum capacity can be obtained, without increase of minimum capacity setting, or, preferably, accompanied by decrease of minimum capacity, if high waves were truly outside the frequency range of the circuit, they may be brought within the range.

Adjustment of Turns

As for number of turns, if the set actually fails to tune high enough in wavelength (one taking care not to be fooled by the sensitivity drop), more turns on the tuned windings will bring in these desired waves. But this method also increases the minimum wavelength to which the circuit will tune, so before more turns are applied, it must be ascertained whether the set now tunes well below 200 meters. If the lowest wave can be tuned in, 200 meters (1,500 kc) with 10 divisions or so to spare, a few more turns may be added with safety. However, it is usually found that a set that does not tune high enough also does not tune low enough, due to the high losses



A radio frequency coupling system, broadly peaked around 550 meters, is used for levelling the response from the sensationally sensitive MB-30 tuner, shown with power amplifier.

from tin shields, or even from aluminum shields too small for the diameter coils used; or, a manufacturer of a cheap set found he could not cover the wave band, so obviously concentrated the cut-off at one end.

Tightening the coupling will improve high wavelength response, while reducing practical selectivity. But the set may not be selective enough to stand this remedy. Simpler by far is the same remedy in its earlier form, lengthening of the aerial, as then you don't have to fuss around with parts difficult of access and best left alone, if that is still consistent with application of a remedy.

Adding Turns

As adding more turns to the tuned secondary increases the maximum wavelength that can be tuned in, and also the minimum wavelength, so taking off turns reduces the maximum and minimum waves to which the circuit will respond. The question to settle when the set tunes high enough, but not low enough, in wavelength is: Do you have enough capacity to spare at the higher wavelength end, to justify taking off turns?

Sometimes a customer will provide an easy way out. (Such things really do happen!) He may say that the set does not tune in the local station that is his heart's pride because his daughter sings over it, and he would be much obliged if you can fix up his set so that he can tune in that station. You may explain to him that you can do it, all right, but he may not be able to tune above 526 meters or so. It may be news to him there are any stations so high in wavelength. He may not care two cents about going up that high. Then your remedy is simple: Take turns off the tuned windings until the lowest wavelength is reached. This may destroy the calibration of a dial on its frequency basis, but all such calibrated dials have the full range of broadcast frequencies printed or engraved on them, although sometimes this complete accounting is only on the dial, not in the set.

Tight Coupling

The condition that brings about failure to cover the wave band is generally due to shielding or tight coupling, or both. When two windings in inductive relationship to each other are close together, with the same number of turns, or with even a 1-to-2 ratio, the capacity between them is large enough to add substantially to the minimum capacity setting of the tuning condenser. Failure to cover the wave band results, whether the cut-off is at the high wavelength end or the low wavelength end, or at both ends.

In circuits for kit construction, it is customary, since shielding became popular, to use .0005 mfd. as the tuning capacity, as then the danger of such a cutoff is easily avoided, simply by proper coil design and proper shield design, material and location.

(*Continued on next page*)

How to Get Selectivity

By Brainard Foote

WHAT is selectivity? It is the property of a radio set that enables it to eliminate all stations other than the station you wish to hear, within certain limits. A selective radio set is one that enables you to pick any station within range, without hearing any other station. You can easily make a set sensitive without making it selective, and vice versa.

Assuming that your set fails to give you the selectivity that you think it should give, what can you do about it?

Aerial and Ground

The practical selectivity is affected considerably by the electrical constants of the aerial system, which includes the ground. If there is much resistance in the aerial system, such as would be caused by poorly soldered joints, poor contacts, fine or broken wires, poor ground connection, etc., the selectivity may not be good.

In another way, the aerial affects the selectivity, depending on its length, closeness to the ground and nearness to other objects. A short but high aerial has a short natural wavelength and a set used with such an aerial is usually selective. The greater the aerial pickup, the poorer is the selectivity.

The set that is not selective because of aerial conditions generally gives very strong volume, especially on nearer stations. In such cases there are two remedies:

(1) Shorten the aerial to about 30 feet, including lead-in; (2) insert a fixed condenser of about .0005 mfd. capacity between the aerial lead-in and the aerial post of your set. This has about the same effect as shortening the aerial. If the aerial is as short as possible, consistent with fairly good volume, the selectivity will be very good. The volume will be less when a shorter aerial is used, also if a series condenser is inserted, while if both methods are adopted the volume reduction may be altogether too great.

Interference Nearby

Those living within five miles or so of powerful broadcasting stations are often put to it to cut out such stations to listen to something else. As a rule, where such listeners are within a couple of miles or so, the station operators are instructed to assist them in attaining the desired selectivity, in many cases going to the extent of furnishing wave traps or other devices for the purpose.

A wave trap is an inexpensive device which is essentially nothing more than a coil of wire and a variable condenser. The tuned coil is coupled to the aerial system by means of a smaller coil. When the tuning condenser is set so that it adjusts the circuit to the wave of the interfering station, a considerable part of the energy from the station is bypassed. The wave trap may have some effect on the tuning of other stations, but in thousands of radio homes a wave trap will be found serviceable to prevent interference from some station nearby. A wave trap may be necessary in your case if you are very close to one or more strong stations.

Set Conditions

What may be done with your set to improve the selectivity? Naturally, the design of the set plays the biggest part in determining the selectivity. In general, it takes a number of separately tuned circuits to achieve sufficient selectivity to cope with conditions nowadays.

However, something can be done without actually changing your set. If batteries are weak, resistance in them broadens the tuning. If the various stages of the radio frequency amplifier are out of adjustment, as evidenced by stations coming in at several places nearby on the dial, selectivity will be poor until the tuning condensers are correctly lined up again.

Modern Circuits

The tendency today is toward a radio set with about four tuned circuits in the radio frequency amplifier. If any individual circuit is made too selective, as can be done, the tone qualities are interfered with. The over-selective set tends to emphasize the low tones, giving an unnatural barrel-like tone. And when such a set is tuned a little "off" the exact wavelength of a station, the tone is then pinched and nasal, because the higher notes are heard alone.

Where a number of separate and successive circuits is used, each circuit need not be so very sharp in tuning, but the total effect is to tune fairly uniformly over a band of waves wide enough to admit must of the audio tones successfully, and thus give good tone without permitting interference.

Too modest a tuner, especially with screen grid tubes will result in broadness. This may be all right for local reception, but it will make distance work impossible or difficult when any nearer station is operating. So, you see, selectivity is a good thing unless its's overdone.

.00035 Mfd. Will Not Cover Wave Band

(*Continued from preceding page*)

Putting on or taking off turns is not a solution, since failure to cover the band, if present, would endure, the maximum and minimum frequencies of response simply being shifted, a different miss-out area being substituted.

So the .0005 mfd. capacity condenser is to be recommended for modern circuits. You will find it in the best factory-made sets and in the best kits, for instance the Hammarlund Roberts Hi-Q 31. When a smaller capacity is used, it is greater than .00035 mfd., because with the required shielding, and the space available, which restricts shield size, it is impossible to cover the wave band with .00035 mfd.

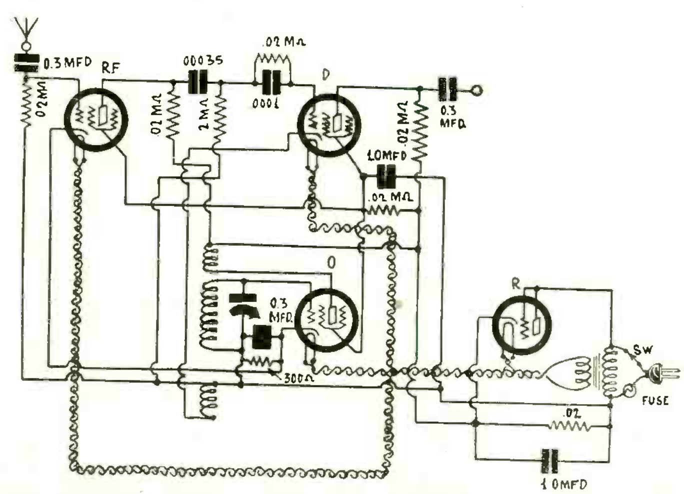
It is not the fault of the coil, but of the shielding requirement, plus the tight coupling sometimes present in coils, and the real grievance is against the choice of too low a maximum capacity for the tuning condenser in the first place.

Use More Than .00035 Mfd.

The capacity need not be fully .0005 mfd., if the coil and shield choices are scientific, because a maximum capacity of .00045 will cover the wave band. National Company's screen grid tuner, the MB-30, probably the most sensitive band pass tuner ever developed, and which brings in stations on every one of the ninety channels allotted to broadcasting, uses a condenser that has a maximum capacity of .00046 mfd. and of course covers the wave band. National Company studied the problem carefully, and solved it nicely by the use of space-wound coils, thus reducing the distributed capacity of the coil, and by effectuating just the right degree of coupling.

All first-class tuners and receivers cover the full wave band. Any set that misses out at either end or at both ends is in the cheap-set class, and it may well be that full coverage can not be attained without shield substitution, plus use of larger maximum capacity for tuning, plus adjustments of the inductance of the tuned winding (usually taking off a few turns), so that from 200 to 545 meters the set responds nicely, and, preferably, with a little to spare at both extremes.

A Suggestion for Rectification



Those desiring to experiment with a short-wave converter with rectifier (R) built in may try this circuit. RF is the amplifier, D the detector, O the oscillator.

Right or Wrong?

Questions

(1)—A hissing sound heard in superheterodynes and short-wave converters at some points of the dials and sometimes over the entire dials, is due to overloading of the modulator tube by the oscillator and can be remedied by loosening the coupling between the two.

(2)—A battery converter is better than an AC operated converter of similar design because there is less hum.

(3)—If the intermediate frequency of a short-wave converter be placed in the broadcast band near the 1,500 kc. limit and the converter is provided with a coil which will tune to 200 meters, there is danger of interference when the higher short waves are tuned in because the converter will act as a booster to the shorter broadcast waves.

(4)—A short-wave converter may be overloaded even if there is no audible signal coming out of the receiver.

(5)—Regeneration cannot be used in the intermediate frequency of a superheterodyne short-wave converter because the circuit will be so selective that no understandable signals can be obtained.

(6)—The fewer the parts used in a receiver for a given number of stages the better the circuit.

(7)—When putting shunts across a current meter to extend the range of the meter, the resistance of the meter has no effect on the value of the shunt.

(8)—The secondary of a push-pull input transformer may be used as a center tapped choke for coupling a detector to a push-pull amplifier.

(9)—Two-volt tubes are unsuitable for portable sets because the filaments are fragile and break easily.

(10)—The two-volt 232 screen grid tube is not as good an amplifier as the 224, because the internal resistance of its plate circuit is much higher, while the other characteristics are approximately the same.

(7)—Crackling sounds in a receiver which begin after the circuit is well heated up often are due to intermittent opening of the resistance in the voltage divider.

Answers

(1)—Right. This fact can be proved very easily by reducing either the input from the antenna or radio frequency amplifier, or by reducing the coupling between the oscillator and the modulator; that is, by reducing the number of turns on the pick-up winding. The hissing usually stops when either of these things is done.

(2)—Wrong. One is just as good as the other, provided reasonable precautions are taken to prevent hum. It is no more difficult to eliminate hum from converters than from radio frequency amplifiers.

(3)—Right. When the converter is designed and adjusted in this manner the converter acts as a booster of the broadcast frequencies because the intermediate frequency channel is not selective enough to separate the broadcast frequencies from the intermediate frequency generated.

(4)—Right. The overloading is caused by the oscillator and may occur even if there is no signal impressed on the modulator.

(5)—Wrong. While the sideband suppression increases with the selectivity and the regeneration and thus decreases the quality, a considerable degree of regeneration can be used before the effect is appreciable. This is especially true when the intermediate frequency is high.

(6)—Right. This is usually the case but it does not apply to by-pass condensers and filter chokes. It applies mainly to tuned circuits, taps, switches and such extras often put in the receiver.

(7)—Wrong. The value of the shunt depends primarly on the resistance of the meter. The current divides inversely as the resistance of the shunt and that of the meter, so that the shunt is always a certain fraction of the resistance of the meter.

(8)—Right. This is a very good use of a push-pull input transformer when the detector is a screen grid tube, for which the load impedance must be very high to cause effective coupling.

(9)—Wrong. They are the most suitable tubes for portable receivers because they require less current than any other tubes of similar characteristics. The filaments are no more fragile than those of many other tubes. The portable set is not supposed to be subjected to baggage-smashers.

(10)—Wrong. As far as the amplification characteristics of the 232 tubes are concerned these tubes are about equally good. The plate resistances are identical.

(7)—Right. Breaks sometimes occur in the resistance wire of the voltage divider, especially near the taps, and these breaks are intermittent. They close when the resistance is cool and open when it is hot. It is difficult to find such a break, for when tests are made the unit is usually all right. It should be tested while in use. Ultimately such resistors open permanently.

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EXPERIENCED SET CONSTRUCTOR, both short-wave and broadcast receivers. Man 20, desires situation. Harley Wood, Box 64, Fishers Island, N. Y.

EXPERT RADIOTRICIAN, trained and graduated by National Radio Institute, high school education, four years' experience in sales and service. Desires position with manufacturing firm. Karl C. Fischer, Gen. Delivery, Knoxville, Tenn.

YOUNG MAN, 21 YEARS OF AGE, desires position in experimental laboratory or factory. Has five years' experience as radio service man. Object is more experience rather than large salary. Will go any place in the United States. Harris A. Sprague, Jr., 48 Nelson Place, Worcester, Mass.

YOUNG MAN, 19 YEARS OF AGE, desires position in radio. Has had six years' experience in building broadcast sets, short-wave sets and transmitters. Interested in servicing and research work. George McClellan, 136 E. Arndt St., Fond du Lac, Wis.

YOUNG ELECTRICAL ENGINEER, 25 years of age, South American. Would like connection with radio manufacturing company to open branch in South America. Have references. D. C. Mendez, 236 Washington Ave., Brooklyn, N. Y.

YOUNG MAN, 25 YEARS OF AGE, with 7 months' training in short-wave at the McKim Radio and Electric School, Akron, Ohio. Would like work in laboratory of a radio manufacturing company. Very much interested in shortwave work. Willing to start at the very bottom and work up. Good character. John A. Williams, Box 13, Star City, W. Va.

27 YEARS OF AGE, TECHNICAL GRADUATE '23, experienced in radio work both in laboratory and in field, also in location department of large power company; speak, read and write Spanish; desire to locate in experimental work or in field; would consider location with some firm having branches in Spanish speaking locality. Good references on request. Address: Fairview, McKinley, Isle of Pines. Cuba.

NATIONAL RADIO INSTITUTE STUDENT wishes position in service and installation work. Jewell test equipment. Experienced in servicing. Willing to do any kind of work. Chas. C. Stutzenberger, 228 Turner Street, Allentown, Pa.

YOUNG MAN, 10 YEARS' EXPERIENCE in designing and building of radio production test equipment, production, designing home and automobile receivers, and elimination of ignition interference in motor radios, desires position with reliable company. Best of references. F. S. Palm, 5815 W. Roosevelt Road, Cicero, Ill.

WANTED, SITUATION. Experienced radio service man desires position. Call or write: Frank Lavallee, 218 Baxter St., Pawtucket, R. I.

INVENTIVELY INCLINED, and have diploma from Radio Training Association of America; would like to get in touch with radio factory with high-class laboratory. Former student in Electrical & Mechanical College of University of Kentucky. P. B. Kehoe, 2100 Lee Street, Fort Myers, Florida.

YOUNG, ENERGETIC MAN; several years' experience building and servicing sets. Has worked in Westinghouse & Electric Manufacturing Co. research laboratories. Excellent references. Free to travel. Not afraid of work. Desires location that will permit of carrying on schooling in pursuit of a degree. Russell J. Ramsey, Alpine Blvd., Wilkinsburg, Pa.

CERTIFIED RADIOTRICIAN. Also high school graduate and at present C. R. E. I. student. Can furnish satisfactory references as to character and ability. Address: H. F. Goodrich, 2020 Seminary St., Dubuque, Iowa.

YOUNG MAN, 33 YEARS OLD, mechanical, electrical and radio knowledge and experience, technical education, seeks position at anything. Paul Weber, 1822 Bleeker St., Brooklyn, N. Y.

SERVICE MAN, five years' experience, with two of Chicago's largest servicing companies. 27 years old, A1 man, good references. Have finest test equipment. Will go any place. Robert Murray, 1520 Howard St., Chicago, Ill.

YOUNG MAN 19, TECHNICALLY INCLINED, desires a position as assistant in laboratory. High School education, several years experimenting with radio and chemistry; formerly radio operator; interested in research work. Melvin Kocher, Pershing, Ind.

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Those not answered in these columns are answered by mail.

Radio University

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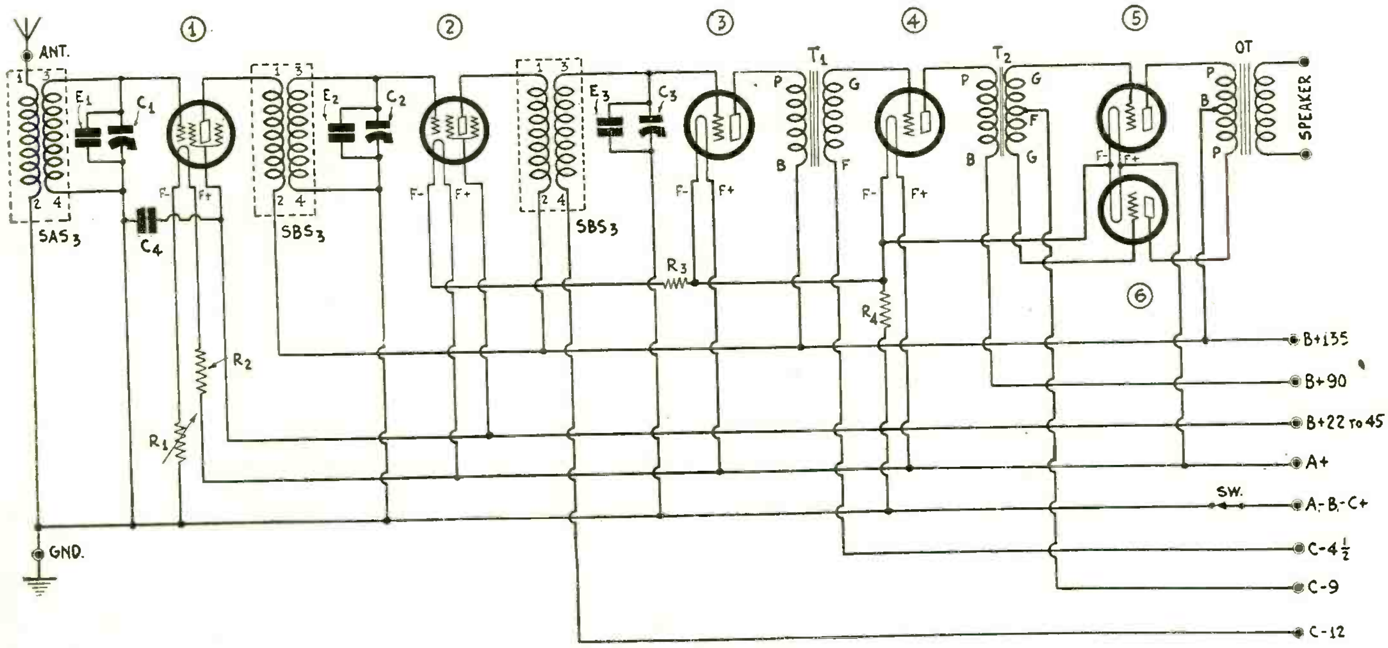


Fig. 892

The diagram of a six-tube receiver utilizing the two-volt tubes and suitable for a portable receiver as well as for a regular receiver in districts where AC is not available or not desired.

Battery Tube Receiver

I AM looking for a receiver incorporating two 232 screen grid tubes, two 230 tubes and two 231, the latter in push-pull. Will you kindly publish a circuit diagram of such a receiver. I desire to build it as a portable. You need not specify the parts, for I can figure this out for myself.—K. L. D.

Fig. 892 gives a circuit like the one you request. You will have to change the bias voltages to those required by the tubes you use. The bias for the power tubes should be 22.5 volts instead of 9 volts. It is recommended that you use a 3 volt battery for the filaments and that you adjust the ballast resistors on this basis.

* * *

Sizzling Condensers

I HAVE a receiver in which the filter condensers in the B supply are of the electrolytic type. They often sizzle. What is the cause of this? Can anything be done to stop it, or does it matter whether they do or not?—B. W. R.

This sizzling indicates that the condensers have broken down, either permanently or temporarily. The voltage across them is too high. If you reduce the voltage and the sizzling does not stop they have been damaged seriously and should be replaced.

* * *

Recording Broadcasts on Dictaphone

IS there a simple way of recording broadcast speeches and music on Dictaphone records? If so, what do you suggest?—V. M. C.

You can place the loudspeaker in front of the trumpet and have the speaker speak as an executive would in dictating a letter. This is the simplest way. It can also be done by putting a magnetic engraving unit in place of the present engraving device. The same type of engraving unit as is used in recording flat records can be used, provided it is arranged so that it will be carried along the cylinder.

* * *

Metals Are Reflectors

IF shields are effective because the electric waves are reflected by the metal, would not highly polished shields be more effective than dull-finished shields? It seems to me that this should be the case, because light waves, which are electro-magnetic, are reflected better from polished surfaces.—W. E. W.

Perhaps there is an advantage in polishing but it is very slight. Polish is a relative matter and if a highly polished surface were viewed through a high-power microscope it would not look so smooth. The surface will appear rough with ridges and hollows and scratches. The reflection of electromagnetic waves from a surface will depend on the relation of these irregularities to the wavelength of the incident radiation. Even a rough surface, such as dull-finished metal, may "look" much smoother to a radio wave than the most highly polished silver surface to a light wave.

* * *

About the Pick-up Winding

WHAT is meant by the pick-up in a short-wave converter and a superheterodyne?

The pick-up is the coupling device between the modulator, or first detector, and the oscillator. In most instances it is a small coil coupled to the oscillator coil and connected in the modulator tube circuit. Strictly speaking, the pick-up is the voltage impressed on the modulator by the oscillator, but it is common to call the coupling device the pick-up.

* * *

Field of a Condenser

WHAT is meant by the field of a condenser? Is it the same as the field of a coil?—B. B.

The field of a condenser is the electric intensity between and around the plates. Between the plates the field is intense; outside it is practically zero. By electric intensity is meant the voltage change per unit distance. The field of the coil is the magnetic flux through and around the coil. The two are related but they can hardly be compared.

* * *

Improvised High Resistance Voltmeter

I HAVE a galvanometer which has a maximum reading of 660 microamperes. Could this be used as a high resistance voltmeter? If so, what would be the resistance per volt and how much should the total resistance be for making the scale read 0-300 volts?—E. S.

It can be used for this purpose and the resistance per volt will be 1,515 ohms. For a 0-300 volt scale the total resistance would be 300 times the resistance per volt, or 454,000 ohms. Since the galvanometer has not been calibrated it would be necessary to calibrate the voltmeter.

* * *

Use of 227 for Rectifier

WOULD it be practical to use a 227 tube as rectifier in a B supply for a short-wave converter? If so, how many tubes would it handle? Could the same heating winding on the supply transformer be used for both the rectifier and the other tubes?—R. E. C.

It would be practical in some converters, provided the total current required by the tubes does not exceed about 15 milliamperes. This would include the bleeder current as well as the plate current. The same heater winding could be used for all the tubes, provided that the plate voltage does not exceed about 45 volts. It would not be safe to do so if the plate voltage is of the order of 135 volts, because then the insulation between the heaters and the cathodes might break down.

* * *

Works Without Ground

MY receiver works just as well without a ground as with one. Can you explain the reason why? The set is electric and my ground lead runs to the cold water pipe in the kitchen.—B. F. L.

It is often claimed that a receiver works just as well without a ground as with one, but the claims are hardly ever true, they just appear to be true. You have a lead running from the ground post on the set to the cold water pipe, but this lead is not the only ground, so that when you remove it you do not really change the circuit. The set is grounded through the power transformer and the ground on the line. Although there is no metallic contact between this ground and the set there is capacity, and this is large enough to ground the set effectively.

Band Passing Receivers

WHAT is the usual width of the band passed in modern receivers utilizing band pass filters? Is it 20 kc to allow for 10 kc in each side band, or is it 10 kc to allow 5 kc in each sideband?—B. W. L.

There is no standard width of the band passed by the different filters used, neither is the band constant throughout the tuning range. But the band is rarely 20 kc wide. More frequently it is less than 10 kc wide. When the coupling between the tuned circuits is by a small inductance or by mutual inductance, the band passed increases as the frequency increases and when the coupling is by means of a condenser the band width decreases as the frequency increases. As a rule, the width of the band is determined for the mean frequency in the broadcast band, which is nearly 910 kc. This is the geometric mean.

* * *

Two-Tuner Converter

IS it worth while to use two tuners in a converter, that is, to use one for the radio frequency signal and another for the oscillator What I mean is, will the selectivity and the sensitivity be improved enough to justify the extra parts and the complications—B. W. J.

It helps to have the extra tuner, although the selectivity is not greatly improved. However, by reducing the coupling between the oscillator and the modulator and also by using loose coupling between the antenna and the first tuner, the improvement in the selectivity is considerable without any appreciable decrease in the sensitivity.

* * *

The Best Ohmmeter

WILL you kindly explain which is the best method of measuring the resistance value of resistors and coils in a radio set? I don't care about high accuracy but only a value that is close enough for practical purposes?—C. L. D.

If you have a voltmeter and an ammeter or milliammeter, the best way is to measure the voltage of a battery and the current that flows through the unknown resistance when this measured battery is in the circuit. Then divide the voltage by the current expressed in amperes. See the explanation of the method in the Feb. 14 issue of Radio World.

* * *

Current from Dry Cells

WHAT is the maximum current that should be drawn from a No. 6 dry cell? I am planning a receiver using four 232 screen grid tubes, one 230 and two 231 power tubes. What will the total filament current be and how many dry cells should be used?—M. P.

Each cell of this size will supply 0.25 ampere, but it is better to draw less from it. The circuit you propose will draw 0.56 ampere and therefore you should connect three cells in parallel so that each would supply 0.1865 ampere. Since you will need 2 volts and one cell only gives 1.5 volts, you will have to connect two in series, and therefore you will need a total of 6 No. 6 cells connected in series parallel.

* * *

DC Receivers

WHEN the 2 volt tubes are used in DC receivers on a 110 volt line, what is the best way of connecting the filaments? I desire to use 232 tubes for radio frequency amplifiers, 230 for audio and two 231 in push-pull for power amplification.—B. W. C.

The best way is to connect the filaments in series as far as this is practical. If you are to use two 231 tubes in push-pull it is best to connect the filaments of these in parallel. The two will require 0.26 ampere, whereas each of the others requires only 0.06 ampere. Considerable juggling is necessary to give each tube the correct current. There is a way of connecting the two 231 tubes in series also, and this will simplify the filament circuit considerably. To do this, however, it is necessary to return the grids of the two power tubes independently to the filament circuit, so as to give each the proper grid bias.

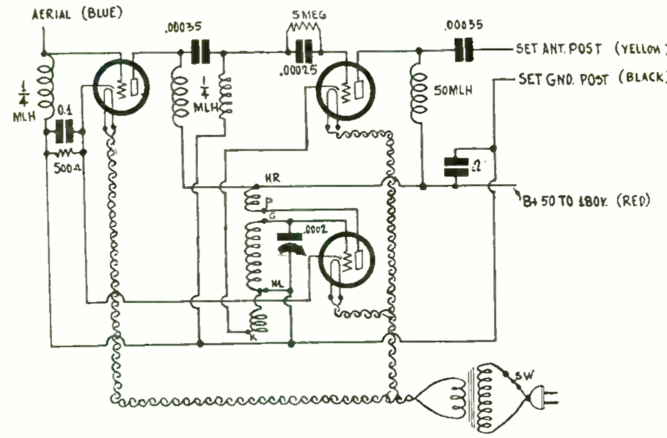


Fig. 893

A three-tube converter circuit containing a single tuner, that of the oscillator. The oscillator coil may be of the plug-in type if the socket is of the UY type, or any type having five terminals.

This requires that the secondary of the input transformer be split so that each side may be treated separately. There is one standard push-pull transformer made so that this is possible.

* * *

Midget Speakers

THERE are many midget speakers on the market, designed especially for midget sets. Is it possible to get as good quality from these as from the large speakers?—C. T. C.

It is quite possible to get equally good quality from these speakers but not quite so much volume because they overload more quickly. However, they will stand more than enough for any home without distortion. Since the diameter of these speakers is much smaller than that of the regular speakers, the low notes will not be reproduced as well, but this can be remedied by using the same size baffle board.

* * *

Three-Tube AC Converter

I HAVE the parts for a three-tube short-wave converter and should like to have a circuit diagram showing how to connect them up. Will you kindly publish it? The parts I have are three quarter millihenry chokes, one 50 mh. choke, a filament transformer for 2.5 tubes, some condensers and resistors, and some sockets for 227 tubes. I also have the tuning coil and condenser.—M. M.

The diagram in Fig. 893 may fit the parts you have. It does to the extent that you have listed your parts specifically. It is a good short-wave converter.

* * *

Small Condensers for Superheterodynes

IS it practical to use midget condensers having a capacity of .0002 mfd. in broadcast superheterodynes? That is to say, will these condensers cover the broadcast band satisfactorily?—W. H. J.

It it almost impossible to cover the broadcast band with a smaller condenser than .0005 mfd. and a .0002 mfd. is entirely too small. If the intermediate frequency is high it is possible to cover the band with the oscillator so that the .0002 mfd. condenser could be used in this position. The intermediate frequency would have to be of the order of 450 kc. The modulator tuner requires a larger condenser. If you use plug-in coils you can use the small condenser both in the oscillator and the modulator tuners and you can not only cover the broadcast band but the entire short-wave band as well.

* * *

Principles of By-Passing

I HAVE noticed that in some instances by-pass condensers in the plate and screen circuits are connected to ground and in others to the cathode. Which is the better method, or does it make any difference? Kindly give the reason why you select one above the other, in case you do.—B. L.

As a rule it is better to by-pass to the cathode when this differs in potential from ground. The reason is that the cathode is the source of electrons and if the by-passing is done to it the signal current is brought back by the shortest route and it does not produce any feedback. If it were by-passed to ground the current would have to go through another condenser or resistance to get back to the cathode, for example, the grid bias resistor and the condenser across it. There are exceptions to this rule when expediency dictates some other connection. One case is that when the by-pass condenser is connected already to ground on one side and it is not desired to use another condenser. Except in a few instances it does not make much difference whether the by-passing is done to ground or to the cathode.

BIG TECHNICAL ADVANCE MADE IN BROADCASTS

Washington.

Arthur Batcheller, travelling supervisor of the Radio Division of the Department of Commerce, has reported that the broadcasting stations of the nation have attained new standards of excellence. The Supervisor recently returned from a 10,000-mile tour.

The Department has just released his summation of the conditions in the broadcasting field. One of the phases is the greatly improved technical operation of the average station. The aims attained are the reduction of man-made interference at the stations and reduction of the level of extraneous noise that used to filter in from such sources as X-ray machines, defective motors and other causes external to the station.

In all, a total of 68 stations have been visited.

Better Carrier Stability

Mr. Batcheller reported as follows:

"From the standpoint of carrier stability, frequency adherence and program improvement, radio broadcasting in the United States has showed a decided improvement.

"By carrier stability is meant that the carrier emissions of broadcasting stations are becoming more and more stable and not subject to the many fluctuations and deviations that were present in the past. There has also been a very marked improvement in station frequency adherence. Frequency adherence and carrier stability are vital elements to an orderly system in broadcasting.

Extraneous Interference Less

"Static and other natural electrical disturbances continue to be a source of serious trouble, whereas great improvement has been made by scientific research in lessening extraneous and parasitic disturbances originating in industrial electrical systems and apparatus associated therewith.

"Largely because of the vigilant service rendered by the Commerce Department's radio Division in regulating broadcasting stations, the listener is getting less and less interference in his programs. Overlapping side bands, or crosstalk, carrier inter-action or beat notes become a serious matter when broadcasting stations deviate their assigned frequency.

Checking System Effective

"A feature of the checking system also includes the use of mobile laboratories installed in specially constructed automobiles equipped with scientific instruments which are for the purpose of traveling to all points in the various districts in order to measure the character, quality and power of the signals emanating from the various broadcasting stations.

Tests Without a Visit

"These observations are made without actually going into the broadcasting station itself. These automobiles are also equipped with apparatus for locating stations operating without a license and for numerous other technical duties which the radio inspectors of the Commerce Department are called upon to perform."

Set in Slim Cabinet

The "Columaire," a novel set in a slim, vertical cabinet, is announced by the Westinghouse Electric and Manufacturing Company. This new set-up occupies a smaller floor area than existing models.

All-Around Good Fortune

The National Broadcasting Co. has gone and done something worth while. It has engaged John F. Royal as director of N. B. C. programs. Mr. Royal has had a wide experience in the entertainment field, having been a notable figure in theatrical management for a number of years, later becoming managing director of WTAM, Cleveland, where he distinguished himself as a far-sighted booker and an executive of rare ability. The N. B. C. is lucky—and so is our great radio audience.

And by the same token, George Engles becomes head of the N.B.C. Artists Service, whose activities have been enlarged to a degree that makes it the biggest enterprise of its kind in radio. Mr. Engles has had many and important contacts with the world's greatest artists, including Mme. Schumann-Heink, for whom he acted as personal booker for a period of years and who recently, in an interview, paid him high tribute as a successful representative and a loyal friend. Again the N.B.C. is fortunate in its selection of the right man for a difficult job.

Literature Wanted

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

Lawson Morgan, Box 655, Tulia, Tex.
Ramon Garcia, 300 W. 17th St., New York, N. Y.
William E. Jones, 93 Hamilton Place, New York, N. Y.
Winston O. Headley, 213 W. 140th St., New York, N. Y.
A. O. Moen, Box 13, Clinton, Minn.
Montgomery Gallup, 425 Second St., Schenectady, N. Y.
Nathan Fredman, Bacon Science Club, 1484 Vyse Ave., New York, N. Y.
Raymond Fancy, 5044 W. 30th St., Cicero, Ill.
Blake Cockrum, McAllen, Tex.
Reed Barton, 1718 Ridge St., Coraopilis, Pa.
M. V. Glock, 4 Central Ave., Caldwell, N. J.
Elbert Edens, Box 205, Exeter, Va.
John N. Stefanko, 411 Pacific Ave., McKeesport, Pa.
James W. Webb, 814 Madison St., N. W., Washington, D. C.

USE OF RECORDS IS IN CRUCIBLE

Much discussion is going on among broadcasting station directors regarding the transmission of recorded programs made specially for radio use. The large chains oppose such methods as being inimical to the highest standards of broadcasting and not in the best interests of either the station or the public. However, since expense is much less, due to reduction of cost of talent and omission of telephone leased wire charges, the practice of using such records is growing, among small stations particularly, while even a few large ones are trying out these records experimentally.

On behalf of interests backing the recorded program idea the following statement was made:

"The once adverse opinion held on the subject of the rebroadcasting of recorded music is undergoing a change. The old opinion was the natural reaction, sponsored by the public in the first instance, who could hardly be blamed for not appreciating the quality of the electrical transcriptions of the old days. The improvements in the art of recording have undergone such revolutionary changes in the past year that the broadcasters have been tempted to sample the new wares, made for radio use exclusively, and finding them acceptable, have reproduced them on the air to get an expression from the public.

"The reaction is favorable, for the number of stations that has increased the percentage of this form of broadcasting has been on the increase and it is expected that this type of program soon will be rooted in the broadcasting practice.

"One of the big advantages of the electrically transcribed program is absence of factors that tend to delay or hamper the progress of the program, such as the announcer's cold, or the temperamental disinclination of a particular artist. Thus the influence of physical impediments is largely removed. In addition to the above, the broadcaster may feel free to reach the desired area when he wants to have the program heard, and the small station, by the use of the recorded program, is enabled ot present the same standard of program that the large station does, thus assisting the station to maintain its prestige without having to undergo the expense of engaging talent.

"Another point in favor of the transcribed program is the comparative absence of extraneous noise associated with chain station broadcasts. The new recording processes have rendered needle scratch inaudible. Finally, the station operator can switch from one record to another without interruption."

Creditor Gets WMBJ Wave

Washington.

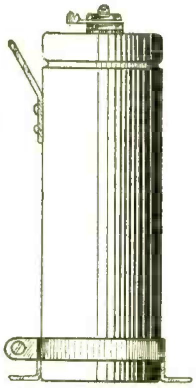
The Federal Radio Cmmission has sustained the recommendations of Examiner Elmer W. Pratt, and denied the petition of the Rev. John W. Sproul, who sought to obtain a renewal of the broadcasting license for WMBJ, Pittsburgh, Pa. The frequency was assigned to William S. Walker, one of the creditors of the plant

The petition of the Pittsburgh Broadcasters, Inc., another creditor, for the frequency assignment, was previously denied.

BIGGEST BARGAINS!

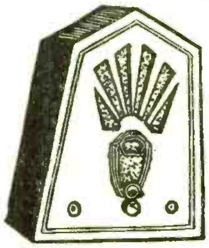
BUY NOW

While Prices Are Lowest!



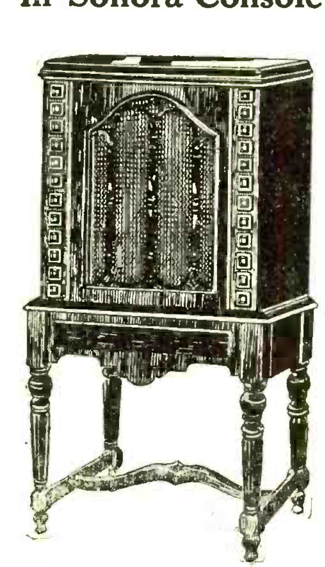
Now all the fans who build their own sets or service men who are making replacements are using the dry electrolytic condenser. It affords high, lasting capacity in compact form. The lug at top represents the anode and goes to the positive side (B+ or C+), while the aluminum case is to go to the negative side, usually ground. The capacity of the condenser is 8 mfd. The condenser, a product of Aerovox, is admirably suited for use in filter circuits, for use on rectified AC or pulsating DC. The condenser must not be used on raw AC. Maximum peak voltage, 500 volts DC. Normal operating voltage, 400 volts DC. Dry, self-healing, high capacity, low leakage, unaffected by moisture. Size, 1-5/16" diam. x 4⅛" overall. Mounts in any position. Brackets supplied. Order Cat. AV-8 @ $1.42

Synchronous motor for 60-cycle lines, 105 to 125 volts, with turntable, producing 80 turntable revolutions per minute. Takes up to 21-inch records. Sturdy and compact, this motor is only 1¼ inches thick. Not affected by line voltage fluctuations. The compactness permits installation in consoles or any other available space. Made by Allen - Hough, makers of the Phono-link pickup. Shipping weight, 7 lbs. Order Cat. SYN-M (with turntable) @ $4.25

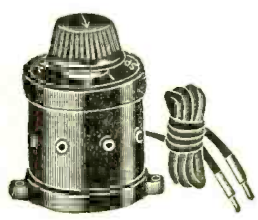


An outstanding example of the vastly popular midget receiver, not very much larger than any good speaker, yet it contains a very sensitive, efficient and powerful AC radio set, AC power pack and a speaker that would do justice reproducing the output of the most elaborate AC receiver! Startling statements, yes, but they are undeniable facts! Imagine, not even as large as most battery operated portable sets, and lighter in weight! The set will duplicate in performance (considering selectivity, sensitivity and volume) that of its much larger and more costly brothers! One dial tuning control, also switch and volume control knob (not illustrated.) Uses six tubes: three 224, one 227, one 245 and one 280. Perfect reproduction! Combined weight of entire set, speaker and tubes less than 20 lbs.! Entirely self-contained! 3 gang tuning condenser. Uses power tubes and push-pull electro-dynamic speaker! Durably built in handsome walnut case. For 110-120 volts, 50-60 cycle AC. Complete set, with the six tubes, cabinet, speaker—nothing else to buy! Order Cat. MDST @ $39.95

Peerless Dynamic In Sonora Consolette

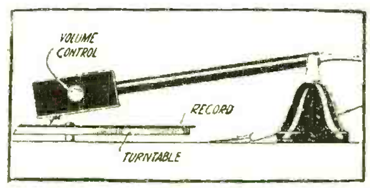


Positively the last word in the most efficient and powerful reproducer made! As a fitting companion, it is housed in a truly exquisite deep two-tone walnut console, of rare beauty and craftmanship! To properly baffle the ultra-powerful Peerless chassis, a chamber 15" deep, 17¾" wide and 18" high houses same. Front baffle of ¾" thickness! Size of opening, 10 inches. Ideal for use with the most powerful public address amplifier. NO RATTLING, NO DISTORTION—JUST PERFECT REPRODUCTION! For that matter it is equally suited with ordinary sets, employing the average type of audio amplification systems.
Order Cat. SSC @ $24.88
[If cabinet only is desired (less speaker) order Cat. SCO @ ....$13.44]



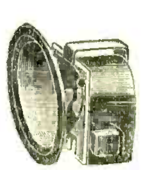
New Speakerelay for connecting two speakers to it and playing either one (position No. 1, left); or the other (position No. 1, right); or both at once (position No. 2); by turning the knob. Built into an attractive black moulded bakelite case, with 18-inch connecting cords to go to the output posts of the receiver or amplifier. The speakers' cords are connected to the relay by plugging into built-in jacks. This device can be used also for switching from "phonograph pickup" to "radio." Order Cat. 121 @ $1.10

PHONOGRAPH PICK-UP $3.32



The famous Phono-link, made by Allen-Hough, enables playing phonograph records electrically, on your set. Volume control is built in.

Adapter, free with each order, enables immediate connection to your set. Instruction sheet enclosed. Order Cat. PHL @ $3.32.

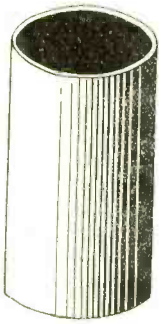


Here is the best buy of the year: A 15" diameter 110 volt D.C. dynamic chassis, with two field coil resistances, 600 ohms AND 4,000 ohms. Contains push - pull output transformer. Designed for use with any super-power amplifier—for auditorium reproduction. Shipping weight, 25 lbs.

Order Cat. 1100 @ ...$16.95

We also offer the following Peerless dynamic chassis:

Cat. No.	Size	Type	Price
719.	14".	110 v. D.C..	$14.95
720.	12".	110 v. A.C..	15.95
721.	12".	110 v. D.C..	9.95
1020.	12"	6 v. D.C..	9.95
1021.	10".	110 v. A.C..	11.95
1022.	9".	110 v. A.C..	9.95
1023.	9".	110 v. D.C..	7.95
1024.	9".	6 v. D.C..	7.95



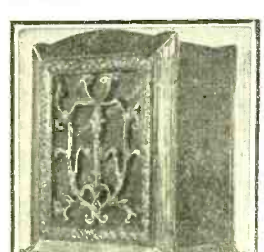
Natural bakelite tubing, made by Spaulding, in two diameters, 1¾ inches and 2 inches, outside diameters. One will fit inside the other even after wire is wound on the smaller diameter.

Length	Diam.	Price
1½"	1¾"	...$0.09
2¾"	2"	..... .12
36"	2"	..... .40

The 1½" length, 1¾" diameter, can be used for winding a primary, and be inserted.

Temple Dynamic $15.34

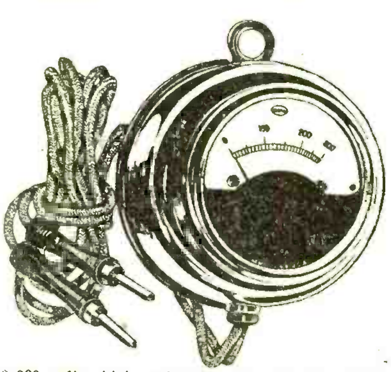
Beautiful Carved Wood Grille Front



This is one of the finest dynamic speakers ever made, and is highly recommended by us. AC switch is provided. A knob is built in for adjusting the speaker impedance to that of your set. An output transformer and dry rectifier are built in. Connect plugged AC cable to 110 volts AC, 50 to 60 cycles and connect tipped cords to speaker post of receiver. This remarkable speaker

The Temple 10 chassis in the fascinatingly decorative walnut cabinet, with carved grille ornament, as illustrated; both front and back finished. (Cabinet not sold separately). Order Cat. TEM @ $15.34

0-600 Voltmeter Reads Both AC and DC



0-600 volts, high resistance; AC and DC (same meter reads both types). DC readings accurate to 2%, also AC readings 2% at 50-60 cycles, but accuracy is less on AC at substantially different frequencies.
Order Cat. F-600 @ $3,75
0-300 volts, high resistance. Accuracy, 2%. Case is full nickel finish. Long connecting cords have especially ornamental tip holders. Meter should be read in perpendicular position.
Order Cat. F-300 @ $2.25
0-500 volts, same as above in appearance, but the range is greater
Order Cat. F-500 @ $3.00

EXTRA-SPECIAL SPECIALS!

(Cat. SPEC-1)—Erla DC dynamic chassis, 9-inch cone, for operation from 6-volt storage battery. Connect speaker-tipped cords to output of set, and connect twisted pair to 6-volt storage battery. Draws ½ amp. from battery. Price............$9.00

(Cat. SPEC-2)—Wave trap, for cutting out interference. Connect aerial to one side of the trap, other side to antenna post of receiver from which aerial was removed, and tune out interfering stations. A great selectivity booster. Price .... .87

(Cat. SPEC-3)—Rider's Supplement No. 1, containing diagrams supplemental to those in Rider's "Trouble Shooting Manual," and an invaluable addition, for completeness, to any who possess Rider's manual. Price.... .73

(Cat. SPEC-5)—Dubilier .01 mfd fixed mica condenser .... .16

(Cat. SPEC-6)—Dubilier .00025 mfd. mica fixed condenser, with clips for grid leak mounting............ .11

(Cat. SPEC-7)—.0001 mfd. Dubilier fixed condenser, for connection in series with aerial to improve selectivity............ .11

(Cat. SPEC-8)—Power transformer, with two chokes built in for B filtration. Primary, 105-125 volts, 50-60 cycles; secondaries, all center-tapped with red leads, are for high voltage for 280 to work 245 tubes, single or push-pull, and rest of tubes in set up to 100 mba; 300 volts DC output; 2½ volts 2 amps. for 245s, single or push-pull; 2½ volts 14 amperes, for 227s and 224s, up to 8 of these; 5 volts for filament of 280. All, including chokes, in one cadmium plated steel case. Leads identified. Chokes are 30 henries each............ 7.50

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Please ship at once the following:

☐ Cat. AV-8 @.. $1.42	☐ Cat. SCO @...$13.44	☐ Cat. 1021 @... $11.95
☐ Cat. MDST @. 39.95	☐ Cat. 1100 @... 16.95	☐ Cat. 1022 @... 9.95
☐ Cat. 121 @.... 1.10	☐ Cat. 719 @.... 14.95	☐ Cat. 1023 @... 7.95
☐ Cat. SYN-M @ 4.25	☐ Cat. 720 @.... 15.95	☐ Cat. 1024 @... 7.95
☐ Cat. PHL @... 3.32	☐ Cat. 721 @.... 9.95	☐ Cat. TEM @... 15.34
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METERS

☐ Cat. F-600 @. $3.75 ☐ Cat. F-300 @. $2.25 ☐ Cat. F-500 @. $3.00

EXTRA-SPECIAL SPECIALS!

☐ Cat. SPEC-1 @ $9.00	☐ Cat. SPEC.-3 @ .73	☐ Cat. SPEC-7 @ $0.11
☐ Cat. SPEC-2 @ .87	☐ Cat. SPEC-5 @ .16	☐ Cat. SPEC-8 @ 7.50
	☐ Cat. SPEC-6 @ .11	

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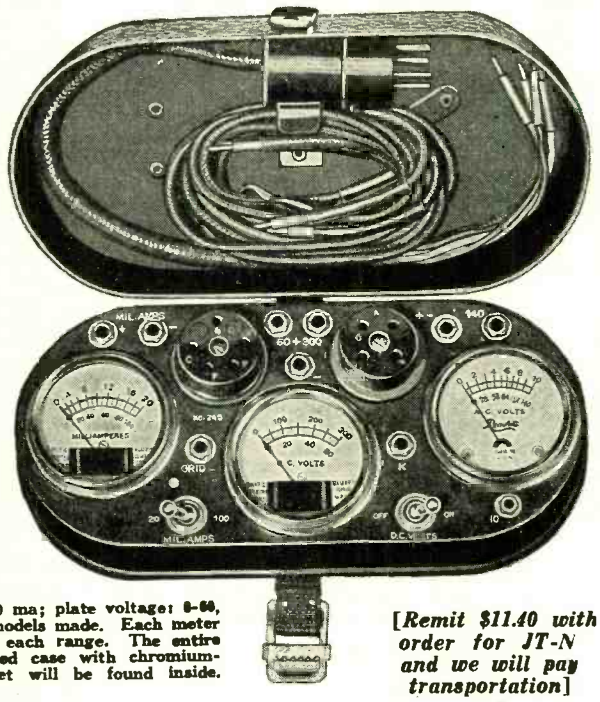
Address ....

City ....State ....

The New Jiffy Tester

Chromium-Plated Case and Accurate Meters

A NEW and improved Jiffy Tester, improved in both performance and appearance, is Model JT-N. The meters are of the moving iron type. Tested on precise batteries, they show errors not exceeding 2%. As for appearance, the case is first copper plated, then nickel plated, then chromium plated, giving a lustrous, permanent, non-peeling non-rusting finish. It is the same finish found on hardware in fine automobiles. The handle and lock strap are genuine leather.



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

[Remit $11.40 with order for JT-N and we will pay transportation]

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Short-Wave Converter Series

In the November 8th issue of RADIO WORLD there began a remarkable series of articles dealing with the construction of short-wave converters that really do work, and that work well. Besides, the cost of parts is low. One model, 30 to 110 meters, no plug-in coils, may be built of parts costing less than $5, for battery operation, or for AC with extra filament transformer external, while another model, 10-200 meters, two plug-in coils, using somewhat superior parts, filament transformer built-in, can be made up by you for less than $10. Surely these are prices within the reach of all.

Low price and high achievement go hand in hand in these designs by Herman Bernard.

The series ran in the November 8th, 15th, 22nd and 29th, and December 6th. 13th, and 20th issues. Send $1 and we will forward these seven issues and a blueprint of the AC $5 model.

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

Enclosed please find $1.00 for which send me the November 8th, 15th, 22nd and 29th, and Dec. 6th, 13th and 20th issues, containing the series of articles on short-wave converters of extremely low price, and a blueprint of the AC $5 model.

Name ....

Address ....

City .... State ....

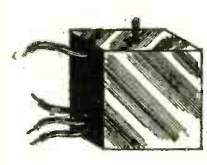
SOLDERING IRON FREE!

Works on 110-120 volts, AC or DC; power, 50 watts. A serviceable iron, with copper tip, 5 ft. cable and male plug. Send $1.50 for 13 weeks' subscription for Radio World and get these free! Please state if you are renewing existing subscription.

RADIO WORLD

145 West 45th St. N. Y. City

Three 0.1 mfd. in One Case



Three Supertone non-inductive fixed condensers of 0.1 mfd. each, (250 v.) in steel case, provided with a 6/32 mounting screw. built in. The black lead is common to the three condensers, the three red leads are the other sides of the respective capacities. Size, 1½" square by ⅞" wide. Order Cat. SUP-31, list price, $1.00; net price, 57c.

GUARANTY RADIO GOODS CO.

143 West 45th St., New York, N. Y.

Subscribers! Important!

Note subscription expiration date on wrapper containing your copy of RADIO WORLD. If nearing expiration date, please send in renewal so that you will not miss any copies. Subscription Dept., RADIO WORLD, 145 W. 45th St., New York City.

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7 cents a word—$1.00 minimum—Cash with Order

RESISTANCES, CONDENSERS, TRANSFORMERS, CHOKE-COILS, etc. Write for sensational low price list. Bronx Wholesale Radio Company, 7 West Tremont Avenue, New York.

DRILL PRESS STAND for the work bench. Blueprint showing how to build it, $1.00. Inquire about complete kit of parts. Super Engineering Laboratories, 1313 - 40th St., Brooklyn, N. Y.

CONSTRUCTIONAL DATA—30 henry choke 50c; laminations in stock. Radio Power, 1028 Forest Road, Schenectady, N. Y.

FLORIDA FRUIT BOX containing 45 oranges, 12 grapefruit, 20 tangerines, 100 kumquats, jar fruit preserves. Express prepaid anywhere, $3.00. Florida Fruit Growers Packing Company, P. O Box 282, Tampa, Fla.

HORN UNIT, $1.95—This is the Fidelity Unit and has stood the test of time. Guaranty Radio Goods Co., 143 W. 45th St., New York.

Hi-Q 31 FOR SALE. F. L. Hanson, Ilion, N. Y.

H.F.L. MASTERTONE. List $195. Sell $85. World's finest radio. W. J. Reed, Aurora, Ill.

"MATHEMATICS OF RADIO."—A great help to everybody interested in radio. $2 postpaid. Radio World. 145 W. 45th St.. N. Y. City.

BARGAINS in first-class, highest grade merchandise. B-B-L phonograph pick-up, theatre type. suitable for home with vol. control, $6.57; phono-link pick-up with vol. control and adapter, $3.32; steel cabinet for HB Compact, $3.00; four-gang .00035 mfd. with trimmers built in, $1.95; .00025 mfd. Dubilier grid condenser with clips 18c. P. Cohen, Room 1214, at 143 West 45th Street. N. Y. City.

MAGICALLY CLEANS FALSE TEETH—WATAJOY Wonder Cleaner. Instantly removes film. Cleans and purifies plate. Approved by licensed chemist. Costs about 5c per mo. A big treat awaits you. Prepaid 25c. **WATAJOY LAB., Alhambra, Cal.**

FILAMENT TRANSFORMERS—1½, 2½, 5 volt, $1.00; 2½ volt, 5½ amp., $1.10; 7½ volt, 3 amp., $1.25. C. T. secondaries, primary 110 volt. Write L. Waterman, 2140 Kirby West, Detroit, Mich.

SMALL MOTOR GEN. 3 phase, 220 to 7½ volts D.C. Like new, $75. R. Campbell, 365 Edgewood Ave., New Haven, Conn.

MAJESTIC, RADIOLA, etc. Drum Dial Cable by foot or mile. Service men's test prods, 50c, 75c, $1.00. Blan, the Radio Man. Inc., 89 Cortlandt St., New York.

"FORD MODEL 'A' CAR." Its Construction, Operation and Repair, By Victor W. Pagé, M.E. 545 Pages, 251 Specially Made Engravings. $2. postpaid. Radio World, 145 W. 45th St., N. Y. City.

"A B C OF TELEVISION" by Yates—A comprehensive book on the subject that is attracting attention of radioists and scientists all over the world. $3.00. postpaid. Radio World, 145 West 45th St., N. Y. City.

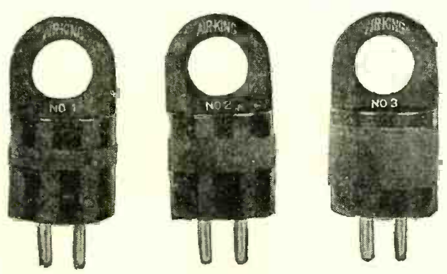
SHORT-WAVE SPECIALTIES

EXTRA-SPECIAL FREE OFFERS OF SUBSCRIPTION PREMIUMS!

RADIO WORLD, now in its ninth year, is the first and only national radio weekly, and publishes the latest, up-to-the-second news of circuits, both of kit types and of 1931 commercial receivers, as well as news of happenings in the broadcasting field. Lists of broadcast and short-wave stations are published regularly. You get your information weekly—which means quickly—and you get it accurately, so be sure to become or remain a subscriber for RADIO WORLD. We are able to offer now specially attractive premiums, and ask you to make your choice from the well-chosen variety of parts offered on this page and on the opposite page. When ordering, please use coupon.

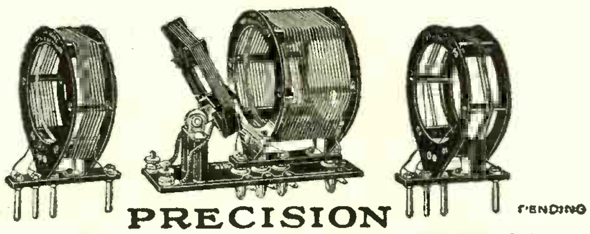
The regular subscription rates are: $6 for one year, 52 issues, one each week; $3 for 6 months, (26 weeks); $1.50 for three months, (13 weeks); $1 for 8 weeks; 15c per single copy.

TUBE-BASE TYPE COILS



Three finger-handle type plug-in coils, wound on tube-base diameter, although of greater height than a tube base, for short wave plug-in service, where a 4-prong (UX) tube socket is used as coil receptacle. There are two separate windings, tightly coupled. The coil socket connections are plate prong to plate, filament plus to phones; grid prong to grid and ant.; filament minus to stator of a feedback condenser. The tuning condenser (stator to grid prong, rotor to filament plus prong) may be .00015 or more for 15 to 110 meters; the feedback condenser .00025 mfd. B voltage is supplied through phones or audio transformer primary. Order PR-TBC free (less coil socket) with 6 mos. (26 weeks) subscription @ $3.00.

PRECISION PLUG-IN COILS



PATENTS PENDING

PRECISION
SHORT WAVE PLUG-IN KIT

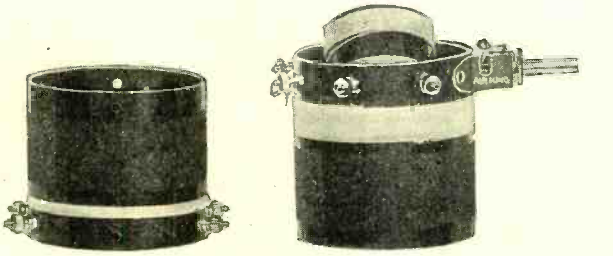
The finest short-wave coils, of de luxe construction, wound on ribs, affording 97% air dielectric, and available for various capacities of condensers, as listed below. All precision short-wave coils are provided with receptacle bases and apply to standard circuits.

For .0001 or .00015 mfd. tuning; three plug-in coils with receptacle base as illustrated, with adjustable primary built onto receptacle, 15 to 150 meters. Order PR-AK-1, free with one year's subscription @ $6.00.

For .00025 or .0002 mfd. tuning: only two coils are required, for 15 to 150 meters. Order PR-AK-2, and get two coils, receptacle and adjustable coil (third inductance) built in. Free with nine months' subscription (39 weeks), at regular rate, $4.50.

Note—We can supply .00015 mfd. (PR-H-15) or .0002 mfd. (PR-H-20) Hammarlund short-wave midline condenser, swings inside 2-inch diameter, with three months (13 weeks) additional subscription @ regular $3 rate.

"DIAMOND" PAIR IN STANDARD AND DE LUXE TYPES



The Diamond of the Air is a popular circuit using an antenna coil and a three-circuit tuner. For this circuit the standard Diamond pair of coils consists of two, wound on 3" diameters, except for rotor on smaller form. The standard pair may be obtained for .0005 or .00035 mfd. tuning. Tickler coil has single hole panel mount. For .0005 mfd. order PR-SDP-5, with blueprint, free with a six-month subscription (26 weeks) @ $3.00. For .00035 mfd. order PR-SDP-35, free with 6-month subscription @ $3.00.

These coils will give extreme satisfaction and are excellent for the Diamond of the Air, being specified by Herman Bernard, the designer of the circuit.

De luxe Diamond pair, with large primaries center-tapped. For the Diamond use center tap and one extreme of the primary for antenna circuit, RF coil (at right); use full primary on tickler (lowest winding at left). The de luxe pair have silver-plated wire, for loss-reduction, wound on moulded bakelite, with threading, so coils are space-wound to reduce distributed capacity. Three-circuit coil is single-hole panel mount. Additional holes for optional base mounting on both using brackets (not supplied.) For .0005 mfd. only. (None for .00035 mfd.) Order PR-GWN free with a year's subscription (52 issues) @ $6.00.

GET THE COMPLETE DATA ON SHORT-WAVE CONVERTERS

Short-wave converters are all the rage. They enable you to tune in short waves on a broadcast receiver of any kind. A serial article by Herman Bernard, on this topic, discussing several models, with full-size picture diagrams, was published in the November 8th, 15th, 22nd, 29th, December 6th, 13th and 20th issues. Send $2 for 17 weeks subscription and get these seven issues free. Order PR-SWCS.

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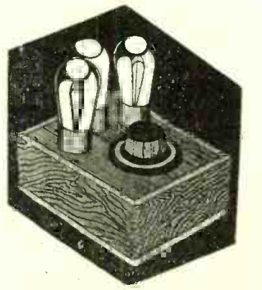
PARTS FOR A SHORT-WAVE CONVERTER



No matter what type of broadcast receiver you have, you can get short waves by using a short-wave converter built of parts we can supply. The panel is only 5 x 6½ inches. There is only one tuning control. No squeals, howls or body capacity. Two models are available, one for A.C., the other for battery operation. The battery model uses three 227 tubes with heaters in series. Full details supplied with order.

All parts for A.C. model (less filament transformer, less three 227 tubes), order PR-SUP-3A, free with a year's subscription @ $6.

All parts for the battery model (less three 227 tubes), free with a year's subscription for Radio World @ $6.00. Order PR-SUP-3B.

A third model (of different appearance than illustrated) enables filament transformer to be built in. All parts, including filament transformer; two wound plug-in coils, 15-200 meters, Hammarlund condenser, (less tubes), order PR-SUP-3FS free with two-year subscription @ $12.