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(See Page 8)

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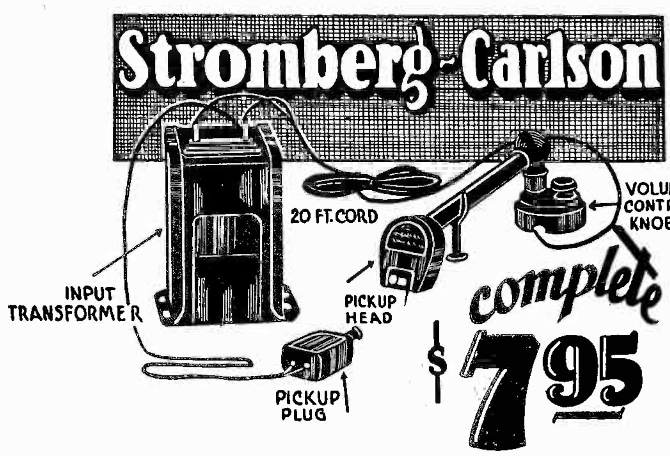

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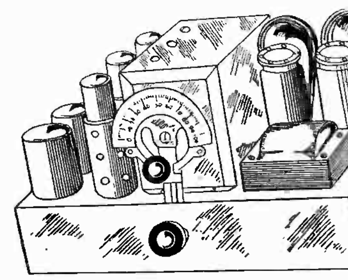
FIVE-TUBE MODEL



A-C operated circuit, 50-60 cycles, 105-120 volts, using two 58 t-r-f stages, 57 power detector and 47 output, with '80 rectifier. Three gang shielded condenser and shielded coils in a sensitive, selective and pure-tone circuit. Dynamic speaker field coil used as B supply choke. Complete kit of parts, including 8" Rola speaker and all else (except tubes and cabinet). Cat. D5CK @............**$15.69**
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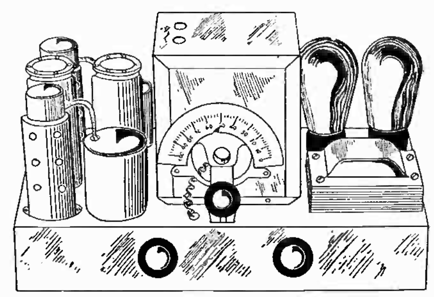
FOUR-TUBE MODEL



The four-tube model is similar, except that there is one stage of t-r-f, and a two-gang condenser is used. Tubes required, one 58, one 57, one 47 and one '80. Complete kit, including 8" Rola dynamic speaker (less tubes, less cabinet). Cat. D4CK **$13.58**

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Accuracy in Calibration of Test Oscillators

By Henry Burr

FIG. 1
Test oscillator and the receiver used for preliminary calibration. High selectivity in the receiver is essential. Not enough points are registered.

FIG. 2
Using the test oscillator also as detector enables elimination of the broadcast receiver and gives closer results. Still too few points.

FIG. 3
To spot a dial for calibrations 10 kc apart, a 10 kc standard frequency oscillator may be used. It will give points by harmonics, say 5th to 50th.

FIG. 4
Instead of using a low standard frequency one may use a high one with test oscillator's harmonics. The points will not often be even frequencies.

THE two principal requirements of a test oscillator are that it shall have good frequency stability and that the dial shall be closely legible to an accuracy not much less than the accuracy of frequency.

It can be realized quite readily that an oscillator that gives a particular frequency reading at a certain setting one time, and another frequency reading at exactly the same setting another time, is of not much account. Moreover, if the setscrew isn't tight enough on the condenser shaft, then the dial may turn slightly at either extreme of an end-stop condenser's rotor displacement, without the condenser moving, and the entire calibration is upset. Condensers with rotors that turn 360 degrees, no end stop, avoid this trouble, but are not commercially prevalent.

Wedge type drive dials, however, prove a good substitute for a continuously turnable condenser, because when either extreme of the condenser rotor's movement is reached, little force is expended on the condenser, and most on the wedge, which turns against the dial disc without moving it.

Coincidence of Circuit and Dial

The frequency stability, or accuracy, of the electrical circuit should be greater than the accuracy with which the dial scale may be read. Within the limits of economy, good results are obtainable from test oscillators with pre-calibrated scales, where the calibration takes care of 10 kc separation from 53 kc to 80 kc, and 20 kc separation from 80 kc to above 150 kc.

The problem of making the tuned circuit conform to the pre-calibrated scale is one for the manufacturer to worry about, but as the considerations affect the accuracy of test oscillators in general, the requirements will be discussed.

The first selection necessarily has to do with the fundamental frequencies of the test oscillator. It has been decided by one manufacturer that a frequency span of 50.7 to 153 kc would be most satisfactory for the fundamental, for then the broadcast band would be taken care of by the tenth harmonic of the test oscillator's fundamental (507 to 1530 kc, 591.3 to 196 meters). Of course the wavelength equivalent range of the test oscillator is 5913 to 1960 meters, but the metrical designations are not used any more, at least concerning test oscillators.

Inductance Adjustment

Having selected the frequency range, and using a standard capacity condenser, 0.00037 mfd., with a 30 mmfd. trimmer, the required inductance of 20 millihenries may be obtained by honeycomb form of winding, which besides produces little distributed capacity, and accounts in part

(*Continued on next page*)

(Continued from preceding page)

for the approximately 3-to-1 frequency ratio.

Once the coils are wound it is found that their inductance is not exactly the same in every instance, and then it is necessary to compute the amount of deviation pemissible. This has to do with the accuracy of reading the high frequency end, because almost all the trouble is concentrated there. The low frequency end takes care of itself if the high frequency end is protected as to accuracy of the electrical circuit compared to the mechanical circuit.

The computed allowable difference in inductance is 2 per cent., and it is based largely on the accuracy to which the dial may be read, hence a test circuit has to be set up so that the inductance of each coil is established to be the required amount, to 2 per cent. or less, and such coils that have too little inductance are discarded, while those that have too much may be reduced to the requirement by removing five turns at a time and retesting. The coil has more than 1,000 turns.

Capacity Adjustment

The actual capacity in the circuit consists mainly of the tuning condenser, at the present time at minimum capacity setting; the input capacity of the tube, the capacity due to the wiring and the adjacency of leads, the distributed capacity of the coil and stray capacities to ground. Since the tuning condenser has a minimum capacity of 18 mmfd., and a trimmer 5 to 30 mmfd., the adjustment may be made here from 23 to 48 mmfd., and is the only capacity adjustment that can be made. However, the range is all-sufficient. The other capacities are held constant, or, if not constant, are so tiny as not to affect the result. The tube input capacity, if a 56 is used, is 3.2 mmfd., the plate to grid capacity is the same, so there are 6.4 mmfd. contributed by the tube alone, not counting the output capacity of 2.2 mmfd., because in the type of circuit illustrated this does not affect the result more than trivially due to the resistance o fthe tube's plate circuit intervening.

From the frequency ratio, 3.11, we know the capacity ratio must be the square of that, or 9.672, and therefore that the sum minimum capacity must be 43.4 mmfd. This is well within the obtainable range, due to the trimmer.

The actual layout of parts, amount of wire used, position of wires, and condition of soldering must be the same throughout, in producing the oscillator, so as to duplicate the model.

So both the inductance and the capacity have to be adjusted to the scale.

The Scale

In the preparation of the scale itself considerable work has to be done. First a hand model scale is made, and then various oscillators are produced, and the dial and scale with ten points or so registered are used on them, so that the results may be checked up on twenty or more units, and when these are found to be all right, the production of a regular kilocycle scale may be undertaken.

Spotting the scale is a problem in itself. By using broadcasting stations as preliminary standards of frequencies, tuning them in on a receiver, and beating test oscillator harmonics with those station frequencies, some of the fundamental frequencies may be registered. Originally, of course, the fundamental frequency range has been checked against a calibrated precision low frequency oscillator, but for a variety of frequencies the broadcasting stations now may be used, especially as the tenth harmonics of test oscillator frequencies could account for all the stations, theoretically. But not nearly all can be tuned in.

The method of using the station frequencies as guides, and of checking up, has been detailed in these columns.

What's What

In the discussion of calibration, the reference to this fundamental and that harmonic, in conjunction with the tuning of either oscillator or broadcast receiver, tends to become confusing. Even engineers' conversation on the subejct is occasionally interrupted when one of them asks: "Which harmonic of what?" or "Are you changing the fundamental or the test frequency?" Then the person addressed may have to stop a moment to consider what, after all, was the exact situation, now that somebody has asked. In other words, the narrator himself gets mixed up once in a while (including this one). So let us set down what's what, that we may bear it in mind, and then follow up with some examples useful to all who desire to calibrate their own oscillators:

(1)—The standard frequency may be held constant, and the test oscillator frequencies changed, the most common method.

(2)—The test oscillator frequency may be held constant and different standard frequencies used.

(3)—Both the standard frequencies and the test oscillator frequencies may be varied.

Example of 570 kc

Say that we live in a locality that readily affords reception of local stations using transmission frequencies of 570, 660, 710, 760, 860 and 1450 kc. We know the approximate frequency range of our test oscillator, we are aware that its tenth harmonics will beat with station fundamentals, and so if we use the third method enumerated above, we may turn our test oscillator to near the highest capacity of the condenser, strike the beat with 570 kc, register the test oscillator fundamental of 57, then tune the receiver to 660 kc, turn the oscillator dial slowly to lower capacity of condenser, and getting the squeal register 66 kc, etc. In this way we might get seven points, but remember we desire to register 103 points.

Suppose we use 570 kc again, now leaving it constant (second method above). We may check up again for the 57 kc position on the test oscillator, and we may turn the test oscillator's dial and pick up other squeals. What are these? The test oscillator generates various frequencies, one at a time, depending on the tuning adjustment, and each of these frequencies has an infinite number of harmonics. The surprise squeals therefore are nothing but lower harmonics of higher fundamentals. They are not the tenth harmonics, because there is only one tenth harmonic and we have met it and it is ours. Since we are using higher test oscillator fundamental frequencies, lower harmonics of higher test oscillator frequencies must be beating with our 570 kc standard.

Other Harmonics, Fundamentals

By dividing 570 kc by 9, 8, 7, 6, 5 and 4, we ascertain which harmonic frequencies of our test oscillator are beating with 570 kc, and which harmonics they are. The test oscillator harmonics (tenth to fourth, the only group useful) will be:

(10)	(9)	(8)	(7)	(6)	(5)	(4)
57	63.33	71.25	81.44	95	114	142.5

So by turning the test oscillator dial we may register any of these points, but as some of them are odd decimal frequencies, we shall avoid those decimals just now, because when raised to the tenth harmonic they will have little significance in respect to broadcast frequencies.

So we select 57, 95 and 114 kc from the group offered by 540 kc.

As we increase the frequency of the standard (higher frequency broadcasting stations used) and go to lower harmonics, more harmonics of the test oscillator will beat with the station fundamental, because the standard frequency is higher, the frequency difference between respective harmonics is greater, hence the points registered on the test oscillator fewer. For instance, 860 kc affords only five registration points on our test oscillator:

(10)	(9)	(8)	(7)	(6)
86	95.55	107.5	122.85	143.33

Whereas we got seven points from 570 kc we got five from 860 kc.

Not Enough Points

The highest harmonic used in the foregoing examples is the tenth, and the procedure is toward the lower order of harmonics, and higher frequencies of the test oscillator, so that the strength of the harmonics does not become less.

Much higher harmonics can be used, with higher test standard frequencies, as will be explained.

It must be evident thus far that not a sufficiently large number of points will be obtained for satisfactory completion of a curve. This applies to the high frequency end particularly. As stated, if all the broadcasting stations could be tuned in, that might solve the problem, provided that the receiver used was selective enough, sharper than 10 kc at all input signal values received, and also provided that the frequencies were known. Some confusion might result because of Cuban and Mexican stations using frequencies ending in 5.

The arrangement discussed thus far relates particularly to that shown in Fig. 1, where a broadcast receiver is used. The set is worked in the customary manner. The oscillator, if of the type diagramed, need not be coupled to the set in any other way than by radiation, although if desired a wire may be run from the left-hand input post to the aerial, being wrapped around the aerial three or four times, and not conductively coupled to it.

Receiver's Selectivity

The selectivity of the receiver, assuming an ordinary set, will not be high enough to insure perfect calibration, and it will be found that frequencies calibrated on the basis of one station will not coincide with frequencies calibrated on the basis of another station, where they should coincide, or, if there should be just a small difference, it may be larger. This is due to the lack of selectivity in the receiver.

All the uncertainties associated with a receiver can be avoided by dispensing with the set entirely. Since the oscillator is of the detecting type, a pair of earphones may be put in the plate circuit, by interruption of the plate lead, with a fixed condenser across the phones, anything from 0.00025 mfd. to 0.002 mfd. Then if the aerial is connected to left input post of the oscillator (there being one post on the other side for grounding) the squeals may be picked up selectively, although the hum modulation will be heard all the time. That is, one can not use the modulation to advantage, but must rely exclusively on the beat. This is the method suggested in Fig. 2.

Again, too few points will be registered, and the problem is to use some method that will furnish all the points desired. Since for part of the dial at least, from 530 to 80 kc, we shall want points 10 kc apart, we might use a 10 kc standard frequency oscillator, and, guided by a few points already known, as determined by the Fig. 2 method, spot nearly every point from one end of the scale to the other, 10 kc apart, using the fifth to fifteenth harmonics. Of course the high frequency end will become crowded, and from 80 kc we shall use each alternate squeal. Then we shall have our complement of 10 kc recording from 530 to 80 kc, 50 channels, and 20 kc recording from 80 to 153 kc, actually 37 recordings. If the dial scale were large enough—and it would have to be more than 6 inches in diameter—we could record 103 points.

High Frequency Oscillator

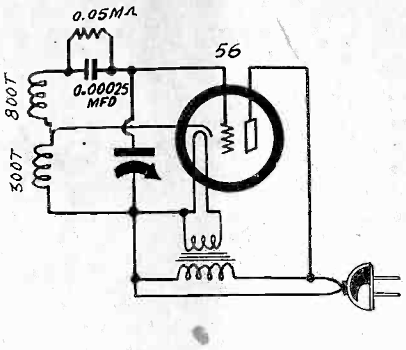
Now, a 10 kc oscillator is not so easy to work, particularly calibrate once built, but if we are content to use high harmonics we shall be able to select a standard frequency high enough so that the total number of harmonics of test oscillator frequencies that will beat with the standard will be 103, or, for convenience, say 100.

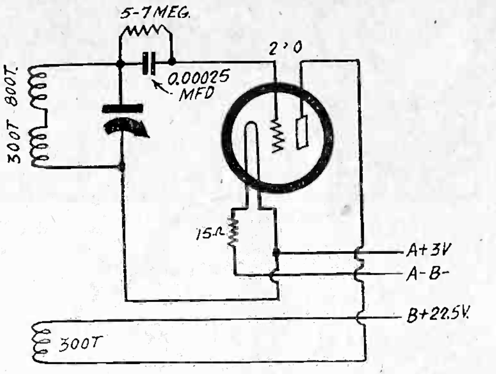
Say, then, we desire to spot 100 channels. If the lowest frequency is assumed to be 50 kc and the highest 150 kc, then 100 channels, 1 kc apart (equal to 10 kc on broadcast band) are represented. Obviously we need a standard frequency which will beat with test oscillator harmonics from the 50th to the 150th, and the standard frequency will have to be the product of these extreme harmonics, or 7500 kc. Now, if we use 7500 kc we shall obtain 100 points, although they will not fall exactly on the 10 kc divisions, but will be variously separated from each other. Still, with large logarithmic plotting paper, 10-cycle for instance, we could reduce the points to a curve, and then communicate the curve to the scale, for instance by protraction. We would have to possess a numerical dial, register the dial settings against frequencies, and then read from the curve frequencies separated by 10 kc, communicating them to the dial.

Examples of Harmonics

Taking 7500 kc, the following 52 harmonics, 50th to 75th and 125th to 150th, inclusive, of the test oscillator, would be represented, the frequencies near the two extreme ends having been selected: (H signifies the order of harmonic of test oscillator, and Fo the fundamental of the test oscillator beating to that harmonic with the standard frequency):

H	*Fo*	*H*	*Fo*
50	150	125	60
51	147	126	59.5
52	144.2	127	59.05
53	141.5	128	58.55
54	138.9	129	58.15
55	136.3	130	57.7
56	134	131	57.25
57	131.15	132	56.8
58	129.3	133	56.4
59	127.1	134	56
60	125	135	55.55
61	123	136	55.1
62	121	137	54.74
63	119	138	54.4
64	117.1	139	54
65	115.3	140	53.55
66	113.7	141	53.2
67	111.9	142	52.8
68	110.3	143	52.5
69	108.7	144	52.05
70	107.1	145	51.7
71	105.7	146	51.4
72	104.1	147	51
73	102.7	148	50.6
74	101.2	149	50.35
75	100	150	50





The figures were obtained from a slide rule, but are very close where they are not absolutely exact. For instance, take two examples of fundamentals that are even numbers where it is obvious that the strictly accurate answer is an uneven number. The 51st harmonic if 147 kc is supposed to be 7500 kc, but in fact the product of the harmonic order and the fundamental is 7497. In terms of the test oscillator this error is only about 1 part in 2500. Take the 139th harmonic of 54 kc, supposed to be 7500 kc, but in reality being 7506 kc, an error of 1 part in 1250. The dial you will use will not be able to record frequencies anywhere nearly as accurately as this, and besides many of the odd frequencies, such as 117.1 and 105.1, may be used as 117 and 105, reducing considerably the number of frequencies that have to be interpolated from a curve.

Frequency Stability

Something has been said about the desirability of frequency stability. Such stability means simply that the same dial position should always result in generation of the same frequency, time and again, particularly that the frequency should not shift due to voltage differences. The line voltage may change from night to night, or even from test to test, but this should not upset the calibration. Therefore the grid leak and condenser are included, and the action in something like that of a diode detector, for the grid serves as anode, the cathode as cathode, and the flow of grid current changes the bias on the tube resulting from the voltage drop in the grid leak. Moreover, greater oscillation amplitudes result in greater negative bias, hence grid current flow is stabilized, and the voltage is stabilized. In reality the thing at stake is the tube resistance, which should be held fairly constant.

The oscillation amplitude is not the same at all frequencies. The plate current, measured at d-c values, will range from about 0.5 ma to about 7 ma, being greatest at the high frequency end of the scale. The amplitude is fairly even for the low frequency half of the dial. We have seen that the greater current means that the bias is less, and that increased oscillation amplitude causes less current to flow, because increasing the bias through the grid leak. Therefore we know that the oscillator does not oscillate as violently at the high frequency end, and we can understand that, too, because the radio frequency resistance of the coil is greatest at the high frequencies, and the condenser capacity in use is less, it being well known that the oscillation amplitude is more stable when the LC ratio is lowest.

No evil circumstances arise from this current instability, as the dial is calibrated on the basis of conditions as they are. As the current will be the same under repeated tests of the same frequency, one may say that the current changes become a part of the calibration and therefore may be ignored.

Effect of High Load Resistor

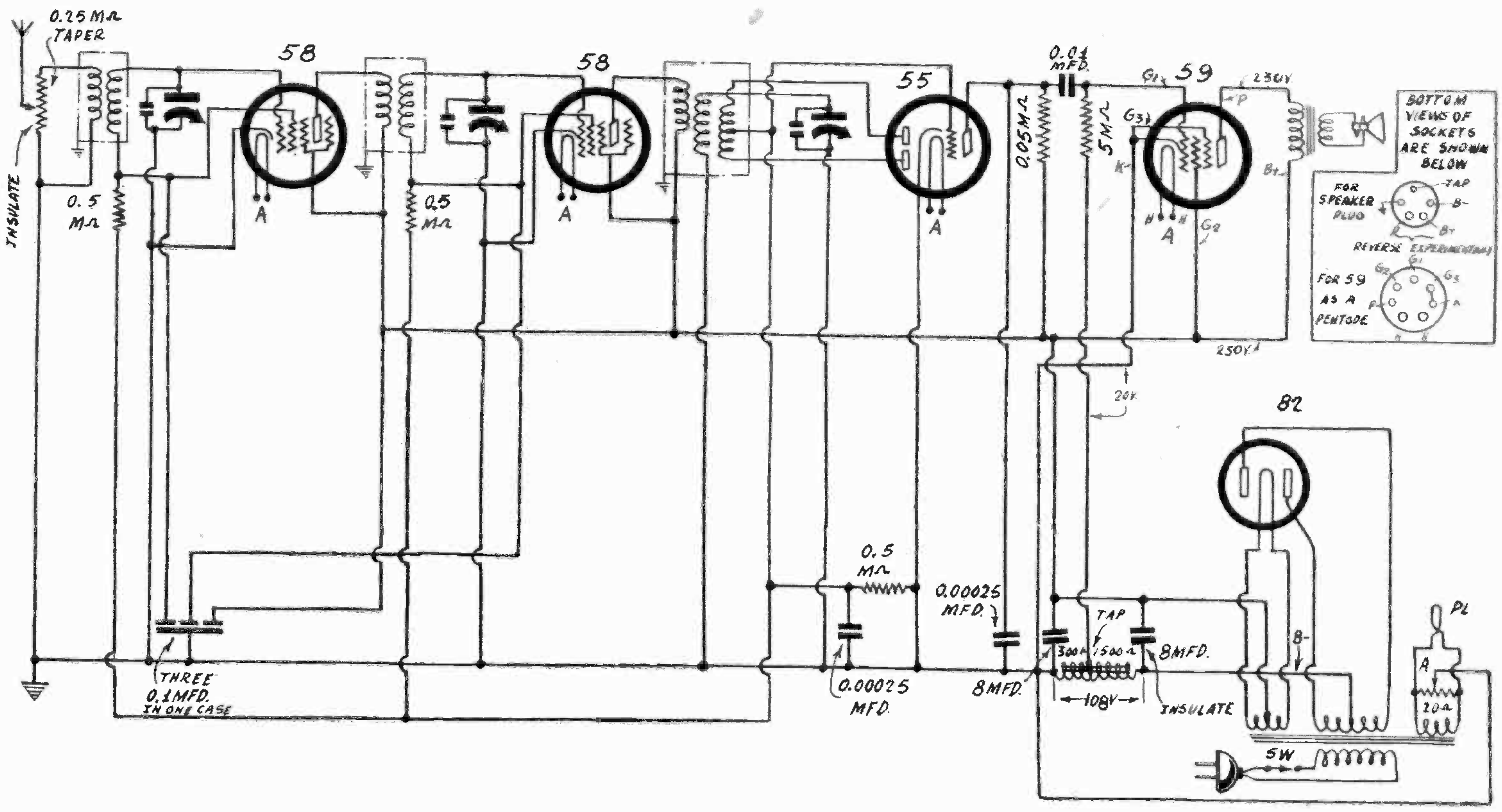
Increase in the plate resistance of the tube increases the frequency. Thus when we used earphones, we may have had 2000 ohms d-c resistance in the plate circuit. So when we remove the phones and want to adhere to the calibration thus obtained we must insert in place of the phones a similarly bypassed fixed resistance of the same d-c value. A high resistance in the plate circuit would stabilize the plate resistance, because the load resistance would be so much greater than the plate resistance, and the total change in plate resistance, or equivalent current, would be much less. However, the tube might stop oscillating if a plate load resistor is high, and besides the small current changes through the high resistance would produce effective plate voltage differences of the same order of instability as the previous plate current changes.

Nevertheless we have concluded that the change in plate resistance is the cause of frequency instability, and the high load resistor would reduce this change greatly, because the current change through the plate resistance of the tube would be so much less. We can not well recommend the high plate resistor unless the applied plate voltage is around 300 volts, whereas here the voltage is the line voltage, and we leave the circuit as we find it, and have a very inexpensive test oscillator that will give abundant satisfaction, with an overall accuracy of better than 3 per cent., usually better than 2 per cent., and sometimes as good as 1 per cent.

Diode-Biased Amplification

Simplified Diamond Has Newest Features

By Herman Bernard



Screens returned to the highest B voltage, no series resistors in cathode circuits for bias, suppressors returned to a-v-c resistors, are interesting features of the simplified Diode Diamond.

THE first impression that one may get from a glance at the diagram of the Diode Diamond in simplified form is that there are several errors in it. First, no bias on the amplifier tubes, except the output tube; second, screen voltage erroneously high, being the same as the plate voltage on all the other tubes.

When the circuit diagram was exhibited to a well-informed radioist he got the impression about the "mistakes," too, but anything that is a departure from regular custom in circuit design is likely to be considered at first as a mistake. When one ascertains the particulars, the so-called mistakes may turn out to be interesting departures from standard practice.

There really isn't any need to follow the rule of rote in radio circuits, even though respectable precedent need not be deprecated, either. What has been done time and again with success merits full consideration, but let not the eye be closed to newer ways of accomplishing results, either.

Unipotential Screens and Plates

Take the single example of the unipotential screens and plates. Those who carefully read the data on the 58 and 57 tubes when these were published last summer may recall that identity of voltages was cited as practical. The point also was made that high values of resistances could be used for reducing the screen voltage when such reduction was to be established. Moreover, the unified voltage for screens and plates, when used, was recommended not to be more than about the normal voltage that would be applied to the screens anyway, and the statement made that in this practice sensitivity was reduced somewhat.

That should establish to anyone's satisfaction that the screen and plate voltages may be the same, and then the question arises whether it is all right to use the higher voltage for both. The answer to that depends on the user. Of course, the tube draws more current, and tube life is shortened, but after all you get as much actual value out of the tube, because during the shortened period you get increased amplification. Instead of a tube life expectancy of 1,000 hours it may be reduced to 800 hours. Even in times such as these it is fairly certain that many would prefer to use their tubes up at a faster rate to bring about better results. The amplification is considerably greater when screens and plates are returned to the high voltage than when they are returned to the normal screen voltage, or when the high voltage is applied to the plate and a lower voltage to the screen.

What? No Bias?

Then as to the bias being absent. The fact is it is not absent. It is true that cathode is returned to ground, and usually that spells no bias, but look at the power tube circuit, where the cathode of the 59 is returned to ground. Yet there is negative bias on the control grid of that tube, because the grid return is made to a point negative in respect to cathode. That point is the tap on the field coil of the dynamic speaker. The field is also the B supply choke, and the voltage dropped across it is about 100 volts, actually having been 108 volts in a measured instance. B minus of the power transformer is the most negative point of the B supply system, hence ground (the other end of the choke) is positive by the amount of the voltage difference across the terminals of the field coil. The voltage difference between tap and ground of course is less, becaues the d-c resistance is less than the total, so the bias is less than the drop total across this winding. The bias will be around 18 volts.

Now let us look at the diode full-wave detector. A signal or other input voltage is delivered to this tube. Usually, of course, that voltage is the signal voltage, but assume that no signal is being received, at least there are some tube noises, the usual rushing sound, and they represent a voltage, too.

Many Advantages

Direct coupling is used between the diode unit of the 55 and the triode unit in the same tube envelope, accomplished by connecting grid to the center-tap of the third winding of the input transformer. Again "no bias," so to speak. And yet there is bias for the same reason, that a potential difference exists between the two extremes of the 0.5 meg. load resistor (center-tap of tertiary to ground) and that since the circuit outside the tube is one in which current flows from cathode to anode, cathode is positive in respect to anode.

The amount of bias on the triode unit therefore varies with the carrier input to the diode. Moreover, it varies in the right direction. The higher the signal, the greater the bias. This not only protects the 55 triode section from overload but also serves as protection of the 59 and moreover permits the use of 5.0 meg. as

LIST OF PARTS

Coils

Two r-f transformers for interstage coupler, for 0.00042 mfd.
One three-winding transformer; secondary for 0.00042 mfd., tertiary a 100-turn center-tapped choke.
One 60 ma. power transformer.

Condensers

One three-gang shielded 0.00042 mfd. in shield.
One shielded block, three 0.1 mfd. (black lead common, goes to ground).
Two 0.00025 mfd. fixed condensers.
One 0.01 mfd. mica fixed condenser.
Two 8 mfd. electrolytic condensers, one with two insulating washers and a special connecting lug.

Resistors

One 20-ohm center-tapped potentiometer.
One 0.05 meg. pigtail resistor.
Three 0.5 meg. pigtail resistors.
One 0.25 meg. tapered potentiometer (250,-000 ohms); insulated type.
One 5-meg. pigtail resistor.

Other Requirements

One chassis, 13¾ inches wide x 2½ inches high x 7¾ inches front to back.
One vernier dial, traveling light type, with bracket and pilot lamp; dial reads, left to right, 0 to 100.
Three knobs (one for dial, one for volume control, one for a-c shaft switch).
One dynamic speaker, 1,800-ohm field coil, tapped at 300 ohms; output transformer built in, has matched impedance for 59 tube used as pentode.
One shelf 7¼ x 2½ inches, with two brackets.
Three six-spring, one five-spring (UY), one 7-spring and one four-spring (UX) sockets. The UY is for speaker plug.
One a-c shaft type switch.
Two threaded bushings ⅝ inches long.
One a-c cable and plug.
Three special aluminum shields for the 58 and 55 tubes.
One rubber grommet for a-c cable exit.
Tubes required: two 58, one 55, one 59 and one 82.

the load resistor in the 59 grid circuit without grid current, a very high value resistance, but one that increases amplification considerably (compared to that obtained from the usual smaller values) and also improves low-note reproduction and reduces hum.

Diode-Biased Triode

A close examination of the circuit will show that the control grids of the 58 tubes are returned, through bypassed resistors, to the center-tap of the third winding on the detector input transformer. When there is any input voltage to the diode, therefore, there is exactly the same bias on the r-f tubes as on the audio amplifier (triode unit of the 55). The diode-biased triode was mentioned as one of the possibilities when the 55 was announced last summer, and circuits shown both for full-wave and half-wave rectification. To be sure, superheterodynes were the exclusive consideration, evidently because the system had not been worked out for t-r-f sets, partly on account of the difficulties attendant on the grounded rotor of the tuning condenser. Those difficulties, which do not arise in the case of the screw-driver adjustment type of semi-fixed tuning condensers in superheterodyne intermediate transformers, are completely avoided by the third winding, which is a 100-turn center-tapped radio frequency choke coil that fits snugly inside the small form on which the primary and secondary are wound.

Subsequently an addendum mentioned the possibility of using the diode-biased triode, with a-v-c, in t-r-f sets, but so far as known the present circuit, the Diode Diamond, is the only one actually built that proves the effectiveness of a-v-c, in t-r-f., has full-wave diode detection, diode-bias on triode and 58's and, moreover, automatic fidelity control, or automatic selectivity control, whereby the set is more selective on weak signals and tends to cut sidebands on them only, leaving the full modulation band to be passed through tuner (and of course audio amplifier) on local stations. The reason is that for distance reception closer selectivity is needed, and some automatic means is highly acceptable for reducing the noise due to static types of interference.

Simplification Effetced

The circuit was described last week in a more orthodox form, although including the features just enumerated. This week a great simplification is effected, and fewer parts required, because there are no independent biasing resistors in the r-f and audio cathode legs, and of course no need for bypass condensers otherwise required. In fact, the circuit, with all the new wrinkles, can be built at less expense than most of the five-tube t-r-f receivers, and besides there is less likelihood of running into trouble. Whenever I see a diagram replete with chokes, resistors and condensers, and that looks rather confusing at first glance because of the many parts included, I always imagine some one designed the set with the primary consideration of including as many parts as possible that could be used from stock, rather than making the set the best it could be even if only a few parts are needed.

While it is possible to obtain commercially a complete kit for he Diode Diamond, it is also true that many have five-tube sets for a-c operation who could very readily change over to the Diode Diamond system. What is there to it, except to leave out some parts otherwise included, put in a couple of resistors marked 0.5 meg. that are not critical and may have some other values thereabouts, if such parts are at hand, and get hold of a center-tapped coil?

Drives a '45 Output

The automatic fidelity control consists simply of tying the suppressor grids to the return end of the two r-f secondaries ahead of the detector. Your output tube you may leave as it is. The 59 is in several respects an improvement over the 47, yet you will get excellent results with the tube you now use, if you got fair results before.

The circuit, as shown, was one actually used in my home, except that I used a '45 output tube, because my speaker had an output transformer for that tube. Moreover, this example is an exception to the rule that two stages of t-r-f and a diode detector-triode amplifier will not drive a '45. With this circuit the '45 is drive a '45. Less than the full 50 volts negative bias are applied, however.

The unipotential cathode system prevails throughout, in that the cathode and the heaters of the receiver tubes are at the same d-c potential. Both are grounded. Now it is a mighty fine asset to have a detector with grounded cathode, because much of the hum found in receivers is due to the a-c line frequency that is introduced into the grid biasing resistor, with elevated cathode, and the screen resistor. The higher these are, the greater the hum, and it takes a whale of a filter condenser to get it out properly. A way often used in getting it out improperly is not to bypass the resistors adequately for audio frequency purposes, and thus attenuate the low frequencies and thus subdue amplification of the hum frequencies. In adequate bypassing, 16 mfd. would not be too much. Here we get the benefit of infinite bypassing across any theoretically resistor, because there is no resistance to bypass. Cathode is grounded.

Various experiments were conducted as different hum conditions were purposely introduced into this receiver, and at one time motorboating was experienced, of a slow frequency, sounding as if someone were saying "a rat trap" over and over again.

How Trouble Was Eliminated

The 5.0 meg. grid resistor in the output stage was shorted, and although the intensity of the motorboating was less, the trouble remained. Of course, the source was the output stage (since this was not shorted) in combination with the coupling though the B supply choke. However, once the point of origin was found, there was really only one remedy left, the output transformer. The first move was to reverse the connections to the output tansformer, so that the terminal that went to plate now went to B plus, and indeed since it was about the only ready remedy it is pleasant to report that it was completely satisfactory.

It will be noted that the usual grid circuit filter is omitted. That is, instead of having two grid leaks in series in the power tube circuit, with a bypass condenser between joint and ground, there is only one resistor. If the output transformer is connected in such polarity that it bucks, the phase is shifted 180 degrees (approximately) and the same end is gained as if the resistor-capacity filter were used. There is enough sensitivity in modern receivers to permit this bucking connection, and since it accomplishes the same result, it is selected as the simpler remedy.

These remarks about the filter omission and the reversal of the connections of the output transformer are to be applied

(*Continued on next page*)

Coils for the Diamond

(Simplified Diode Model)

A shield over a condenser increases the minimum capacity, so to cover the wave band with a shielded condenser 0.00042 mfd. was selected. This requires 181 microhenries inductance to tune to just a trifle lower than 540 kc (99 on the dial for 540 kc). Then 1,500 kc comes in at 2 on the dial.

The inductance of 181 microhenries may be obtained by winding 109 turns of No. 32 enamel wire on 1 inch outside diameter. The primaries are all the same and consist of 15 turns of any insulated fine wire, separated from the secondary by insulating fabric, and wound nearer the bottom of the secondaries. The coils are connected alike, with bottom to ground and top to grid, for the secondaries, and with top of primary to ground or B plus and bottom to aerial or plate.

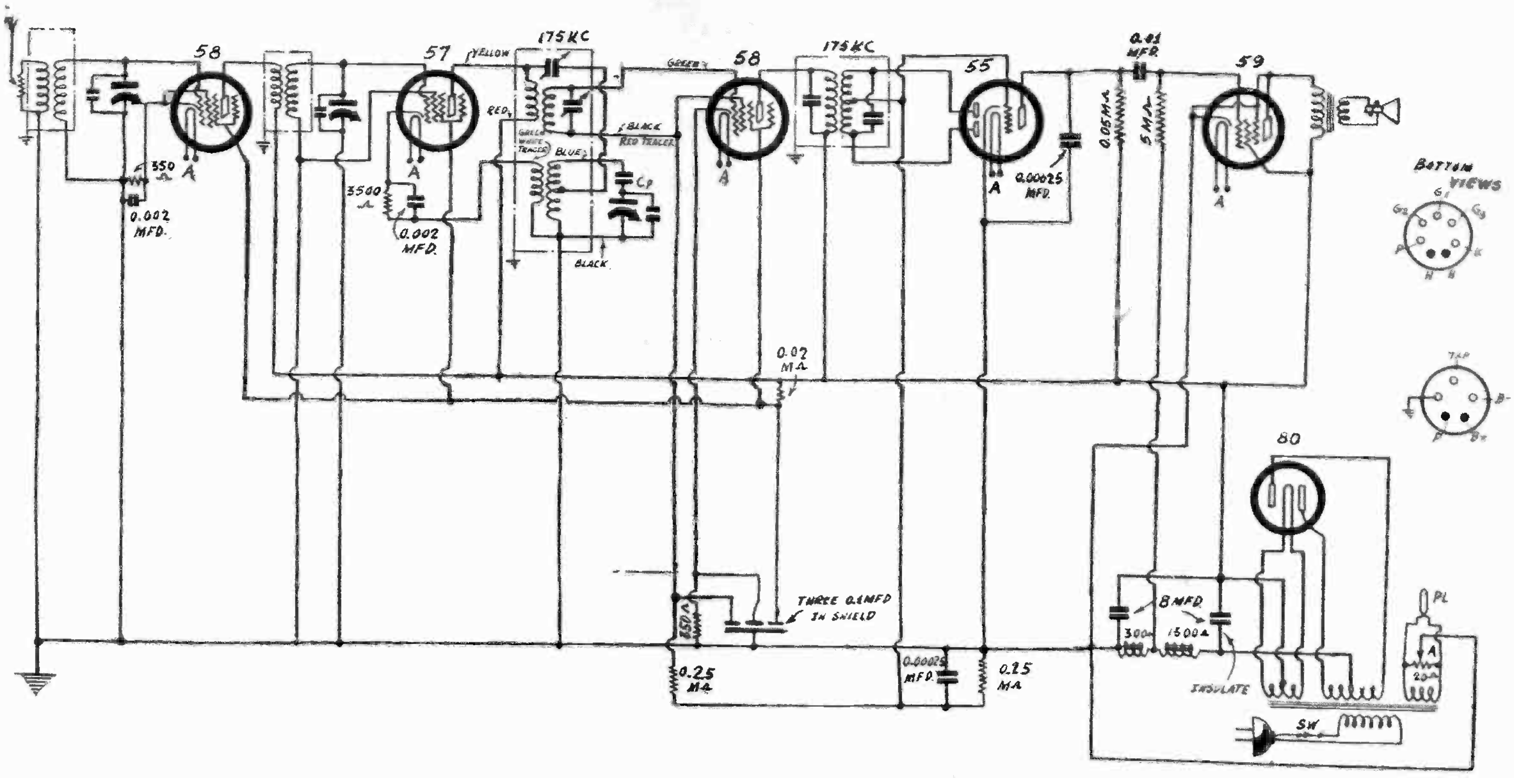
Some who can not get No. 32 enamel wire can get No. 28 enamel and may wind the secondaries, using 125 turns of this size wire, instead of 109 turns of No. 32 enamel. If the primaries are wound with the same size wire, No. 28, use 20 turns instead of the 15 prescribed, for fine wire. The coils should be in aluminum shields at least 2 inches in diameter, 2½ inches high.

The center-tapped choke coil used for pickup to feed the diode is a honeycomb of about 1 inch outside diameter, but as winding such coils requires a special machine, there is no need to give the directions. These coils are commercial products, and RADIO WORLD's Trade Editor will be glad to assist readers inquiring about parts.

If an unshielded condenser is used then 0.00035 mfd. capacity may be used, secondaries 245 microhenries, primaries same as previously. For 245 microhenries wind 127 turns of No. 32 enamel on 1 inch diameter tubing, or, using No. 28 enamel, wind 160 turns.

THE SUPER DIAMOND

Six Tubes in a DX Circuit



QUALITY and sensitivity are good in tuned radio frequency receivers, but when one wants selectivity of an order commensurate with the requirements of far-distance reception, then one has to select a superheterodyne. Certainly excellent results are obtainable from five-tube tuned radio frequency sets (including the rectifier among the five), but it can be demonstrated quite easily that the sensitivity will be greater and the selectivity far greater if an extra tube is added and the circuit made into a superheterodyne.

The six-tube receiver diagramed herewith is one that fulfills the requirements in that it will cut out a strong local and bring in a distant station 10 kc removed therefrom, and could attain a sensitivity of the order of 2 microvolts per meter. This is somewhat greater sensitivity than is really wanted, because the more sensitive a set the greater the noise, so the biasing resistors are made a little higher than usual, and may be increased even beyond the values stated. These are the resistors that furnish the fixed bias for the r-f and intermediate amplifier tubes.

Full Band Covered

With the circuit as it stands the reception provided response from 80 of the 96 channels in one night's test, and the tuning was from 1500 kc at 3 on the dial to 540 kc at 98 on the dial, showing that the broadcast band is exceeded.

The receiver consists of a stage of t-r-f, an autodyne tube (modulator and oscillator combined in the same tube) a single intermediate amplifier tube, subject to automatic volume control and automatic selectivity control, a full-wave detector and two stages of resistance-coupled audio, of which the first is the triode unit of the 55 tube, and the second is the new 59 output tube, which is one of the finest of the whole line of power tubes. That tube is so sturdily and roomily constructed that it does not get nearly so hot as the filament type tubes with which we have been accustomed.

The only point concerning the 59 tube that requires special attention is the fact that, since the tube is of the heater type of construction, there is a delay of a few seconds between the time that the juice is turned on and the time that the emission is near its normal value for reproduction. During this lapse, not present to nearly so great an extent in filament type tubes, there is at first no starting current, then a small value, hence the voltage across the filter condensers is higher than in the case of the 47 and other filament type tubes at the turning-on instant. Therefore the rating of the condensers should be well in excess of the continuous duty voltage requirement imposed.

Need for Higher Rating

Since all the tubes in the set—save the rectifier alone—are of the heater type, the

Reverse Speaker Connections As Hum Reducer

(*Continued from preceding page*)

strictly to two-stage audio amplifiers, for such is what the audio channel is in this receiver, with the first stage being the triode unit of the 55 and the second stage the output tube. This is one stage more than ordinarily found, and the phase relationship may be different therefore, since each extra stage of resistance audio causes a phase shift of about 180 degrees. Nor are these remarks to be read as a denial that other detector tubes (such as 57, '24, 56, '27 or any other triode, quadrode or pentode) is not be rated as an audio amplifier, though it is classified as detector.

Marvelous Tone

As stated in last week's instalment, the tone quality is the thing in this receiver. The set is so far superior in tone to any other five-tube receiver that I have ever heard that I advise all readers to try the Diode Diamond system by all means. The sensitivity is high indeed, another advantage, so much that there may be r-f squealing unless the primaries are not too large, and the two bypass condensers specified as 0.00025 mfd. not too small. An easy remedy for squealing, if you don't care to use higher capacities than 0.00025 mfd. if needed for this purpose, or reduce primary turns, is to put a fixed resistor between the upper end of the volume control potentiometer (aerial-ground circuit) and the aerial end of the primary. This reduces sensitivity a little, but there is plenty to spare.

As for selectivity, the circuit has a variable sort, as intimated, and the greatest selectivity is on the weakest signals. However, if you are in a location troublesome on account of local interference you can not well use the automatic fidelity control, and for greater selectivity on locals will return suppressors of the 58 tubes to cathode (ground) instead of to the volume control isolating resistors.

The volume control increases selectivity as volume is cut down, and while this might seem a remedy even if locals are troublesome, the volume has to be cut down too much before the selectivity is high enough in the troublesome cases cited. For other than those suffering interference from locals close to them, the circuit as shown is entirely satisfactory, especially as an instrument of high musical calibre, one that lets you hear everything that is transmitted, even the unintentional sighing sounds of male quartet singers as they quickly take their husky breaths.

effect is cumulative, but as there is virtually no current instantaneously, this condition leaves the field coil unhelpful. So if you use wet electrolytic condensers, and they produce a boiling sound when the set is turned on, you must get condensers that will stand a higher voltage, and these are usually dry electrolytics. An extra series resistor will not help sufficiently, for the same reason, that the current does not attain any appreciable value before the charging of the condensers is completed.

With this simple precaution stated early, so that all who run into condenser trouble will know it for what it is, as well as know the cure, we shall proceed to a discussion of this most excellent circuit that affords fine tone quality, high selectivity (though not too high for quality) and a sensitivity as great as is useful.

The t-r-f stage is standard. The volume control is in the antenna circuit, being a potentiometer across the primary of the antenna transformer, and the carrier voltage input being regulated by adjustment of this control. In this position the volume control is entirely too critical if the resistance change is linear, so rather the control should be tapered, approximately on a logarithmic basis, for then the critical aspect is removed, although for room volume on far-distant stations it is usually necessary to have the volume control turned "full on." Some other type of volume control may be used e. g., in the audio channel, as some prefer. This will be discused next week.

Stopping Stray Oscillation

By making the resistance value high the reduction of selectivity becomes negligible, and therefore a value of 250,000 ohms was selected. Such a high resistance virtually rules out wire-wound types, and while other types wear out faster, they are more suitable because there is hardly any scratchy sound when the control is turned. If scratchy sounds are heard, particularly if only over the higher frequency part of the dial, it is an almost sure sign that the 58 t-r-f tube is oscillating, which it mustn't do, and therefore you would have to increase the value of the biasing resistor to whatever value is necessary to get rid of oscillation. Another remedy would be to leave off the 0.002 mfd. bypass condenser, and let the resistance remain 350 ohms.

The next tube is the mixer or autodyne. The use of the 57 tube for this purpose is greatly facilitated by having the oscillator coil system and the first intermediate transformer in a single shield. The construction is such that the two coil systems are actually separated from each other magnetically, but the set-screw type tuning condenser across the primary, accessible from the top of the shield, has one end connected to plate and the other end to a tap on the oscillator tuned winding. This connection is made at the factory. It is hardly practical to make the autodyne coil on the basis outlined without factory facilities.

By returning one side of the primary tuning condenser to the tap some r-f plate voltage is fed into the oscillator's tuned secondary, and oscillation arises from the coupling of the cathode circuit to the oscillator's secondary. The magnetic fields of the cathode and plate circuit windings unite to produce oscillation if the connections are such as to provide the correct phase. To avoid any difficulty on this score the returns of the cathode pickup winding and the oscillator's tuned secondary are made to the same outlead. Then if the color code is followed, oscillation is assured, unless there has been an error at the factory.

Code for Combination Coil

The correct color code is as follows:

Yellow lead to plate of the 57, red lead to B plus, maximum resistance 40 ohms; green lead (emerging from top of the shield) to control grid cap of the 58 intermediate amplifier, black with red tracer, return lead for the green, resistance 40 ohms; blue lead, high potential end of the oscillator's tuned secondary, to free side of padding condenser, black to a-v-c, resistance 12 ohms; green lead with white tracer to cathode of the 57, and black lead to cathode return, ground, resistance 6 ohms.

The input of the r-f level is to the control grid of the autodyne tube, as this is the best place to put the original signal when the 57 tube is used. The input is virtually standard, except that the biasing resistor is placed between cathode and one terminal of the pickup coil (green with white tracer) and thus reaching ground, instead of between cathode and ground directly. Since the ends of the pickup and tuned windings for oscillation are to a common outlead (black), the biasing resistor has to be lifted in that fashion, and the bypass condenser across it must not be grounded. This is the 0.002 mfd. across the 3,500 ohms.

The intermediate amplifier tube, also a 58, has its grid returned to a fixed pigtail resistor of 0.25 meg., with a bypass condenser from the end of this winding to grounded B minus. The other side of that resistor goes to the center tap of the second i-f transformer's secondary, to pick up the direct voltage developed in the 0.25 meg. load resistor of the diode unit of the 55. Thus besides the starting bias of about 3.5 volts, there will be extra negative bias on the intermediate amplifier, approximately equal to the voltage developed across the diode load resistor. This voltage may run as high as 20 volts on strong locals, for just a fraction of a second, or until the a-v-c decreases the amplification by increasing the bias of the intermediate tube, which sends the diode load resistor voltage down, too.

The a-v-c is most effective on strong signals, as it should be, and the reason for not including a-v-c on the r-f and autodyne tubes is to keep the sensitivity high. A compromise has been struck in the interest of greater ability to reach out for distant stations. No fading was experienced with this receiver, nevertheless.

Sensitivity Protected

The intermediate amplifier tube has its suppressor tied to the automatic volume control resistor, so that on weak signals the suppressor voltage will be less negative, the plate resistance higher and the selectivity still better. This makes the relative selectivity higher on weak signals than on strong ones, and tends to reduce background noise and inter-station interference and also to insure quality on locals while offering needed selectivity on DX. But if local reception is not selective enough, tie this suppressor instead to cathode.

If intermediate squealing is experienced the same corrective may be applied as recommended previously. This time the biasing resistor of the intermediate tube, marked 350 ohms, should be increased until oscillation stops. The reason for the hesitancy to fix an adamant value is that conditions vary, tubes are different and resistors of imprinted values may differ sufficiently to cause oscillation where none was intended. The choice of a "safe" value of resistor in the two positions accounted for by the 350 ohm units has been avoided, because of the necessary sacrifice of sensitivity involved in such a "safe" choice. Better to have the set oscillating at both levels, and then correct to the right value, than to have no oscillation where none is wanted, and lose some of the advantage so deeply desired.

The full-wave diode detector, since the two halves of the center-tapped secondary work alternately, gets one-half of the input it would get by the single-sided method, but there is plenty to spare, and if the full voltage of the input were utilized the intermediate tube would oscillate, and the amount of "gain" would have to be taken away to provide stability.

The center tap of the secondary is connected to the control grid of the 55, which is the tube cap. By this method direct coupling of the audio component of the output diode is made to the triode input. The output is orthodox. The two 0.00025 mfd. fixed condensers are advisable as squealing correctives. Theoretically no condenser would be needed across the diode load resistor if there were perfect balance in the secondary, which is not to be expected. The plate bypassing is also to the end of removing the intermediate frequency from the audio amplifier, stopping from getting into the audio amplifier.

Socket Diagrams

The plate load resistor of the triode unit of the 55 is not critical, and any resistance value from 20,000 to 100,000 ohms may be used. Here 50,000 ohms is specified (0.05 meg.), while the grid leak in the power tube stage is 5 meg., to enhance the low note response and improve the audio sensitivity throughout.

The 59 tube has seven prongs. The diagram of connections is shown, also the diagram of the speaker socket, to conform to the standard practice in Rola, Magnavox and Jensen speakers. Note that the cathode is grounded and that the grid return (of control grid, or Grid No. 1) is made through the 5 meg. to the tap on the field winding. Check up on the field winding to be sure the 300 ohms are between tap and ground in the circuit, and not between B minus and grid return. See page 6 for grid identities.

The only trick in the circuit is to achieve proper padding. This can not well be done without an oscillator, preferably a modulated oscillator, but as some do try to make a super work well, without use of a test oscillator, a method will be outlined without any recommendation that it be used.

Make the intermediate tube oscillate and beat with 1400 or 700 kc supplied by any receiver. Adjust the i-f condensers.

Stop the oscillating condition. Select two stations, one at the low frequency end, 570 to 540 kc, and another at the high frequency end, 1500 to 1450 kc. You must be certain of tthe stations and their frequencies.

Padding Procedure

Take an insulated wire lead about eight inches long, solder a grid clip at one end, bare the other end. Remove the 57 from the set, twist the bare end of the test lead about the grid clip formerly used on the 57, remove the grid lead clip from the 55 and put there instead the grid clip of the test lead. Now the receiver is a t-r-f set, one stage of t-r-f, triode of 55 as a zero bias stray detector, and 59 as output. The sensitivity is good enough to enable the reception of local or modestly distant stations of the desired frequencies. Ascertain the dial settings for the two extreme or nearly extreme frequencies selected, and line up the two tuning condenser sections by adjusting the trimmers for the high frequency setting.

Now restore the set as a superheterodyne, turn the oscillator trimmer half way down, and note the dial settings for these two frequencies. These will be governed by the oscillator, except that there may be two settings for the low frequency station, one occasioned by the oscillator, the other occasioned by the t-r-f section, the latter weaker than the oscillator determinant. This, plus lack of selectivity, shows absence of tracking.

Turn the dial to the number for the low frequency oscillator. Poor sensitivity may result in failure to pick up the low frequency station, but adjust the padding condenser until response is loudest. Since the padding condenser, Cp, is not grounded, body capacity effects will be noticeable, and when you turn the screwdriver until there is maximum volume, and then remove the screwdriver, volume drops. You will have to add more capacity, a

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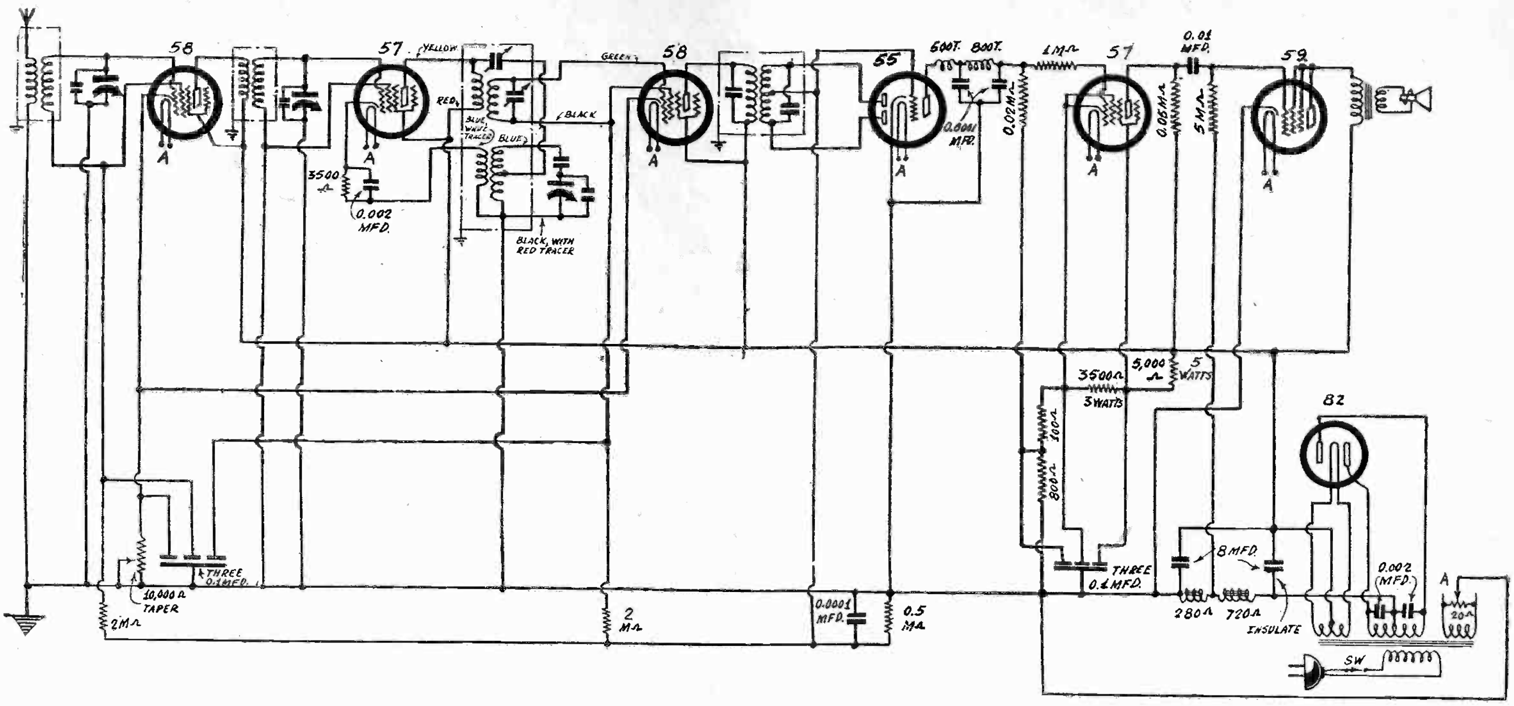


This circuit was tried but did not work out so well, as the DX-getting ability was not sufficiently pronounced. The extra 57 is for automatic noise suppression, but the a-v-c effect was reduced in the later model so that noise suppressor was not necessary.

(*Continued from preceding page*)
little at a time, by turning the driver in a right-handed direction, removing the screwdriver after each tiny fraction of a turn, until volume is maximum after your hand capacity effects are removed.

Oscillator Trimmer

Now turn to the other frequency. You may tune in police calls, which shows that the oscillator is tuning to too high a frequency. Turn down the trimmer on the oscillator until coincidence is established at this end. The dial is set for what it should be at this frequency and the oscillator trimmer adjusted. This trimmer has to be at least half way down, usually more than half. It may be necessary to adjust slightly the trimmers for the r-f and input of the autodyne, because in the upsetting effect of the autodyne coil system now functioning, which changes slightly the inductance values compared to the t-r-f trial system first tested.

When this work is completed the high frequency end is lined up, but the low frequency end has to be readjusted probably, and only the padding condenser need be molested. This has virtually no effect at the high frequency end, so we need not worry about disturbing the settled padding at that end when we adjust at the other end. When the readjustment of the padding condenser is made, the work is completed.

It may so happen that the padding condenser, turned to maximum capacity, gives greater and greater response, for the selected station frequency, or tunes in lower and lower radio frequencies, until full capacity is reached, and one desires to use more capacity but it isn't there.

Two remedies are open. One is to put a small trimming condenser, across the padding condenser, the other is to increase the intermediate frequency until the low frequency station comes in loudest, with padding condenser at maximum. When the intermediate frequency is changed the alignment at the high frequency end has to be done all over again.

Use of Test Oscillator

With a test oscillator the procedure is similar, but the frequencies are known definitely. In the first place, the intermediate frequency is settled. In the second place the tie-down points may be selected on a basis established by the inductance, which makes 600, 990 and 1450 kc the preferred points. The tiedown is made on the basis of the two extremes first and checked up on the basis of 990 kc.

The procedure is to line up the intermediate amplifier first, by putting the oscillation voltage into the plate circuit of the autodyne, and adjusting the manual trimmers on the intermediates. These are four, two on primaries and two on secondaries. Then the set is established as a t-r-f receiver on the basis already discussed and 600, 990 and 1450 kc dial points are registered. The receiver is restored as a superheterodyne, the oscillator trimmer turned down half way, and the padding condenser adjusted for 600 kc. Next the high frequency end is adjusted by means of the oscillator trimming condenser, and r-f and autodyne input trimmers readjusted, too, if necessary, as determined by turning them while remembering the setting originally established. Then the low frequency end is readjusted, padding condenser set, and the checkup established at 990 kc.

Oscillator Frequencies

With a test oscillator it is practical to determine the oscillator's frequencies at the three settings independently, by removing the r-f-tube and loosely coupling the test oscillator to the plate circuit of the r-f amplifier, reading the frequencies put in, and added thereto the known intermediate frequency, e.g., 1625, 1165 and 775 kc for the three tiedown points.

If there the set is not lined up properly for the high frequency end (trimmers) the sensitivity will be poor here, while if the padding condenser is not properly set for the low frequency end the reception will be poor at low frequencies, with not many stations but possibly many squeals heard at the high frequency end.

When the set is lined up properly DX will come pouring in, and perhaps that is the best retest.

[*The above discussion is preliminary. The diagram next week will show some minor circuit improvements and the text will deal with construction.*—EDITOR.]

Next Week!

Issue of December 24th!

Full Constructional Details on the Super Diamond.

Follow the articles on this DX receiver!

Europe's Latest Gadget Open for Distribution

Postal Radio Co., 135-137 Liberty St., N. Y. City, announces that it has succeeded in making arrangements to throw open the entire United States for distribution for Pix, the latest radio sensation of Great Britain and Europe. This unique device has met with much favor as a device to cut out interfering stations and to aid in bringing in foreign stations. It is sold on a money-back guraantee.

For servicemen and experimenters the company has a fine sales proposition and has issued a sales aid circular that will assist anybody to sell them. This will be sent free with full information as to how to get started in the radio agency business. The idea is going over big in New York and New Jersey and there is plenty of room for more activity.

Intermediate Lineup When Using A.V.C.

By Einar Andrews

ADJUSTMENT of the intermediate circuits and the padding in a superheterodyne equipped with automatic volume control offers quite a problem. It is customary to adjust for greatest volume, either by ear or with the aid of an output meter. But this method is not dependable in a circuit where the gain is affected by the strength of the signal. While fair adjustment can be obtained by this method it is not as good as it should be.

There are several methods by which the adjustment could be made. This simplest, perhaps, is to kill the automatic volume control while the adjustments are made, for then the output meter method, or the aural method, could be used just as if no a.v.c. were built into the circuit. To kill the a.v.c. it usually suffices to short circuit a condenser, the condenser that is connected from the junction of the various individual filter resistors and the single resistor from the load resistance of the diode. This may not be permissible in some cases as it might possibly short the signal also.

Another method is to cut the common lead from all the controlled grids to the a.v.c. and then connect to ground. This also would kill the a.v.c.

Using Tuning Meter

Still another method is to use the tuning meter. If this meter is connected in series with the plate returns of the controlled tubes it would only be necessary to adjust for minimum reading on this meter, provided that the input signal were kept constant during the adjustment. This works because the plate current in the controlled tubes is minimum when the sensitivity is greatest, for then the bias on the controlled tubes is greatest.

Methods requiring cutting of leads and adding parts are objectionable, especially when many circuits are to be tested. Therefore the above methods are not desirable, except the tuning meter method when the set is already equipped with this device.

Another method of making the adjustment is to put a high resistance voltmeter across the automatic bias resistance. When this voltmeter reads maximum, the circuit is the most sensitive. But if this meter is used it must be one of very high resistance and it must be connected so that it does not detune anything appreciably. Perhaps the only suitable voltmeter is a d-c vacuum tube voltmeter. If the voltage is measured between the common grid return point of the controlled tubes and ground there would be very little effect on the tuning.

Another possible method is to arrange an adapter for plugging into the detector socket arranging it so that the detected current would flow through a sensitive milliammeter. The same tube, of course, would be used and the only change in the circuit would be the insertion of the milliammeter in series with the diode from which the automatic volume voltage is obtained. This amounts to cutting a lead and inserting the meter in the break, but the use of the adapter would obviate any actual cutting.

If this method is used adjustment should be made for maximum current. It is clear that a sensitivity of the meter used must be high, for the load resistance may be of the order of 0.5 megohm and the highest voltage across it may not be more than 50 volts. That would make the current 100 microamperes. A zero to one milliammeter might be used but it would be better to have a zero to 200 microammeter.

Zero Beat Oscillator

Now let us suggest a method that may be suitable where many sets are to be tested, or where the suitable equipment is already at hand. This method, let it be understood, is theoretical as it has not been tried, but it appears to be sound in theory.

Suppose we have an oscillator that generates the intermediate frequency. It ought to be adjusted to a single fixed frequency, but if it is calibrated so that the right frequency can be selected **accurately,** that would be all right. First of all we adjust the intermediate tuning with this oscillator. We then know that the intermediate amplifier is tuned exactly to this frequency. Of course, one of the problems raised by the a.v.c. enters into this also, for at least one tube in the intermediate amplifier is automatically controlled. But the effect is not nearly as great as in the entire receiver, and the adjustment can be made with the usual output intensity method.

Next let us calibrate the r-f tuner. This can be done without trouble from the a.v.c. All that is needed here is to make sure that the trimmers are set so that the whole band of broadcast frequencies can be tuned in and to find out where two broadcast frequencies, say 600 and 1,450 kc, come in.

Now let us set the r-f tuner at one of these and let us supply that frequency from the laboratory oscillator. The oscillator in the circuit will now generate a certain frequency that will beat with the signal frequency to produce some intermediate frequency. It should be exactly equal to the intermediate frequency to which the i-f amplifier has been tuned, but chances are that it will be widely different. The question now is how to make it equal to the intermediate frequency. If we succeed in doing that the padding has been done at that particular setting of the r-f tuner.

Using I-F Oscillator

Now let us start the i-f oscillator again, the one that was used in tuning the i-f amplifier. It generates the frequency we want exactly. Let us couple it to the i-f amplifier loosely. It will now beat with the beat frequency between the r-f and the high frequency oscillator. If we make this second beat zero we have solved the problem.

Suppose the r-f frequency involved is 1,450 kc. Then we adjust the trimmer condenser on the oscillator to make the adjustment. As we turn the adjusting screw the beat frequency between the r-f signal and the oscillator will vary, and consequently the beat between this beat frequency and the intermediate oscillation will also vary. Turn the screw until the audible beat is of zero frequency. Then the beat between the two high frequencies will be exactly equal to the intermediate oscillator frequency and the line-up will be exact.

Now let us set the r-f dial on the point found for 600 kc. This time vary the series padding condenser until the audible beat is zero. Then the line-up will be exact at 600 kc.

This method of adjustment does not depend on intensity at all and hence the automatic volume control does not affect the result in the least. However, the work must be done carefully or the results will not be satisfactory.

Recapitulation

This beat method of adjusting the superheterodyne depends on the use of an accurate intermediate frequency oscillator. Let us suppose that its frequency is *f* kilocycles. We use this oscillator for tuning the intermediate amplifier. Then we couple it loosely to the intermediate amplifier so that it continually feeds the desired intermediate frequency into the circuit.

Next we find out where the two tie-down frequencies, say Fo and F1, come in on the r-f tuner. Set the r-f tuner on one of them, say Fo, and supply a radio signal of exactly this frequency Fo. If this is the higher tie-down frequency, adjust the trimmer condenser on the high frequency oscillator until the beat note in the output is of zero frequency. Then the circuit is adjusted at the high frequency Fo. Now set the r-f tuner on F1, the lower r-f tie-down frequency, and supply this frequency. Now adjust the series condenser on the high frequency oscillator until the beat note in the output of the set is of zero frequency. The circuit has been adjusted at the lower tie-down frequency, and the circuit is completely adjusted.

Detuning Corrected

Of course, in making the second adjustment the first is slightly thrown out of adjustment. With the ordinary intensity method of adjusting the padding the detuning can usually not be detected, but with the beat method of adjustment it is possible that the detuning will be sufficient to send the beat in the output above audibility, that is, above about 10,000 cycles.

If a large detuning effect is noticed it should not be ascribed to the adjustment for there are two major effects involved. One is the difficulty of setting the signal generator at exactly the same frequency it had when the adjustment was first made. The other is that it may not be possible to set the r-f tuner where it was the first time. If the r-f tuner is off the high frequency oscillator is off and that may account for the greater part of the noted detuning. If a suitable high frequency broadcast signal is available one of these uncertainties is removed for the frequency of that station will not vary appreciably between the two adjustments, and certainly it will not vary because of anything that is done on the receiver. Then only remains the uncertainty of setting the receiver condenser the second time. It may possibly be set to an accuracy of one-tenth of a division, but even that amounts to quite a bit at that end of the dial.

Uncertainties of the signal frequencies may also be avoided by having two fixed frequency oscillators accurately adjusted to the two tie-down frequencies, or a single oscillator which can be set at one or the other frequency by throwing a switch. But even that leaves the uncertainty of setting the r-f tuner on the receiver.

The detuning due to the second adjustment is very small if the change in the series condenser capacity is small.

CURVES ON

Currents Differ

By J. E

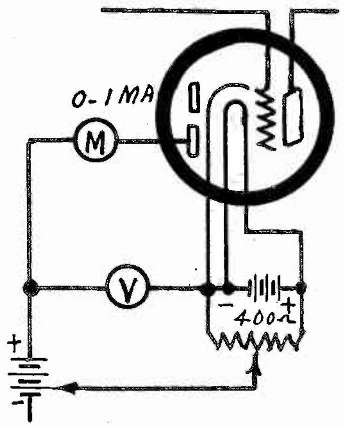


FIG. 1
A simple set-up for measuring the anode current as well as the grid current of an 85 tube for various voltages in the anode circuit. Dissimilar currents arise.

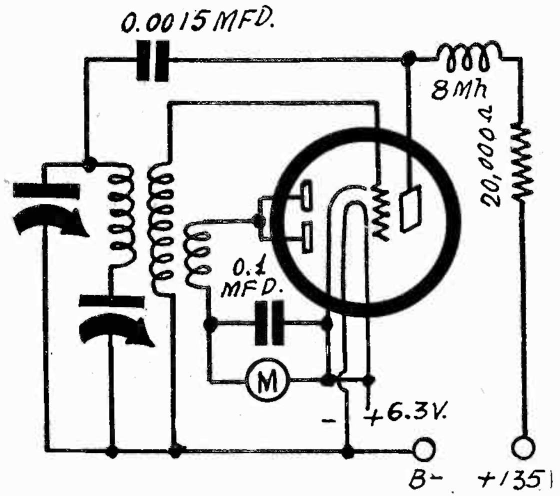


FIG. 2
An experimental oscillator built around an 85 tube in which the diode plates are used for indicating the rectified current flowing in the pick-up coil.

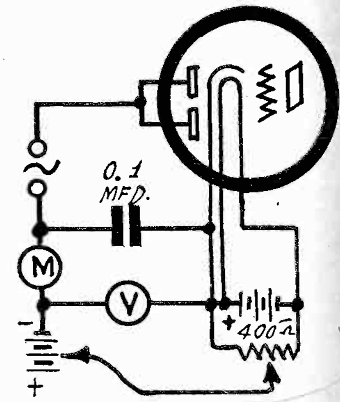


FIG. 3
A simple set-up for using an 85 tube as a peak voltmeter. This is the same circuit as in Fig. 1, except that the voltages have been reversed.

AN ATTEMPT was made to use a duplex diode triode as a frequency converter in a superheterodyne by impressing the radio frequency signal on one diode and the oscillator voltage on the other, completing the circuit through an intermediate frequency circuit. The resulting modulation efficiency was nil as far as could be judged by the amount of output. Just why it did not work was not evident because it seemed that at least something should have come through.

The experiment led to the taking of curves on the diode as well as of the grid. The tube used was an 85 in a circuit as shown in Fig. 1. A 0-1 milliammeter was put in the anode lead and a voltmeter between the cathode and one side of the milliammeter. The tube was so connected that the 6-volt storage battery could be used as part of the anode voltage. A 400-ohm potentiometer was connected across the battery by means of which the anode voltage could be adjusted. A small external battery was also used. Current readings were taken for every volt on the anode up to 10.6 volts.

Law of Current Variation

The resulting current from the first anode is given by curve A1 in Fig. 4 and that obtained from the other anode is given by curve A2. It will be noticed that one anode is considerably more efficient than the other, probably because the anode plate was closer to the cathode. In one case the current varies from zero with no anode voltage to about 0.8 milliampere when the anode voltage was 10.6 volts. In the other the current varied from zero to about 0.59 milliampere for the same voltage range.

Both curves follow quite closely the 3/2 power law. That is, if I is the current and V the anode voltage, $I^2 = kV^3$, where k is some constant of proportionality. Only k differs for the two curves.

A considerably greater current was expected, but the fact that it is so small does not explain why the device failed to function as a mixer. It may be that the near linearity explains it, for in order that there shall be mixing and the generation of a beat frequency current there must be considerable wave form distortion. In a device following the 3/2 power law there is relatively little wave form distortion. Much better results could have been expected from a device that follows the square law, which is very nearly the case with a grid bias detector provided that the operating bias is adjusted correctly.

Just the same, there is some distortion in the 3/2 power curves and some mixing should have resulted. It will be tried again under slightly different conditions.

It has been said frequently that detection and frequency conversion are identical so that if a device is a good detector it is also a good frequency converter. But the diode is a very good detector. There is a difference between the two functions because even if the curve followed the first power law, that is, if there were no distortion at all, the diode would still be a good detector. It remains to be seen whether it is also a good frequency mixer.

Grid Current

The grid circuit can be used as a mixer by using the proper grid impedance and since the grid is used as an anode in this application it would seem that there would be no difference, unless there is a difference between the grid current ar the anode current. But the grid curre follows the same law as the anode curren insofar as detection is concerned. Tl grid current of the same tube was tak and the resulting curve is that shown curve G. The current scale for this cur is the same as that for the anode curre curves, but the voltage scale is 10 tim as great. That is, where the voltage sca says 10 volts the positive grid voltage w only one volt. It is clear that the gr current is many times greater than eith anode current for the same voltage. Tl highest grid voltage for which a curre was obtained is 1.6 volts, at which val the current was about 0.85 milliamper The anode currents for the same volta are 0.053 and 0.028 milliampere. The gr current is more than ten times as great the sum of the anode currents, and times as great as the mean anode cu rent. Except that there is an appreciab grid current at zero anode volts the gr current follows the same law as tl anode currents.

Since the curves are the same shape would seem that the anodes can be us as mixers if the grid can be so used a that all that is necessary is to provide t proper load impedance on the diode.

The mixing was also attempted by co necting the two anodes together and th connecting the two voltages to be mix in series. This was more favorable th when one anode was used for each vo tage. But there were strong interactio between the tuned circuits supplying t voltages.

A-C Anode Voltage

It was thought that perhaps the vo

THE DIODES

the Two Anodes

nderson

tages impressed on the anodes were not high enough to cause much current. To test this point the oscillator in Fig. 2 was hooked up, for this was the oscillator used in the circuit that failed. The oscillator was built around the 85 tube with the ordinary tickler in the grid circuit and the tuned circuit in the plate. The regular pick-up coil was connected in the anode or rectifier circuit. The frequency range of the oscillator was approximately the same as that required of an oscillator for the broadcast and 400 kc intermediate.

With a plate voltage of 135 volts, the deflection on the milliammeter was 0.2 milliampere, and this remained nearly constant over the entire range of the tuner. This is the sum of the two anode currents. If we take the sum of the two anode currents from curves A1 and A2, Fig. 4, we find that with d-c on the anodes 0.2 milliampere corresponds with 3 volts. But current was due to an alternating voltage. The peak of this was measured and it was found to be 6 volts. This was surely enough to cause a considerable output. A similar measurement of the signal voltage showed that this was much less but still sufficient to give a good output. But it did not give any at all.

Peak Voltmeter

Incidentally, the diode circuit can be used as a peak voltmeter if connected as in Fig. 3. This is the same circuit as that in Fig. 1 except that the voltages have been reversed. The advantage of this tube as such a voltmeter is that it has a very sharp cut-off, which cannot be set of tubes such as the 58 and 39. Of course, when the diode is used as a peak voltmeter there will be a small current when the reading has been reduced sensibly to zero but it is so small that the accuracy is not appreciably impaired.

The principle of the peak voltmeter is as follows: When a signal is impressed on the diode circuit and there is no other voltage in the circuit there is a certain current due to rectification. If now a d-c voltage with the negative toward the anode is applied the rectified current is diminished. When the rectified current has been reduced just to zero the peak voltage is equal to the d-c voltage applied and that read on the voltmeter. To obtain the voltage that will reduce the current just to zero, and not a greater voltage, there should be the merest flicker of current in the positive direction as the circuit is closed. The smaller this flicker the more accurate the reading because the voltmeter reading is then more nearly equal to the peak voltage and also because then the current is least and hence the damping on the a-c circuit is also least.

Application of Peak Voltmeter

The voltage in the pick-up coil in Fig. 2 was measured in this manner merely by putting a d-c voltage in series with the meter and adjusting it to the value that gave a minute flicker.

Of course, the grid could also be used as the rectifier in the peak voltmeter but due to the fact that there is current when the voltage is zero it would be necessary first to find what negative bias was necessary to reduce the current to zero when there was no signal input and then repeat with the signal in the circuit and to take the difference between the two readings of the voltmeter as the peak of the signal. This would be less convenient and not any more accurate for the accuracy is determined by the sensitivity of the indicating meter.

If the grid current curve follows the 3/2 power law, the current should cut off at 0.369 volts negative. The curves, of course, assume that there is no voltage on the plate.

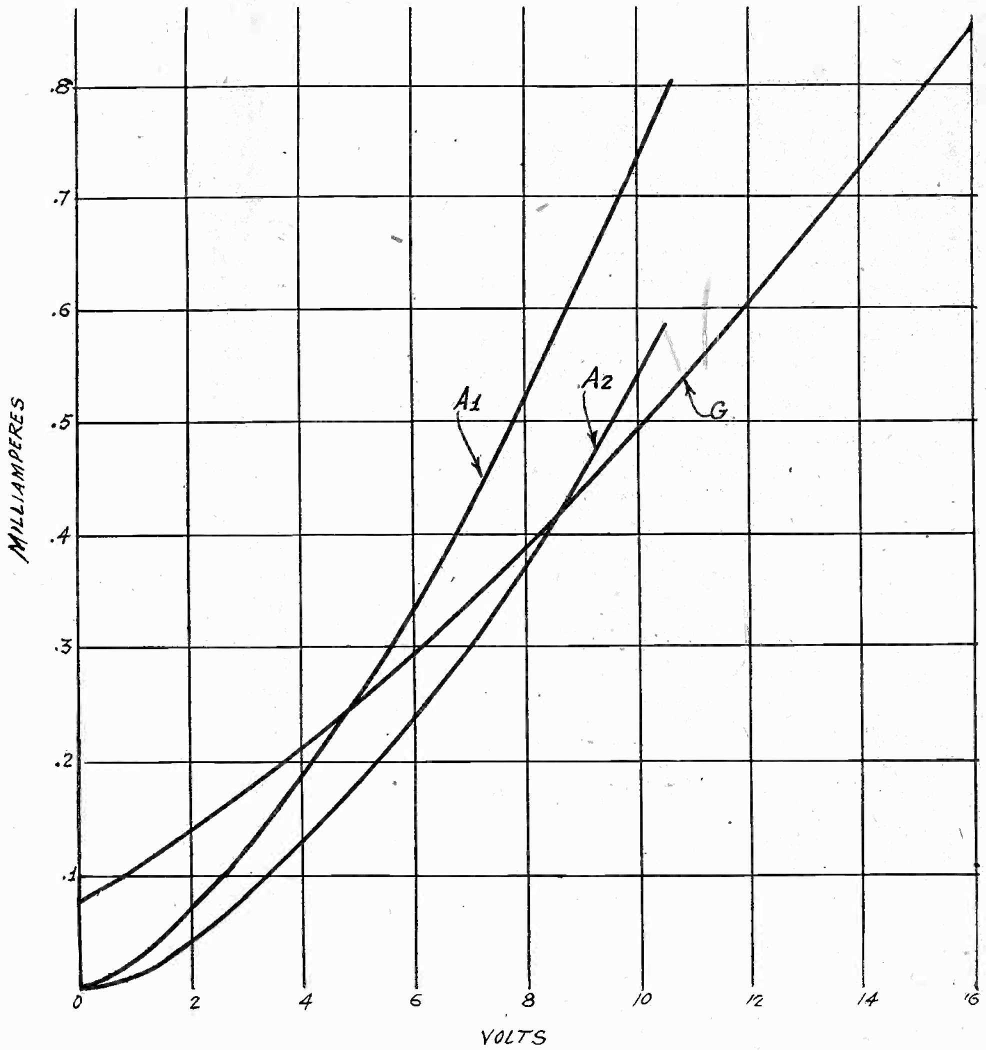


FIG. 4

These curves show the variation in the anode and grid currents, each element acting as an anode, with different voltages on the elements. A_1 is for one anode of an 85, A_2 is for the other anode, while G is the grid current at one-tenth the voltage scale.

"Roxy" Theatre Name Awarded to R. K. O.

According to ruling of Special Master Addison S. Pratt, in a report to Federal Judge Francis G. Caffey, the name of "Roxy" properly belongs to S. L. Rothafel and the Radio-Keith-Orpheum Corporation for use in connection with the new R. K. O. motion-picture theatre in Radio City. It is expected that a writ will be granted restraining the Roxy Theatres Corporation from the use of that name for the Roxy Theatre at Seventh Avenue and Fiftieth Street, of which Samuel L. Rothafel was managing director for several years.

Hum Due to Tube Structure

Coupling of Electric and Magnetic Fields

By J. E. Anderson

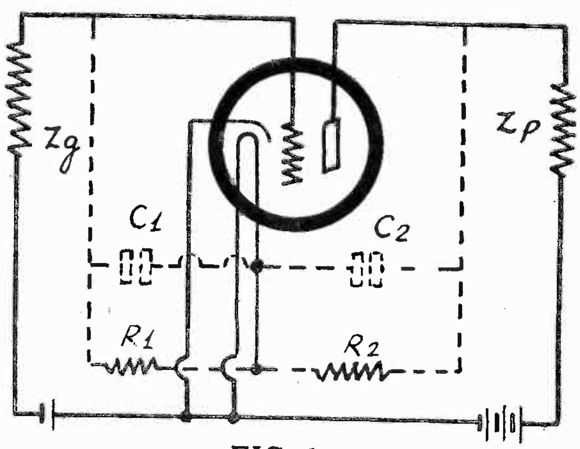


FIG. 1
Capacity and conductive couplings between the heater and the grid and plate of a heater type tube circuit as indicated here cause hum in the output.

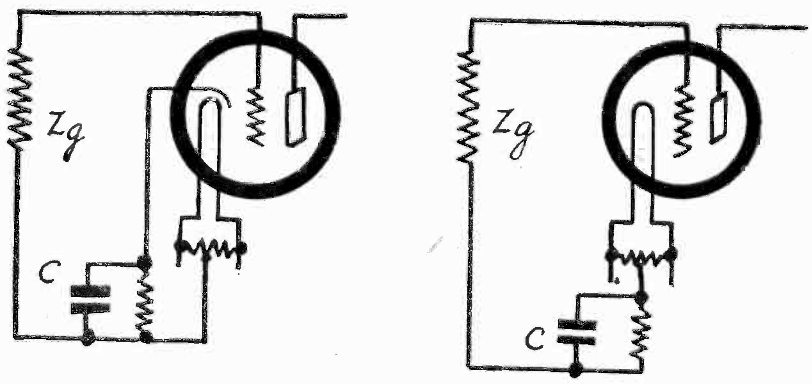


FIG. 2
Whether a heater or filamentary type tube is used on a-c the center of the filament should be grounded as here shown, either directly or by means of a condenser.

THE advantage of a tube with an indirectly heated cathode is that the heater is really external to the tube. While the filament is physically inside the tube it is external to it in the sense that it is not connected to any of the element proper, and its only function is to heat the cathode. If a suitable structure could be found allowing the cathode to be heated with a gas burner that would make just as good a tube as one in which the cathode is heated with a current-carrying filament. Of course, a filament is more convenient than any other type of heater. The fact that the heater circuit can be made "floating" indicates that the filament is not a part of the triode or tetrode or pentode.

When designing receivers in which cathode type tubes are used it is most convenient to regard the heater as an external element. However, due to the fact that the filament usually carries alternating current certain disturbances are set up inside the tube. These are caused by the magnetic effect of the heater current on the cathode, grid, and plate, by capacity coupling between the heater and the other elements, and also by leakage between the heater and the other parts of the tube.

Reducing Magnetic Effect

The magnetic field of the filament passes directly through the insulating material between the heater and the cathode and to the other elements. Hence disturbances due to this effect, that is to say, hum, must be eliminated by special precautions. It is well known that if a conductor is doubled back on itself, with the two branches very close together, the inductance of that part of the circuit is extremely small. Saying that the inductance is small is the same as to say that the magnetic field is small, for the inductance of a circuit is only the total magnetic field about that circuit when unit current is flowing. So-called non-inductive resistances are made by doubling the wire back on itself. The same thing is usually done in a tube. The filament is made of the so-called hair pin type. That is to say, the insulator on which the cathode is placed contains two tiny holes in the axial direction and the filament is run through one and then back through the other. These holes are very close together and therefore the inductance, or magnetic field, is very small. It is not zero, however, because the two branches cannot be infinitely close together.

Since the strength of the magnetic field is proportional to the current that flows, another way of reducing the magnetic field is to decrease the current, and that is what is being done. One of the reasons why the new series of heater tubes is better than the old is that the filament current has been reduced from 1.75 to 1 ampere. Special tubes have been made with a voltage of 10 and a current of 0.3 ampere for the express purpose of reducing the magnetic field and hence to reduce hum from the filament circuit.

Another way of minimizing the magnetic field is to use two concentric conductors. The outside one is spiraled and the inside is a straight conductor. Although the outside conductor is much longer its field is practically neutralized by the inside straight conductor. Still another way of minimizing the magnetic field is to surround the heater with a magnetic shield. But this raises the problem of getting a material for the shield that will retain its magnetic properties at the high temperatures involved. This has been solved by developing a special cobalt steel that has the desired magnetic properties at the high temperature and still that can be worked down to the required small dimensions.

Reducing Electric Field

The electric field from the heater circuit also affects the flow of electrons from the cathode to the plate, and has the same effect as the electric field of the control grid. This field can be minimized by connecting the midpoint of the heater to the cathode. This is usually done either by connecting the center of the filament winding to ground, or to the cathode, or by using a centertapped resistor across the heater and connecting the center to ground or to the cathode. The point of minimum hum is not always the center because other disturbing effects, such as the magnetic field and leakage, shift it a little to one side or the other.

The electric field can be reduced by means of a shield around the cathode. This shield does not have to be made of magnetic material, but if it is it serves also as a shield for the magnetic field. Thus it would seem that the special iron-cobalt steel would reduce hum considerably.

Some of the effects that reduce the magnetic field will increase the electric field. For example, the method of reducing the heater current, which in turn requires increasing the voltage across the heater, increases the electric field, for that is proportional to the difference in potential between the end of the heater and the cathode. This potential is greatest when the cathode is connected to one side of the heater, but even if the cathode is connected to the midpoint the electric field, now reduced to one-half, is still greater the higher the terminal voltage of the heater. Shielding would be quite effective in reducing the electric field regardless of the value.

Resistance-Capacity Disturbances

Disturbances will arise due to resistance and capacity coupling between the heater and the grid and the heater and the plate. A typical circuit is shown in Fig. 1, in which Zg is the regular grid input impedance, Zp is the regular plate load impedance, C1 is the capacity between the high potential end of the heater and the grid, R1 is the leakage resistance between these points, C2 is the capacity between the high potential end of the heater and the plate, and R2 is the leakage resistance between these points. That the stray couplings may be so represented has been proved experimentally.

It will be noticed that one end of the heater has been connected to the cathode and that the stray effects are measured with respect to the other end of the heater. If some other point of the heater circuit were connected to the cathode, other coupling effects would be introduced, but they would be of the same nature as those shown in the figure, but probably the case illustrated represents the worst possible case.

The voltage that is introduced from the heater into the grid circuit through R1 and C1 will be amplified by the tube and will appear in the plate circuit considerably increased in intensity. But the voltage introduced into the plate circuit through C2 and R2 will not be amplified by the tube shown, but will be amplified by the next tube.

External Stray Coupling

It is clear that if the impedance Zg is low for the disturbing voltages practically no disturbing voltage will appear on the grid because it will be shorted out by Zg. But this will not in general occur, for Zg may be a very high resistance, a high inductance choke, or the high impedance of the secondary of an audio transformer. It may be a grid leak with a small condenser across it. Under such conditions virtually all the voltage that is transferred from the heater to the grid will be effective and will be amplified. In a radio frequency amplifier the impedance Zg will be so low that no disturbing voltage will appear on the grid. The same thing applies to the plate circuit and Zp. In a grid bias detector circuit Zg would probably be negligible while Zp would not. Even in a grid bias detector the biasing resistor, which would be a part of Zg as well as of Zp, unless completely by-passed, the disturbing voltage would be introduced with sufficient intensity to cause much hum.

All the coupling indicated by C1, C2, R1, and R2 is not necessarily inside the tube. Much of it may be outside. For example, the lead to the control grid may run very close to the heater circuit leads outside the tube as well as inside it. Likewise the plate lead may run close to the heater circuit. In case the tube is of the screen grid type where the control grid is brought out at the top there is little chance that the coupling between the grid and the heater circuit will amount to a great deal externally. But it is still possible that inside the tube it will amount to considerable, especially in view of the fact that the amplification in the tube is very high.

As far as the external coupling goes it can be reduced a great deal by keeping the high potential leads, both plate and grid, as far away from the heater leads as possible. At any rate, they should not be in contact with each other even though the insulation may be thick.

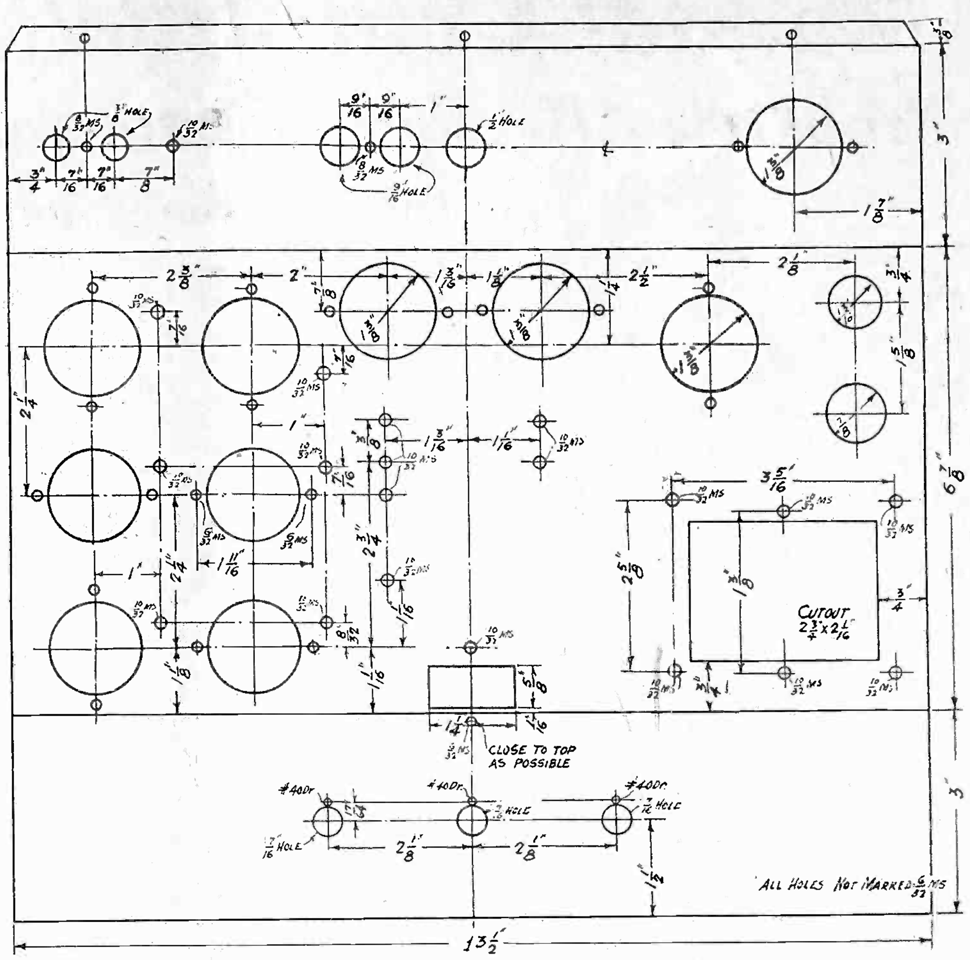
Filament Tubes

In a filament tube the cathode and the filament are identical. The magnetic field of the current affects the electron stream just as in the case of a cathode tube, and to a greater extent because the go and return branches of the filament are not so close together. The electric field is also the same as before. Usually the center point of the filament is grounded because it is necessary to do so if hum is to be kept down.

In this type of tube the filament current is usually much less than in a corresponding cathode type tube, and that fact keeps the magnetic field down. But that increases the electric field, for usually the filament voltage is higher. Instead of being 2.5 volts it is 5 or 7.5 volts. If the center of the filament is grounded the highest voltage between the center and either end is equal to one-half of the total voltage. However, there is a tendency to balance out the hum in the fact that the two ends of the filament are at opposite potentials at all times. That is, the potentials at corresponding points in the two branches are 180 degrees out of phase. Thus if one end tries to make the grid positive by a certain amount, the other end tries to make it negative by the same amount. The net result is no change. That is the reason there is a marked minimum in hum when the center of the filament is grounded. It would seem that the remaining hum, when the center of the filament is grounded, is due mainly to the magnetic field.

Filamentary tubes are used only on a-c in the last stage of the audio amplifier

LAYOUT FOR 6-TUBE SET



Tubes and coils at left in rows, two audio tubes at rear center, rectifier at right, electrolytics extreme right, comprise this layout, speaker socket hole at right rear.

where there is no amplification of the hum after the tube.

Harmonic Hum

One of the causes of hum in filamentary tubes is the gradual heating and cooling of the filament as the current rises and falls. This gives rise to a hum the frequency of which is twice the frequency of the supply current because in every cycle the current reaches maximum twice and zero twice. Of course, it makes no difference in the heating which way the current flows.

This effect is greater the greater the filament temperature because the greater the temperature the more rapid the cooling. In filaments that burn only dull red the effect is relatively small.

Of course, the same effect is present in a cathode type tube but it is smaller than in a filament tube because the cathode and the insulator between the heater and the cathode act as heat filters. That is, they tend to keep the filament temperature constant regardless of the instantaneous value of the heating current.

Another cause of hum in a filamentary tube is that the neutral point does not remain fixed but oscillates back and forth. This also causes a hum of twice the frequency of the supply current. The range of oscillation of the neutral point is not great, so the hum due to this is small.

Typical Circuits

In Fig. 2 are shown two circuits indicating how the heater or filament circuits are grounded at the center by means of centertapped resistors. At the left is a cathode tube and the cathode is returned to ground, as is the center of the heater. At the right is a filamentary tube in which the bias resistance is put between the center of the filament and ground. In each case a bias resistance is used and it is by-passed with a large condenser.

If the reactance of the condenser at the hum frequency is large, as it is likely to be, a hum is introduced in the grid circuit, but this hum is partly neutralized by the fact that an equal voltage is introduced in the plate circuit. In the case of the filamentary tube the voltage due to the oscillation of the neutral point would be introduced directly into the grid circuit. This voltage would be introduced regardless of whether the bias resistance and the by-pass condenser are used.

While the bias resistance in either circuit tends to reduce the hum by reverse feedback it is nevertheless important that the condenser is large because the signal also is reduced by reverse feedback. This degeneration is considerable in some cases. Let us take an example. In the 48 tube the required bias resistance is 400 ohms. The load resistance is 2,000 ohms and the internal resistance is 10,000 ohms. The voltage amplification factor is 28. With these values it can be shown that the effective amplification is 2.37 times, which is the ratio of the signal voltage across the load resistance to the input voltage. Without the grid bias resistance the amplification under the same conditions would be 4.66 times. Thus the gain is cut down to one-half of what it should be.

This loss occurs on the low frequencies unless the by-pass condenser is enormously large. With a condenser of one microfarad across a 400 ohm resistor, the gain at 400 cycles per second under the same conditions as above is 3, which is still considerably less than what it should be. At the highest audio frequencies there is virtually no loss due to degeneration because the condenser is effective. This is one reason why the high notes come through better than is expected.

Manual Control With A. V. C.

Problems Affecting Selection of the Attenuator

By Brunsten Brunn

RECEIVERS with automatic volume control have appeared with the manual control placed in the antenna circuit, in the cathode circuits of the automatically controlled tubes, and in the audio frequency amplifier. Where is the best place to place it and why is it the best place?

Suppose we put it in the antenna circuit so that the input signal is controlled before it reaches any of the amplifier tubes. If the manual control were set for maximum sensitivity and left there, the automatic volume control would be called on to hold the amplification constant. That is as it should be. But why should we put the manual control in the antenna circuit when its proper setting is such that the pick-up is maximum? There is no particular reason why we should use it at all. If the automatic volume control really works, the only effect of varying the control when put in the antenna circuit would be to vary the amount of noise in the set, for as the manual control is turned down the sensitivity of the amplifier would go up, keeping the signal level constant but greatly increasing the noise developed in the amplifier.

Control in Cathode Circuits

Now if we put the manual control in the cathode circuit where it would control the bias on the tubes, the manual volume control would simply be called on to do what the automatic control is to do. If the control is set so that the bias is high, the automatic volume control would not have to do as much. If the control is set so that the bias is low, the automatic volume control would have to do much more for the volume would be held almost constant in either case. But if the automatic volume control is not called on to do all that it can, there will be relatively little automatic control in the circuit.

In most midget sets the manual control is such that it varies the input voltage at the same time that it varies the bias, the two being phased so that the two increase

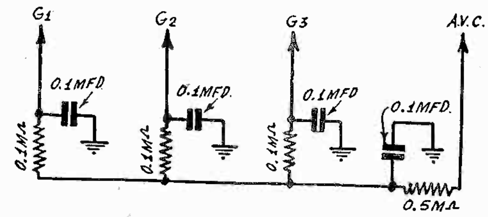


FIG. 1
A typical arrangement of the grid returns in a receiver equipped with automatic volume control.

and decrease the volume together. If the manual control is of this type it is simply a combination of the two preceding cases. Neither one nor the combination is desirable if the circuit is to have automatic volume control as well as manual control.

Let us now put the manual control in one of the grid circuits of the audio amplifier. It may be in the very first grid circuit, say in that of the detector, or it may be in the next grid circuit. Let us use a potentiometer with the slider connected to the grid. The radio frequency and intermediate frequency amplifiers are now set at maximum gain. The circuit will be tremendously sensitive on weak signals, just as it should be, and it will be less sensitive on very strong signals. That, too, is as it should be. Hence the logical place to put it is in the audio amplifier.

Noise in Receiver

But a receiver in which the automatic volume control is allowed to have full swing and the manual control is put in the audio amplifier is noisy because between channels, that is, in the absence of a carrier, the circuit sensitivity is maximum and all noises, whether picked up from the outside or generated in the tubes, are amplified to the full. But on strong stations the noise is no greater than it would be in any other receiver, for the automatic volume control would reduce the amplification.

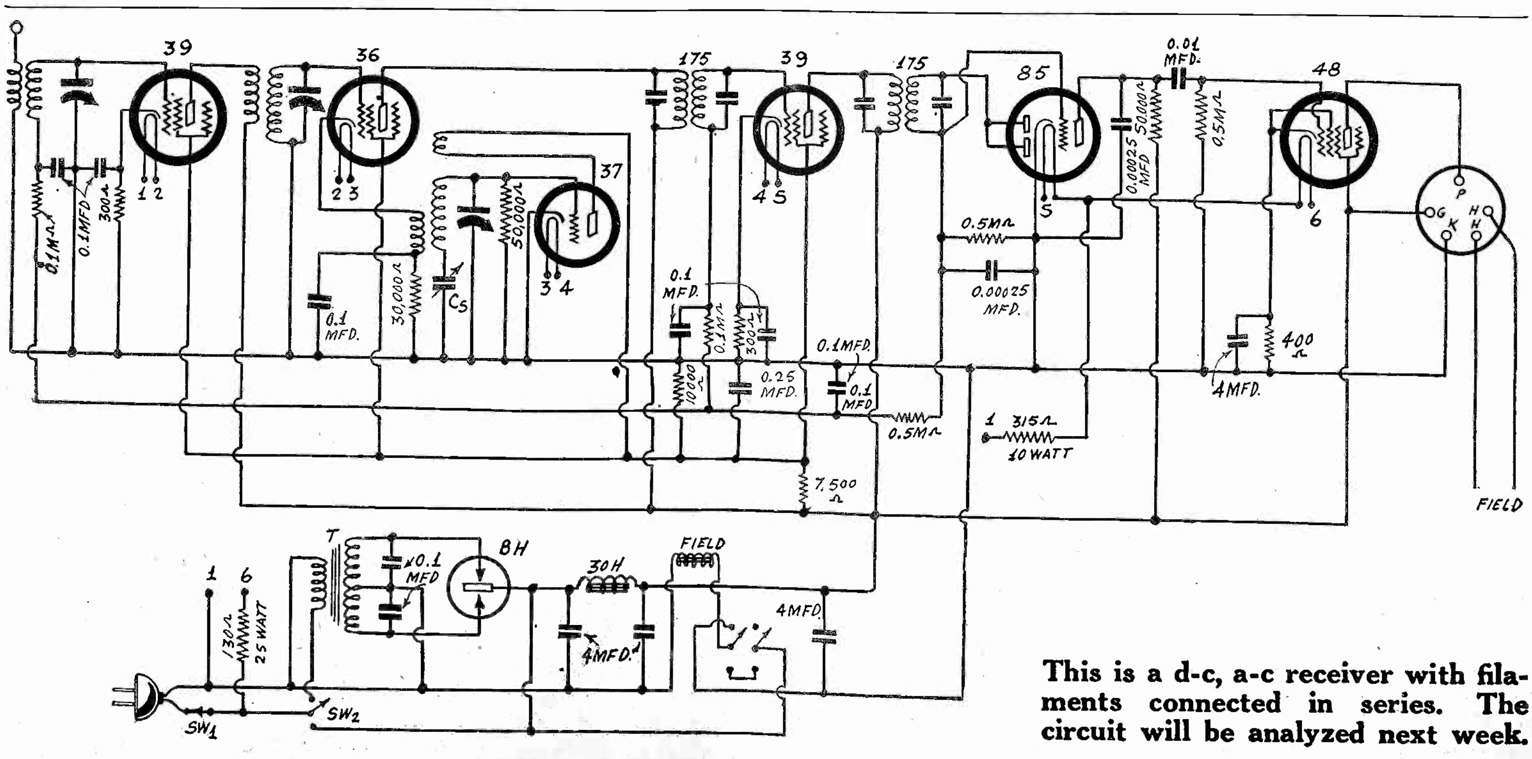
Because of the interchannel noise in a set provided with a good automatic volume control is very high, the noise suppression device has been introduced in many circuits. This device is merely another automatic control that works in the opposite direction and works so as to prevent any audio amplification when there is no signal present to be amplified. Usually, the noise suppression tube is the first audio amplifier after the triode of the diode detector tube. The triode itself does not function as an audio amplifier but as a d-c amplifier. It controls the operating bias on the next tube, the noise suppression tube. A receiver equipped with this device is no more noisy than one in which there is no a. v. c.

Arrangement of A. V. C. Circuit

In Fig. 1 is shown the arrangement of the grid returns in a circuit equipped with a. v. c. This is a typical arrangement. G1, G2 and G3 are the grid returns of the controlled tubes. Of course, there may be more than three in some receivers, or there may be only two, but the arrangement is the same. The 0.1 mfd. condenser and 0.1 megohm resistor in each grid return are used for filtering and are not essential to the idea of the a. v. c. However, when G connects with a tuning coil and the tuning condenser is grounded, the associated 0.1 mfd. condenser is a part of the tuned circuit.

The 0.1 mfd. condenser associated with the 0.5 megohm resistor is also used for filtering. The 0.1 megohm resistor is used to prevent short circuit of the load resistance of the diode, which is not shown. The arrow pointing to A.V.C. connects with this resistor. In case the a.v.c. circuit and the detector circuit are independent the arrow would not be necessary.

In case the manual control is put in the audio amplifier the grid returns would be as shown in Fig. 1 and the cathodes would go to ground through the usual limiting bias resistors.



This is a d-c, a-c receiver with filaments connected in series. The circuit will be analyzed next week.

Radio University

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

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

Motorboating Remedies

MY AUDIO amplifier is resistance coupled and contains one 227 and one 247. The detector is a 224 using a high resistance grid leak and a 0.0001 mfd. condenser. The circuit motorboats severely. Can you suggest a remedy? Would it help to change the detector to the grid bias type?—F. W. C., Binghamton, N. Y.

With a combination like that it is very difficult to stop motorboating. It is quite likely that changing the detector will help because as you now use it the tube functions as an amplifier as well as a detector. By changing it over to the grid bias type there will not be so much feedback. It may be that this will not stop the trouble alone. If it does not, reduce the grid leaks in the two audio tubes and the grid condensers too, if necessary. Omitting by-pass condensers from the bias resistors in the audio amplifier will help also. Try reversing the connections to the speaker if output transformer is used.

* * *

High Resistance Loads

IN A RESISTANCE COUPLED amplifier in which the resistance in the load circuit is very high, is it not necessary to increase the applied plate voltage in order that the effective voltage on the plate be equal to the recommended voltage? How is it possible for a tube to deliver any power unless this is done?—P. C., New York, N. Y.

It is not necessary to increase the applied plate voltage just because there is a high resistance in the plate circuit. The effective voltage on the plate varies with the signal and the variation may at times be equal to the applied plate voltage. That is, the effective voltage may vary from zero to the full applied voltage. It is this variation that is the output voltage. Of course, if the variation is allowed to be so great the tube is overloaded. If the signal is so strong that overloading occurs, then it is necessary to increase the applied plate voltage, as well as the grid bias. A tube is not supposed to deliver any power when used in a resistance coupled amplifier. It is supposed only to deliver voltage. About the only reason for not increasing the load resistance to enormously high values is that the higher the resistance the greater the effect of stray capacities in cutting down the higher audio frequencies. There is no sense in making the plate resistance extremely high if the grid leak after it has a smaller value.

* * *

Meaning of Phase

PLEASE EXPLAIN what phase means as applied to radio. What is the meaning of phase difference?—W. H. C., Wheeling, W. Va.

Phase usually has to do with the aspect of a wave at a given time but often it is measured in terms of time from some beginning. The beginning of a wave is that instant at which the value is zero and the intensity begins to increase in the positive direction. Sometimes the time, or the phase, is measured from some other instant, when the wave has some other aspect. For example, it may be measured from the time the intensity is maximum in the positive direction and it begins to decrease. The time is measured in electrical degrees. The phase difference is the number of electrical degrees between the phases of two wave phenomena. For example, it may be the difference between the voltage and the current or it may be the difference between the phases of two currents in different circuits. If one is maximum with positive direction when the other is zero, the phase difference is 90 degrees, or one quarter period, and the first leads the second by that amount. The difference in phase between the voltage and the current in a pure inductance is 90 degrees, the current lagging behind. The phase between the voltage and the current in a perfect condenser is also 90 degrees, but in this case the current leads the voltage. The difference in phase between the a-c voltages in the grid and plate circuits of a vacuum tube is 180 degrees. That is, they are always opposite. That is in the case when the circuit is purely resistive. If there is capacity or inductance associated with the tube, the phase difference may have some other value.

* * *

Automatic Selectivity Control

SOME RECEIVERS have automatic selectivity control. Will you kindly explain the principle?—C. O. B., Newark, N. J.

This device works on the theory that the selectivity varies with the resistance to which the primary, whether tuned or untuned, of a transformer is connected. The higher the resistance the higher the selectivity. A given tuned circuit is more selective when it follows a tube having a very high plate impedance than it is when connected in the antenna circuit, for the antenna has a comparatively low resistance. The automatic feature is controlled from the suppressor of the tube. The plate resistance of the tube decreases rapidly as the negative suppressor voltage is increased, up to about 40 volts. Hence the selectivity can be decreased by increasing the negative voltage on the suppressor grid. The negative voltage for the suppressor can be obtained from the same source as the a-v-c voltage, and it may be the same voltage. Thus the selectivity of the receiver would automatically become less as the strength of the signal became greater. On local stations the set would not be selective but the quality would be good. On distant stations the selectivity would be very high but the quality would not be so good because of sideband cutting.

* * *

Grid Dip Meter

I HAVE a grid dip meter which ordinarily works as it should. The other day I tried to measure the natural frequency of an oscillator and the meter acted queerly. It did not dip where it should but it kicked up. What is wrong?—G. W. M., Cleveland, Ohio.

Nothing is wrong. The oscillator was oscillating and fed energy into the grid dip meter instead of taking some. The dip is due to removal of energy from the oscillating circuit in the grid dip meter. If some energy is added, the dip is negative, that is, there is a kick-up.

* * *

Estimating Turns

MY RECEIVER tunes to 600 meters, judging by the fact that I can just tune in code stations of ships. But the tuner fails to reach 200 meters. Will you please tell me how many turns I should remove from the tuning coils to make the set tune to 550 kc?—J. M. B., Atlantic City, N. J.

The turns required are approximately proportional the wave length for a given value of the tuning capacity. Your tuner now reaches 600 meters and you want it to tune to 550 meters, very nearly. Hence if you now have N turns and you want n, we have N:n::600:550. Solving for n we obtain n = 550N/600, or n = 0.917 N. Just how many turns you should remove depends on how many turns you now have on the coil; that is, on what the value of N is. You should remove 8.3 per cent. of the number of turns now on the coil. If this change in the coil does not bring in the 200 meter stations it is because the distributed capacity is too high in the circuit and not because the inductance is too high.

* * *

Controlling Volume in Diode

WOULD IT BE all right to control the volume by making the diode load resistance a potentiometer and connecting the grid of the triode to the slider? How would it be to control the volume in the same tube by making the grid leak a potentiometer and connecting the grid to the slider?—F. W. K., Salt Lake City, Utah.

Either method is all right. The first method is suitable when the tube is diode biased. The second method is all right when the tube is biased by a bias resistor or by some other method.

* * *

Tracking the Trap

IN THE December 10th issue you had an article on a tracking trap. This seems to be all right, but how would you go about the actual tracking adjustment? Could it be done as easily as adjusting a super in which only the oscillator is padded?—A. B., New York, N. Y.

No, it cannot be done as easily for there are two circuits to pad, or possibly three. The first thing to do is to calibrate the trap circuit, which is not padded. In particular the location of the two tie-down frequencies, as referred to the trap circuit, should be found accurately. Next the r-f circuit might be padded. The laboratory oscillator can be set at f kc higher than the tie-down frequancies and the r-f circuit tuned to them, the trimmer alone at the higher frequency and the series condenser alone at the lower frequency. When this padding has been done the rest of the work is the same as if the r-f circuit had not been padded. In other words, the oscillator is padded in the regular manner and the receiver is supplied with the desired signal frequencies, not the trap circuit frequencies. It would be difficut to make these adjustments without the aid of a signal generator which will generate any desired frequency, including those required by the trap circuit. Of course, the i-f amplifier is tuned to the intermediate frequency f and not to the double frequency 2f.

* * *

Automobile B Supplies

HOW IS THE voltage of the storage battery in a car stepped up to the high voltages required by the plates of tubes? I know there is a vibrator in these devices, but I don't see how they enter into the circuit.—G. F. L., New Rochelle, N. Y.

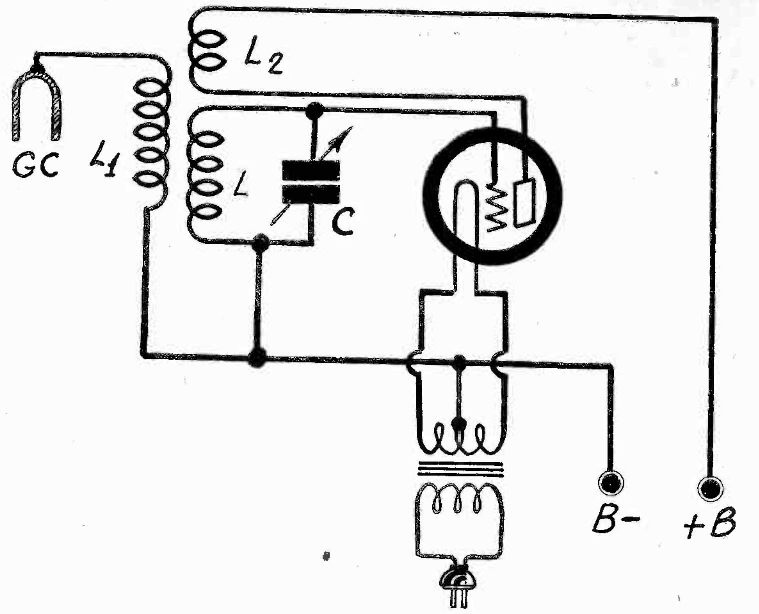
The voltage is stepped up in about the same way as the high tension for the ignition is stepped up. The vibrator breaks the current and creates current pulses. These are sent through the primary of a high ratio step-up transformer. The voltage in the secondary is alternating and can be impressed on a rectifier tube in the ordinary way. A rather heavy current is required in the interrupter circuit; that is, in the primary, in order to get the required wattage out of the rectifier. Suppose, for example, that we need a current of 40 milliamperes at a voltage of 180 volts. That is 7.2 watts. Since the primary voltage is 6.3 volts, the primary current should be 1.15 amperes. And that does not allow for power losses in the transformer and the rectifier. Actually, the device would take a little more current to make up for these losses.

* * *

Voltage Delay in A.V.C.

WHAT IS a.v.c. delay and why is it used? Does it have anything to do with the

(*Contnued on next page*)



A simple laboratory oscillator in which the tuned circuit is made of a regular tuning coil and an ordinary variable condenser.

(Continued from preceding page)

time constant and the delay in the time of taking effect of the a.v.c.?—W. H. B., Philadelphia, Pa.

It has nothing to do with the time constant of the a.v.c. circuit, but is a limiting effect determining at what signal level the a.v.c. begins to take effect. Without the a.v.c. delay the control takes effect immediately there is a carrier, however weak that may be. With the delay the signal has to have a certain intensity before the a.v.c. takes hold to maintain the output constant. The device makes the circuit less sensitive by an amount depending on the delay voltage. The term delay is really a misnomer in this respect because it does not delay anything.

* * *

Speech Inversion

CAN YOU explain how speech inversion is brought about and can you suggest a circuit that will do it? I am interested in this subject and should like to make some experiments.—B. L. C., Kansas City, Mo.

As far as we know the details have not been published. However, it looks reasonable to assume that it is accomplished by beating speech frequencies with a constant frequency of about 10,000 cycles and selecting the lower sideband of the product of the modulation. Suppose, for example, that we set up a circuit that will do this. A sound of 10,000 cycles would become either 20,000 cycles or zero. A sound of 100 cycles per second would become 9,900 or 10,100 cycles. Thus if we select the lower sideband by means of a suitable filter speech sounds would be inverted about 10,000 cycles, for a sound range from zero to 10,000 cycles would become 10,000 and zero. A sound of 5,000 cycles would remain 5,000 cycles. It would have to be a filter with a very sharp cut-off to separate the lower sideband from the upper, for if the lowest audio frequency is taken as 40 cycles we would have a band of only 80 cycles at 10,000 cycles in which to operate. That is, the transition region between transmission and attenuation would have to fall inside this band. A superheterodyne mixer in which the signal is the speech and the constant frequency is 10,000 cycles would do the inversion. A low pass filter with a cut-off at 10,000 cycles would have to take the place of the intermediate frequency selector. An audio amplifier would do to amplify the inverted speech. Most of the frequencies in the upper sideband would be beyond audibility so that no great difficulty would be experienced in designing an adequate low pass filter.

* * *

Laboratory Oscillator

PLEASE PUBLISH a one tube laboratory oscillator in which the oscillation is taken off by means of a third winding, preferably such that it can be connected to the grid of a screen grid tube.—F. W. R., Atlanta, Ga.

In the diagram published on this page is shown such an oscillator. The tube may be a 201A, 230, or 112A, provided that the voltage of the transformed is suitable to the tube used. The plate voltage need not be more than 45 volts. For the tuning coil use a regular r-f coil with a large primary. If L consists of 127 turns of No. 32 enameled wire on a one inch form L2, the tickler, should have at least 90 turns. The pick-up winding L1 need not have more than one to 5 turns. If the clip GC is to be connected to the cap of a screen grid tube, one turn is plenty for pick-up. If a higher voltage than 45 volts is to be used on the plate it is advisable to use a grid bias. This may be provided by putting a 1,500 ohm resistor in series with the lead to the center tap of the filament transformer. Connect a 0.1 mfd. condenser across the resistor if it is used. It is also well to connect a similar condenser across the B battery. Let c have a capacity of 350 mmfd. A cathode type tube can also be used by connecting the cathode to B minus. In case this is used with a bias resistor connect it in the cathode lead.

Silent Tuning

REGARDING THE Stromberg-Carlson 41, November 19th, 1932 issue, please explain the "Q" or quiet circuit and the power filter.—K. V. L., Milford, County Donegal, Ireland.

The "Q" circuit for providing quiet operation for tuning between stations consists of the other diode of the first audio a. v. c. tube in conjunction with the 57 relay tube. When there is no carrier coming in, the action of this circuit is to put high negative potentials on the diode system and the control grid of the triode of the demodulator tube, thus preventing reception of inter-station noise when tuning. When a carrier of suitable strength comes in these negative potentials are removed and the signal is received. An adjustment is provided so that this "Q" circuit can be set for the noise level of the location in which the receiver is used. This adjustment is controlled by a small metal knob in the back of the chassis.

From the triode portion of the first audio a. v. c. tube the audio signal is coupled to the push-pull output triodes by a transformer. The adjustable automatic clarifier system is connected across the primary of the push-pull input transformer. The output transformer feeds the signal from the power triodes to the high quality electro-dynamic speaker.

The power supply system employs two stages of filter, the first being of the resistance type and the second using the field of the speaker as a choke. The plate supply for the output tubes is tapped off between the filter sections, while the remainder of the voltages are supplied from the voltage divider resistor.

Provision is made for a phonograph attachment in the No. 41 model. As will be seen from the circuit diagram, the terminals for the phonograph are in the grid lead of the second 55 tube, the terminals being shorted when radio is to be received and joined by the phonograph pickup when the phonograph is to be played through the audio amplifier.

Tube List Prices

Type	*List Price*	*Type*	*List Price*	*Type*	*List Price*
11	$3.00	'32	2.35	56	1.30
12	3.00	'33	2.80	57	1.65
112-A	1.55	'34	2.80	58	1.65
'20	3.00	'35	1.65	59	2.50
'71-A	.95	'36	2.80	'80	1.05
UV-'99	2.75	'37	1.80	'81	5.20
UX-'99	2.55	'38	2.80	82	1.30
'100-A	4.00	'39	2.80	83	1.55
'01-A	.80	'40	3.00	'74	4.90
'10	7.25	'41	2.85	'76	6.70
'22	3.15	'45	1.15	'41	10.40
'24-A	1.65	46	1.55	'68	7.50
'26	.85	47	1.60	'64	2.10
'27	1.05	48	2.80	'52	28.00
'30	1.65	'50	6.20	'65	15.00
'31	1.65	55	1.60	'66	10.50

Has Fine DX List

From Kansas City, Mo., comes a claim for championship in DX. Robert Rosenberger, 17 Jannsen Place, used a table model commercial receiver and during thirty-five days his list included CPK, Bolivia, 1,000 watts; LR9, Buenos Aires, Argentina, and LR6, who shares time; CX20, Montevideo, Uruguay, 2,000 watts; LV7, Yucuman, Argentina, 500 watts. Besides this the list includes Germany, Sweden, Portugal, Spain and Daventry, England. His only excuse for not getting Japan is that he does not arise early enough in the mornings, but he still hopes to get Africa. Well, that certainly is a fine list and should give the boys something to try for. It is our hope to publish some startling records from time to time, but where the catch is unusual and difficult we would appreciate confirmation cards.

Board Reports to Congress

Television Improving, Amateurs Grow

Washington.

In a report to Congress the Federal Radio Commission stated television is improving, that the administration of broadcasting station licenses is better, that the previous year showed expansion of radio services, and that protests are relatively few. The status of the amateurs—to whom 30,374 licenses were issued as of June 30th—was stressed. The number is steadily increasing.

Commissioner Harold A. Lafount, acting chairman, pointed out, in transmitting the report, that the Commission is developing a radio jurisprudence that stands the test in appellate courts, and also a code of ethics. He added:

"The number of amateur stations increased during the year from 22,739 on June 30, 1931, to 30,374 on June 30, 1932. In addition to the use of radio by amateurs for regular experimental work, many of these stations cooperated with the Army, Navy, and Red Cross in handling emergency traffic and by practicing the use of established military and naval operating procedure, thus preparing themselves for military service in time of war.

Legal Advance

"Special attention is also invited to the numerous and complex legal problems as a result of the newness of the subject and formative state of radio law; however, a real effort is being made to build a radio jurisprudence and code of ethics that will stand the test of appellate courts. On that subject your attention is invited to the fact that the Court of Appeals of the District of Columbia sustained the Commission in each of the nine cases decided by the court during the year.

"During this fiscal year practically all cases designated for hearing by the Commission were heard by examiners. Controversial points were raised before the Commission upon exceptions to examiners reports and in proper cases oral arguments were heard by the Commission. The system of holding hearings before examiners has been more successful than in the preceding fiscal year. The rules and regulations of the Commission which became effective Feb. 1, 1932, provide for greater safety to the interests and rights of all parties who might be involved in any hearing. Under the new regulations issues are more clearly defined than formerly. The ever-increasing body of judicial decisions relating to problems involved in this new field of law has been a distinct aid to the examiners in their application of rules of evidence and in the proper formulation of findings of fact, conclusions of law, and recommendations to the Commission.

Permit Expense Cut

"Progress has been made in the matter of so grouping applications as to permit the hearing of those involving common issues at the same time and place, thus saving to applicants or licensees much of the expense incident to repeated trips to Washington for the purpose of participating in hearings.

"Also, the practice of taking depositions in different parts of the country of witnesses unable to appear in Washington, or when the expense involved in bringing witnesses to Washington is out of proportion to the importance of the case, has been extended and has proven a decided benefit to a licensee who, in the position of a respondent in the matter of an application for his facilities, is not required to go to such great expense in defending his right to the facilities which he has, as formerly. These, the outstanding forward steps in the matter of hearings, have resulted in a more expeditious handling of cases before both the examiners and the Commission."

Television Improving

Improvement in the detail of pictures transmitted by radio has marked the experimentation in television during the year without any startling inventions, the Commission points out in its report.

Increased attention has been paid to technical details in the optical pick-up system, in the photo-electric cell and amplifying systems, and in actual modulation of radio waves emitted.

Many new developments, the report points out, must still be made before television can be accepted as a satisfactory entertainment service. Transmissions are limited in a majority of cases to faces of one or two performers at most rather than scenes covering large areas. That portion of the report describing experimental visual broadcasting follows in full text:

"While no startling inventions have come to light in television during the past year, the progress that has been made has been marked by a steady improvement in the detail of pictures transmitted. This improvement has been made possible through increased attention to technical details in the optical pick-up system, in the photo-electric cell and amplifying systems, and in the actual modulation of the radio waves emitted. This development has in a general way paralleled the progress that was made in the early stages of sound broadcasting.

Turn to Higher Frequencies

"Much attention has been given to the part of the spectrum in wihch television emissions will best fit. Although there are at the present time four 100-kilocycle bands between 2,000 and 3,000 kilocycles assigned to television, it has been evident for a considerable time that this space is not sufficient to meet the requirements of this new and growing art to furnish entertainment to the public.

"The experimenters have turned to the unexplored regions above 30,000 kilocycles. The work at these frequencies has shown signs of real promise as a future locus for this service, and the Federal Radio Commission has assigned wide frequency bands in this region for experimental work in television. Proposals have been received by the Commission from the industry to increase the space in this band in order to protect the future of television.

More Development Needed

"Although considerable progress has been made in scanning methods using both the mechanical type of scanning and the electrical or so-called cathode-ray type of scanning, it appears that many new developments must still be made before television can be accepted as a satisfactory entertainment service.

"While attempts have been made to broadcast scenes covering large areas, the majority of television stations have limited their transmissions to faces of one or two performers at most. This type of program, while of interest because of its novelty and usefulness for experimental work, has a very small amount of sustained "look-in" interest.

"Such programs fall far short of what the public has been led to expect in the way of entertainment, considering especially the fact that the technical improvements made during the last few years in sight-and-sound motion picture technique have created in the mind of the public a desire for very high technical standards of performance."

Another A-C Patent Invalidated

Washington.

The Supreme Court announced that it will not review four cases brought before it involving the validity of Edelman Patent No. 1680370, covering devices for furnishing the electric power for the operation of radio receiving sets, and Edelman Patent No. 1682492, covering a radio battery eliminator.

The invention of the patent, according to petitioner's brief, relates to apparatus for changing the alternating current from household light sockets into direct current required for radio receivers, and includes combinations of certain electrical devices which effect such a conversion and eliminate distortion.

A district court decision that this patent was valid and had been infringed was reversed in part by the Circuit Court of Appeals for the Seventh Circuit, which held that claims 1, 2 and 3 were invalid on the ground that a combination of old elements each performing a well-known function constituted aggregation and not patentable combination.

Urging reversal of this decision, the petitioner stated to the Supreme Court in his brief that the lower court had erroneously decided an important question of Federal law which has not been settled by the Supreme Court. He stated the question as follows:

"Whether or not an electrical circuit which is new and which produces a final result which is new, unitary and non-divisible, is to be condemned as an aggregation as distinguished from a patentable combination merely because the elements in such circuit operate in succession."

Another Edelman patent claims "a filter circuit including two choke coils having separate cores so placed that the mutual coupling between said coils causes ripple current flowing in one of said coils to be substantially opposed by electromagnetically induced ripple current supplied by the other of said two coils, and a by-pass condenser connected at the junction of said coils."

The Court of Appeals rejected another man's patent on the ground that his structure was for a different purpose and performed a different function, and on the evidence in the record would not eliminate ripple currents as Edelman's filter eliminates them.

The difference in structure, said the lawyer for the defeated patentee, is merely a matter of degree of output as between his client and Edelman and is one that would not support a patentable distinction. The appeal brief claimed that by being able to adjust the mutual inductance or mutual impedance between coils the same effect is produced.

50 kc Rule Improves Reception

Board Satisfied with Five Months' Results

Washington

The Federal Radio Commission issued the following statement:

The Commission is gratified to be able to announce that the general reception of broadcast stations has been materially improved by the new regulations requiring all stations to maintain the frequency within 50 cycles of the assignment. This improvement is apparent to listeners by the absence of audible heterodyne or squeals in the reception of stations on duplicated channels.

Before the enactment of the 50-cycle rule, listeners residing within the order of eight or ten miles from a 250-watt station may have received objectionable heterodyne or squeals from other stations on that channel, but by the new frequency maintenance, this heterodyne or squeal is entirely eliminated, permitting the stations to service that area and 12 to 15 miles away very satisfactorily, whereas the previous service was unsatisfactory or materially impaired.

Example Cited

For a specific example, 4½ miles northwest of a certain station, before the enactment of this rule, satisfactory reception was virtually impossible at night due to heterodyne. But now at the same point the reception is entirely free from heterodyne and the majority of the time the cross-talk is not objectionable; so that the station now renders good service at this point, whereas previously the service was extremely poor at night.

These benefits have been brought about in the broadcast industry, first by Rule 144, which requires all stations to maintain the frequency within 50 cycles of the assignment, and second by Rule 145, which requires an approved frequency monitor to assist in maintaining the station within 50 cycles of the assignment. It is not considered possible that stations could maintain the frequency within the 50-cycle requirement without this separate monitor.

As of November 15th, nearly all of the 615 broadcast stations had installed approved monitors and all except 23 of these had obtained a check of the calibration of the monitor with a reliable standard and determined that its accuracy met the requirements of the Commission.

Non-Conformists Classified

The 51 stations that had not installed monitors by November 15th may be divided into the following classes: Stations that had an extension of the working of Rule 145 to November 30th, 1932, on the basis that they had ordered an approved monitor with promise of delivery and installation prior to that date. There are 14 stations in this class.

The second group consists of stations that have been given an extension of Rule 145 to November 30th, 1932, on the basis that they have ordered frequency monitors that have not been approved but are now undergoing test at the Bureau of Standards. Nine stations are in this class.

The third group consists of the irregularities in cases where suspensions of the working of Rule 145 have been granted due to the renewal of license of the station having been set for hearing, heard, or stations operating under stay orders of the court; also certain of these stations have neither ordered monitors nor have they operated since the Rule became effective.

All stations in this class must procure monitors before they may resume operation or upon the decision in cases of litigation before operation may be resumed. In this class there are 28 stations.

There are 23 stations that have installed approved frequency monitors but have not submitted data to the Commission on a satisfactory check against a standard to show the calibration or accuracy meets with the required specifications of the Commission.

Drift from Accuracy

The records show that many of the monitors drifted in frequency after having once been calibrated; and, therefore, a regular routine check of the accuracy or calibration of the monitor is necessary to insure operation within the required limits. In approving the frequency monitors, the Commission realized that after installation many monitors might drift; and it is expected that the licensees of all broadcast stations will provide for regular checks of the monitor.

There are several ways in which this may be done. The simplest way is to arrange a check of the frequency of the station with some commercial standard and set the frequency exactly by the monitor and then have the commercial standard check. This gives an accurate indication of the calibration.

Another and desirable way is to provide equipment so that the calibration may be made from the standard signals transmitted by WWV, of the Bureau of Standards, at Washington, D. C. These signals are transmitted on regular schedule for this purpose.

Monitor Check-up Modified

Heretofore the Commission has permitted its monitoring stations to check for the licensees of broadcast stations; however, due to the limited appropriation and personnel it is necessary to limit this service, and monitoring stations will not be permitted to make commercial checks for licensees of broadcast stations except under representation that it is impossible for such stations to obtain a check with any other source. Under such circumstances the Commission will permit its monitoring stations to make the checks.

It is considered that this check should be made once each week or two weeks until it is definitely determined that there is no drift in the frequency of the monitor, and after such determination the checks of the calibration of the frequency should be made at less frequent intervals.

There is a pitfall that several deviators have fallen into; and that is the monitor becomes defective, due to such causes as the heater tube failing or frequency drifting due to other causes; and the operator changes frequency of station to agree with the monitor when, so far as may be determined, there is nothing to indicate that the station is wrong and the monitor right.

Wants Fewer Apologies

Under all such circumstances, the suspicion of the operator should immediately be aroused, and he should check with an external source to determine which is incorrect, the station monitor or the transmitting equipment, before blindly depending upon the monitor's accuracy. This has given rise to many deviations, and the Commission can not continue to accept such explanations unless due precaution is taken to determine that the monitor has not drifted.

Also, it appears that but few of the stations deviating to a major extent are using the auxiliary aural checks as specified in the Commission's letter announcing approved frequency monitors, and as a result such stations have not been able to make satisfactory explanations. This condition can not continue without further action being taken by the Commission.

These rules have been in effect since June 22d, 1932, and heretofore the Commission has been lenient on deviators, due to the fact that it has considered a certain length of time was necessary for the operators to become familiar with the routine of operation; but this time is rapidly drawing to a close.

* * *

Subsequently to the issuance of the above statement the Commission adopted a rule calling on stations to check their own frequency monitors under peril of not being given further leeway for general non-conformity to the frequency rule. The Commission issued the following:

"The Commission decided not to extend further the working of Rule 145 in case of broadcast stations that have installed approved frequency monitors but that have not obtained a satisfactory check of the calibration. All stations in this class should proceed immediately to obtain the necessary check. This must be done before it can be considered that the frequency monitor is in all details operating according to the requirements of Rule 145. However, if an approved monitor is installed and due diligence is being exercised in obtaining a check and the required calibration, Rule 145 may be considered satisfied."

Station Ouster No Free Speech Violation

Washington.

The refusal by the Federal Radio Commission to renew the license of a broadcaster who has used the facilities of his radio station "to obstruct the administration of justice, offend the religious susceptibilities of thousands, inspire political distrust and civic discord, or offend youth and innocence by the free use of words suggestive of sexual immorality" does not constitute a denial of the right of free speech, the Court of Appeals of the District of Columbia ruled.

As an instrumentality of commerce, radio broadcasting was declared by the appellate court to be subject to limitations in the public interest. Personal sentiments of the broadcaster offensive to religious susceptibilities and morals, defamatory, and obstructive of justice, "without facts to sustain them," were said to fall within the regulatory power of the Radio Commission in licensing, renewing or modifying a license as part of its statutory power to determine whether such a grant by it is in the public interest, convenience or necessity.

This decision was announced in the case of Trinity Methodist Church South v. Federal Radio Commission, No. 5561, before the court on appeal from the Commission's refusal to renew the license of Station KGEF, Los Angeles.

STATION SPARKS
By Alice Remsen

The Sailor's Tale

For Bill Stoess and His Flying Dutchmen

Sunday nights, midnight, WJZ
Thursday nights, 10:30, WLW.

A raging storm beat o'er the coast,
Our gallant bark, its captain's boast—
Was battling bravely on.
The lightning rived the muddy sky,
And in its flash we did descry
A ship—just seen—then gone!

A ship which sent a shiver through
Our gallant captain and his crew,
A ship of ghostly fame.
And then came music wild and weird—
Our captain clutched his graying beard,
A shudder shook his frame.

Then came another lightning flash—
Another awful thunder crash—
We saw the ship again!
And then there came a sudden shock—
Our little bark and struck a rock—
It slowly broke in twain.

I clutched a spar—retained my hold—
I lost the crew and captain bold—
They perished in the gale.
I think of it and get a chill—
I saw The Flying Dutchmen; still—
I live to tell the tale.

—A. R.

* * *

THE LEGEND OF THE FLYING DUTCHMAN is an old one, but the music of Bill Stoess and his boys is up to the minute. Bill is a wonderful conductor and the special arrangements he uses of current tunes are the talk of the radio rialto. That boy knows how to pick musicians and arrangers. Listen in; you'll like them—and don't forget I sing with 'em too; please don't miss that!

* * *

The Radio Rialto

As I write this I am listening to the radio; Lou, Florrie and Edythe Handman are singing "The Little Street Where Old Friends Meet" and making a good job of it, too . . . and now they're starting Lou's latest song, "The Next to Last Kiss," . . . at the conclusion of their program Powell Crosley sends out a message to listeners, asking them to write in and let the station know what style of program they DO NOT LIKE, with a dissertation on the difference between sustaining features and commercial programs. . . . Mr. Crosley believes that the radio audience prefers musical programs to the conversational tvnes . . . but, of course, he is not certain, so he asks the radio audience to tell him which they prefer . . . if my readers would like to state their preference, they are invited to drop me a line and let me know; we'll conduct a sort of poll of our own. . .

I'm beginning to like Cincinnati . . . it's not a very beautiful city in the winter time; rather gloomy; and they must use an awful lot of soft coal here; can't seem to keep my hands and face clean for longer than ten minutes . . . but the neighborliness shown by Cincinnati folk make it a most delightful place.

Our old friend, Jeff Sparks, is sick with the flu; his little wife has just come from New York and is nursing him. . . . Ed Wynn is now broadcasting over the blue network, WJZ, WLW and associated stations, which cuts out my Tuesday broadcast. . . . Received word from New York that the well-known Scotch comedienne, Jean Gordon, (Jane Hood) is in the French Hospital undergoing an operation. . . . Feist has a new number which you'll hear plenty via the ether; it's "The Whisper Waltz." . . . Thelma Kessler is homesick. . . . Franklin Bens did a good job last week as Ralph Rackstraw in "H.M.S. Pinafore." . . . He has a very fine tenor voice, and is on a par with such outstanding radio personalities as Frank Munn and James Melton; I predict a great future for this boy. . . .

I promised to tell you my broadcasting dates, didn't I? . . . Well, so far as I know here they are: Thursdays at 10:30 P.M. with the Flying Dutchmen (some orchestra, Bill Stoess conducting); Fridays, 9:15 P.M., another nice orchestra with Gene Perazzo conducting; Saturdays, 9:30 P.M., on the Crosley Follies program; and Sunday at midnight from WLW over WJZ and the blue network, with Bill Stoess and his Flying Dutchmen. . . . Hope you'll tune in and listen to your girl friend. . . .

Eddie Sobol, managing the road show of the "Cat and the Fiddle" is stopping at the Netherland Plaza here this week. . . Show doing very well. . . . Jan Garber opened at the Netherland Plaza this week; has a nice band and the following vocalists: Virginia Hamilton, Norman Donahue, Fritz Hulbron, Rudy Rudisill and Lea Palmer. Jan is featuring "The Whisper Waltz." . . . Kate Smith is getting along with her picture; word comes that Sally Blane has been chosen to play the romantic feminine lead; she will have the role of Kate's sister, and will still continue her romantic association with Randolph Scott, who also has a big part. . . . Todd Rollins, the young WINS baton wielder, claims the record for the most undress broadcast ever made . . . he and his orchestra were scheduled to go on the air from the Don Juan Club. The whole band overslept; as they lived next door to the club they made the broadcast on time, in five minutes to be exact, but they were all attired in pajamas and nightshirts. . . . Nat Shilkret, maestro of the Chesterfield "Music That Satisfies" program, is gathering the men who used to play in his Schrammelband; their beer garden music will be heard in a motion picture short which Nat is making with Weber and Fields. . . .

Billy Hillpot is at it again; a limousine ran into his taxi the other night, overturned it—but Billy, as usual, escaped serious injury; he is the luckiest boy I ever knew. . . . In case you'd like to know, Harry Frankel (Singin' Sam), is one of the handsomest men in the radio profession; over six feet in height, broad shouldered, but not fat, fine cleancut features, blue eyes, perfect teeth, fair hair and a grand smile. . . . Whispering Jack Smith's first job was with the six-day bicycle races, as a song plugger. . . . The clan Smith is beginning to dominate Columbia programs; within one hour on Wednesdays Kate Smith, Whispering Jack Smith and the Smith Brothers air their musical wares. . . . Johnny Hart will continue his adventures in Hollywood at an earlier time than usual and on an extended network. The time is now 6:15 P.M. five times weekly over WJZ and the Blue Network. . . .

John McGovern, hero of the "Evening in Paris Mysteries" on WABC, pulled a boner the other night; he should have said "I'll give the bell a pull," instead of which it sounded like this: "I'll give the bull a pill." . . . Frank Crumit has been officially installed as Shepherd of the Lambs for the coming year . . . quite an honor, as honors go these days. . . . Jack Smart has shaved off his mustache. . . . Fred Long, for four years manager of Station WEAN at Providence, Rhode Island, has joined the production staff of CBS. . . . Ted Collins, Kate Smith's manager, is not only a radio announcer—he is an actor also and will play the role of Kate's manager on the silver screen in her new picture. . . . Morton Downey's uncle, Dan Fogarty, Irish horse breeder, is in the United States on his first visit from Ireland. . . . Jack Pearl has the nice habit of complimenting other performers on his program before they slip out of the studio. . . . Paul Specht, well-known band leader, has returned to the air after a long illness; he will be a regular feature of the Tydol program every Monday, Wednesday and Friday, with the Three X Sisters, 7:30 p.m. WABC and network. . . . Another new feature on WABC is the Five Star Theatre, under the joint sponsorship of the Standard Oil Companies of New Jersey, Pennsylvania and Louisiana, and the Colonial Beacon Oil Co. A five-night-a-week schedule for thirteen weeks will be divided between the WABC network and WJZ's network. I think this establishes a precedent. The Columbia programs, in which Joseph Bonime's symphony orchestra, guest stars of the opera and Milton Aborn's Light Opera Company, will be featured, will be on the air each Tuesday and Thursday night from 10:00 to 10:30 p.m. . . .

The NBC programs will be heard Monday, Wednesday and Friday and will feature Groucho and Chico Marx, dramatized stories by well-known popular authors, and a radio version of Earl Derr Bigger's "Charlie Chan" stories. . . . Rather an ambitious radio project. . . . Well—I've come to the end of my tether as far as news is concerned and this has to reach the New York office by Friday morning and it's now Wednesday evening, so I'd better say toodle-oo until next week, trot down to Fountain Square and mail this.

* * *

W. PELHAM, New Harmony, Ind.—Am writing you the data on the miniature photographs. . . . I agree with you on the "too much advertising," but then again, we must allow the fellow who pays the bills a little courtesy.

C. H. ANNIS, Tacoma, Wash.—So glad to hear from you again, even though you are a little cryptic. Can you get WLW out in your part of the country?

* * *

Biographical Brevities
ABOUT JOHN G. DALY

John G. Daly, who plays the title role in "Fu Manchu," is a citizen of the world. He was born in Bombay, India, where he lived until he was nine, when the family returned to their native England. When Daly was seventeen years old he studied with D'Oyley Carte, famous light opera producer. His first job was the part of Gaspard in "Chimes of Normandy" at Drury Lane Theatre.

Then wanderlust gripped him; Canada was his first stop. He farmed awhile, then joined the "Mounties." During the war he was with the Royal Canadian Dragoons, and almost died of wounds received at Hartz River. Was invalided home. Played Canadian theatres for a short time, then went to Mexico City on a construction job. After that joined a stock company for a tour of the Orient. On this tour he covered India, Egypt, South Africa and Australia. Back in New York he became stage director for the Shuberts; this continued until three years ago when he decided to enter the radio ranks in Chicago; he has kept at it ever since, playing a long and varied list of parts, winding up as Fu Manchu each Monday evening over the WABC-Columbia network and Achmed in the Sunday presentation of Tales of the Foreign Legion. A fine actor and a fine fellow.

CBS Television on Ultra Wave

The Columbia Broadcasting System has begun regular daily transmission of images from a new ultra wave experimental station, said William A. Schudt, Jr., television program director of the company.

Licensed by the Federal Radio Commission under the call letters W2XAX, the new transmitter has been installed alongside of W2XAB, sight and sound 107 meter station located in the CBS building in New York City.

For the past few weeks W2XAX has been on the air with test programs. The new station began scheduled television transmission on a frequency of 44 megacycles. W2XAX transmits television images every day except Saturday and Sunday, from 4:00 to 4:45 P.M., E.S.T.

The recent experiments by Marconi, during which he successfully "bent" ultra short waves, took place on frequencies close to 44 mgc. used by the CBS television station.

Literature Wanted

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

L. E. Brumfield, Box 124, Stuarts Draft, Virginia.
Victor Warminster, 2342 Yemons Str., Hamtramck, Michigan.
Dr. Roy L. Johnson, 110 Gateway Building, Minneapolis, Minn.
Walter M. Green, 3813 Philip Ave., Detroit, Mich.
C. W. Price, 1921 N. Lawrence Ave., Wichita, Kans.
F. E. Smith, Capron, Okla.
J. Duprez, Prof. in Radioelektricteit ter Nijverheidsschool, 15 Schaliestraat, Ghent, Belgium.
Charles J. Dewey, Gen. Del., Los Angeles, Calif.
A. M. Sutherland, 122 West Willis SF., Detroit., Mich.
Bishop Radio Laboratory, 706 Florida St., Amarillo, Texas.
Henry Zajder, Homer City, Penna.
Joseph Winer, Majestic Auto Radio Headquarters, 937 Ellicott Cor. Best, Buffalo, N. Y.
J. B. Nance, 114 Bartlett Ave., Houston, Texas.
C. A. Peebles, Electric Wiring and General Repairing, N. Main St., Quincy, Mich.
Warnisher's Electric, 711 Barnes St., Lewistown, Mont.

NEW INCORPORATIONS

Canton-Kay Corp., New York City, radio business—Attys., Shattuck, Bangs & Davis, 42 Broadway, New York City.
Silver-Marshall, Inc., Wilmington, Del.—Attys., Corporation Trust Co., Dover, Del.

CORPORATE CHANGES

Capital Increases

Radio-Chassis, New York City, 200 to 600 shares of which 500 are preferred, $100 each; 100 common, no par.

Name Changes

Oneida Electric Co., Oneida, N. Y., to Charles L. Lloyd.

BANKRUPTCY PROCEEDINGS

Petition Filed—Against

A. H. Grebe & Co., Inc., manufacturing radio parts, 70-72 Van Wyck Blvd., Brooklyn, N. Y., by Bush Terminal Buildings Co., for $15,749.74, Bush Terminal Co., $315.01, and Crowe Name Plate & Mfg. Co., $45.

TRADIOGRAMS

By J. Murray Barron

Servicemen, experimenters or even those who are only interested in reading about the new developments of the radio industry can turn this interest into dollars and cents. Right along new gadgets appear on the market that sell fast. They may be very simple and inexpensive, yet they serve a definite purpose and in the majority of cases satisfy the purchaser. They are a kind of accessory, ready sellers. Possibly their sales life may be none too long, in many cases just one season, however, during that period the turnover is large. The sales resistance with most of these items is small, so while they are popular they practically sell themselves, if brought to the attention of the public.

Practically anyone with a little time to spare, by just featuring these new items in their community or neighborhood, can make many a dollar during the popularity of the article and later can find other items to take their place as a sales proposition.

To handle articles of this kind does not necessarily involve a large outlay. The first step is to locate a popular or new small-priced article and obtain the sales rights in your community. To locate these items one has to watch the trade papers, and a letter to the manufacturer will bring the desired information. If this interests you, the time to act is right now.

* * *

To the many thousands who have promised themselves to buy that particular radio essential for the holidays, whether it be a complete receiver, a speaker or that short-wave outfit, they can not go wrong by doing their Christmas shopping now. Perhaps they may never again see the variety of merchandise that is now being offered to the public as displayed all over the country. Whether it be State or Madison Streets in Chicago or Market and Chestnut Streets in Philadelphia, or Washington and Stuart Streets in Boston, all have their unusual displays and extraordinary choice of selections.

No matter how much you enjoy that old set, and no matter what you may have paid for it, unless it be of a recent vintage you are in reality missing radio's real treat. You must have a modern receiver to enjoy fully the programs of today. Where the receiver is situated a distance from the living room or perhaps in the dining room, an extra speaker will prove an acceptable gift. Possibly junior would like to have his personal set, or maybe dad would appreciate a short-wave receiver, or possibly an adapter. And so on down the line. There are dozens of things one can do in the way of radio buying and give some dear one a lasting gift. If this applies to you and your friends, it likewise applies to hundreds of others.

* * *

Jewell Radio Company is again back in the old neighborhood. It has taken over the premises at 88 Cortlandt street where a large stock of public address apparatus and amplifiers will be carried.

British Airway to Use 15 cm Wave

A micro-ray equipment giving radio communication on the shortest wavelength employed at any non-amateur radio station in the world has been ordered by the British Air Ministry for use in connection with cross-channel flying services, according to advices just received by the International Telephone and Telegraph Corporation. This equipment will be manufactured by Standard Telephones and Cables, Limited, a subsidiary of the I. T. T., in its Hendon, England, factory.

Some eighteen months ago the first demonstration of practical radio telephony on a wavelength below one metre was given by the International Telephone and Telegraph Laboratories at Hendon, working in cooperation with the laboratories of Le Material Telephonique, Paris. On that occasion radio telephonic communication was established between Dover, England, and Calais, France, on a wavelength of approximately eighteen centimetres (about the width of the printed surface of this page).

The equipment now ordered will operate on an even lower wavelength, in the neighborhood of fifteen centimetres. For communication on this minute wavelength transmitting and receiving aerials less than one inch long are used. Micro-rays oscillating at a rate of about two billion times a second are generated in a special micro-radio tube. These oscillations are led through the tiny transmitting aerial and are then concentrated by a combination of mirrors into a fine pencil of rays, which are thrown into space from a circular reflector, about ten feet in diameter. This reflector is focused on to a similar reflector at the receiving station.

The equipment ordered by the British Air Ministry will be located at Lympne Airport, near Hythe, England, and will operate in conjunction with a similar equipment ordered by the French Air Ministry, to be situated at St. Inglevert aerodrome, nearly seven miles southwest of Calais. It will be used for announcing the arrival and departure of airplanes that are not fitted with radio, and for routine service messages. An extremely interesting feature of this new service will be the use of teleprinters both for receiving and transmitting messages. In this way typewritten messages will actually be sent across the channel by radio, thus providing a permanent record at each end. The use of teleprinters will also help to overcome the language difficulty since it is easier to understand a written message in an unfamiliar language than a spoken one. Moreover messages can be received on a teleprinter during the temporary absence of the operator.

A great advantage of the use of micro-rays is the fact that they are almost entirely unaffected by atmospheric conditions. Another advantage is that on this extremely low wave band there is practically no interference from congestion of the ether or from nearby machinery.

It is expected that the station will be in operation early next spring and its use will relieve the volume of traffic at Croydon and Lympne wireless stations.

DX CORNER

There is evidently considerable interest in various good receivers to the DX-er, judging from correspondence. Some are interested in a-c jobs, while a large number are interested in battery receivers. The point in mind is that a circuit or receiver that is now actually being used by a DX-er and performing in an excellent manner would naturally be of most interest. The DX-er is interested in knowing what receiver is bringing in the distant stations and making records.

If you have a hook-up, circuit or standard receiver that is really performing unusually well, you will be doing a great favor to your brother DX-ers by sending along the good news with full information. It is only by this spirit of co-operation that we can be of any assistance. In return you can share some of the radio tricks the other fellow passes along.

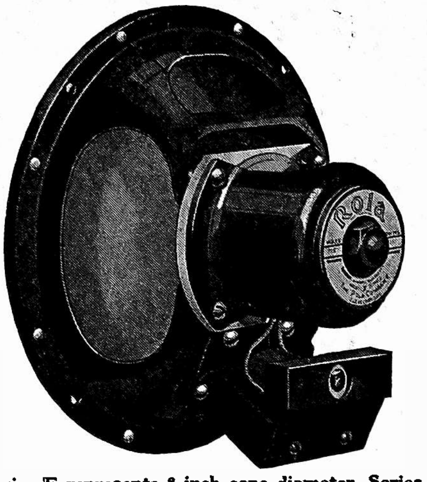
High up in the Sierras, near the California-Nevada border, at Tallac, Lake Tahoe, California, Geo. H. Buckley sends along his approval of a DX column and reports good reception on a six-tube receiver of his own make. He pulls in the Atlantic Coast, also has to his record four stations in Japan. In addition he uses a short-wave converter of his own construction and gets the police stations from all over the country.

While very little has been said regarding short-wave reception in the DX Corner, if there is an interest in that respect, either in reporting records with a receiver or converter or an adapter, we shall take care of that end. The main point is to give the DX-ers just what they want and we earnestly solicit opinions.

Wide Choice of

ROLA

SPEAKERS



Series F represents 8-inch cone diameter, Series K-7 represents 10.5-inch and Series K-9 represents 12-inch, in the catalogue designations. The field coils of all speakers may be used across 110-volt d-c line, in d-c sets, where a separate B choke is used. The field is most often used as B choke and bias source in a-c receivers.

All speakers have field coil, tube-matched output transformer, plug and cable. Besides the speakers listed we can supply models for other purposes, of the same manufacture. Inquire for prices.

8-INCH DIAMETER

Cat. FP, for '47 or 89 single output; 1800 ohm field coil tapped at 300 ohms....$3.75
Cat. F-P-59, same as above, except for the new 59 tube 3.85
Cat. F-P-2, for two '47 or 89 tubes in push-pull; 1800 ohm field coil tapped at 125 ohms....3.80
Cat. F-P-2-59, same as above, except it is for new 59 tubes 3.90
Cat. F-P-2 59-PAR, 1800 ohms tapped at 125 ohms, for two 59 tubes in parallel.... 3.90
Cat. F-45, for single '45 output; 1800 ohm field coil tapped at 800 ohms.... 4.15
Cat. F-45-2, for two '45 tubes in push-pull; 1800 ohm field coil tapped at 500 ohms.... 4.50

10.5-INCH DIAMETER

Cat. K-7-P, 1800 ohm field tapped at 300 ohms. For single '47 or 89....$4.20
Cat. K-7-59, same as above, except for new 59 tube 4.30
Cat. K-7-45, 1800 ohm field, tapped at 800 ohms; for single '45 output.... 4.20
Cat. K-7-P-2, 1800 ohm field, tapped at 125 ohms; for push-pull '47 or 89.... 4.80
Cat. K-7-2-59, same as above, except for new 59 tubes 4.90
Cat. K-7-45-2, for push-pull '45's; 1800 ohm field, tapped at 500 ohms.... 5.10

12-INCH DIAMETER CONE

Cat. K-9-P, 1800 ohm field, tapped at 300 ohms; for single '47 or 89 output....$5.25
Cat. K-9-P-59, same as above, except for new 59 output 5.35
Cat. K-9-45, for single '45 output; 1800 ohm field tapped at 800 ohms.... 5.45
Cat. K-9-P-2, for two '47 or 89 tubes in push-pull; 1800 ohm field tapped at 125 ohms.... 5.75
Cat. K-9-P-2-59, same as above, except for new 59 tubes 5.85
Cat. K-9-45-2, for two 45's in push-pull; 1800 ohm field tapped at 500 ohms.... 5.95

MAGNAVOX AUTOMOBILE SPEAKER

6 inch cone, 6 volt field for connection to car's storage battery. Shielded cable supplied with each speaker. Cat. MAG-AU @ $4.50

Guaranty Radio Goods Co.
143 West 45th Street, New York, N. Y.

MODULATED OSCILLATORS

Broadcast and Intermediate Frequencies

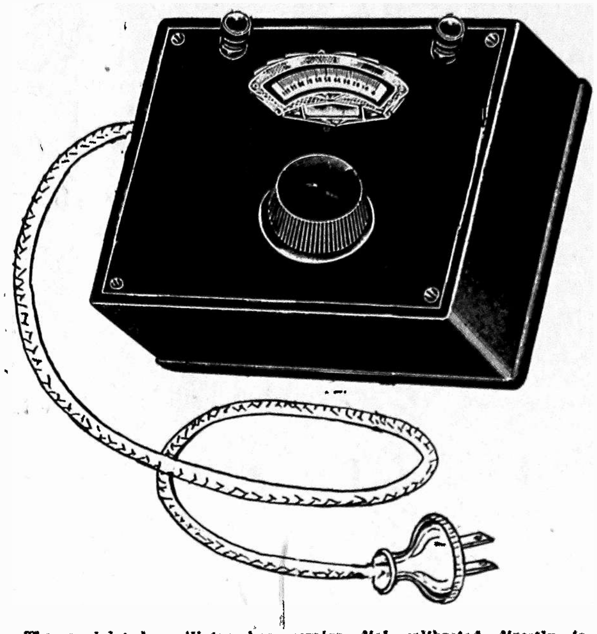
An a-c operated modulated oscillator (105-120 v., 50-60 c.), fully covering the broadcast band (1500 to 540 kc.) and all the commercial intermediate frequencies (115, 130, 172.5, 175, 177.5, 260, 400 and 450 kc.). The vernier dial has scale calibrated in broadcast frequencies, while the eight intermediate frequencies are also recorded directly on the scale. No chart references necessary. Accuracy is 3 per cent. or better, averaging better than 2 per cent. Broadcast calibration is for 5 kc. divisions at low frequency end, 10 kc. in the middle and 20 kc. at the high frequency end.

Fundamental frequencies of oscillation will be from 50.7 to 153 kc, so that some intermediate frequencies may be tested on the fundamental, others on the second harmonic, while the broadcast band is taken care of by the tenth harmonic. No switching necessary despite wide frequency coverage. Sharp tuning, clear squeals in heterodyning, and strong modulation by the 60-cycle line frequency. No hum except at resonance. Frequency stability is of a high order, due to stabilized grid circuit. Calibration is for a 56 tube.

Cat. WOSC, @ $6.93
(56 tube is 87c extra)

Same as above, except for battery operation, with high audio frequency modulation, and requiring 3-volt dry battery and 22.5 volt B battery (not furnished). Tube required is the '30.

Cat. WOSCB, @ $6.53
(230 tube is $1.08 extra)



The modulated oscillator has vernier dial calibrated directly in frequencies, covering broadcasts and intermediate. The tube is inserted by removing the panel. Output post is at left, ground post at right.

Direct Radio Co., 143 West 45th Street, New York, N. Y.

No More Need to Calculate Inductance!

Correct Answer Obtained from Charts in 10 Seconds!

PRECISION charts have been prepared by Edward M. Shiepe, E.E. (Massachusetts Institute of Technology) relating inductance, capacity and frequency, and giving the number of turns of different sized wires for attaining inductance values for solenoid form diameters of ¾, ⅞, 1, 1⅛, 1¼, 1⅜, 1½, 1¾, 2, 2¼, 2½, 2¾ and 3".

The tri-relationship chart (inductance, capacity and frequency plotted, so that when any two are known the unknown may be read directly in 10 seconds) is necessary for use of the inductance table that covers any particular wire size for all the specified form diameters.

The charts are on 9 x 12" photostat sheets, white lines on a black field.

The tri-relationship chart covers inductance values of 0.1 to 10,000 microhenries, capacity values of 50 to 600 mmfd. and frequency values of from 100 to 20,000 kc.

The tri-relationship chart is Cat. CHT-TRI, @ $1.00

WHILE any one of the three quantities may be determined, the chief purpose of the tri-relationship chart is to give instant reading of the inductance needed when capacity and frequency are known.

The turns charts (number of turns needed for specified inductance) are thirty-six in number, one for each of the following different wire sizes and insulations: Enamel Nos. 14, 16, 18, 20, 22, 24, 26, 28, 30; Single Silk Covered, Nos. 14, 16, 18, 20, 22, 24, 26, 28, 30; Double Silk Covered or Single Cotton Covered (same data apply to both), Nos. 14, 16, 18, 20, 22, 24, 26, 28, 30; Double Cotton Covered, Nos. 14, 16, 18, 20, 22, 24, 26, 28, 30.

Each turns chart gives the number of turns for inductance ranges well in excess of commercial uses of particular wire sizes on the specified diameters. Short waves included for larger diameter wires, very long waves for finer diameter wires.

The turns charts are Cat. CHT-TNS followed by the wire size and insulation. Thus, turns chart for No. 30 Double Cotton Covered would be Cat. CHT-TNS—30—DCC. The price is $1.00 each.

The accuracy of these charts is so high that it may be relied on in engineering practice.

All charts are on a logarithmic 5x3-cycle basis.

RADIO WORLD, 145 West 45th Street, NEW YORK, N. Y.

Quick-Action Classified Advertisements

7c a Word — $1.00 Minmium Cash With Order

WANTED TO BUY—One or more Silvertone Neutrodyne radio sets, models 106, 108, 110 or 95. Purchased from Sears, Roebuck & Co. between June, 1930, and June, 1931. Need not be in operating condition but must have manufacturer's nameplate. Will pay commission to service man locating required set, if satisfactory. Box 1724, Radio World, 145 West 45th Street, N. Y.

"THE CHEVROLET SIX CAR AND TRUCK" (Construction—Operation—Repair) by Victor W Pagé, author of "Modern Gasoline Automobile," "Ford Model A Car and AA Truck," etc., etc 450 pages, price $2.00 Radio World, 145 W. 45th St., N. Y. City.

PARTS AT LOW PRICES

6" Baldwin Dynamics for Diamond....$2.20
Power Transformers, 4 or 5 tube.... 1.30
Filter, 2 Electrolytics in can.... .80
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Midget Cabinets 2.00
Steel Chassis for above.... .50
Kit of Four Tubes.... 3.00
Five Sockets Marked for Diamond.... .40
DOWAGIAC RADIO MFG. CO., Dowagiac, Mich.

NEW AMERICAN BOSCH VIBRO POWER RADIO. Only American Bosch has vibro power, new discovery in radio. Get our prices before buying elsewhere. We will save you 25% on your radio purchase. McGuire Distributing Co., Bosch Radio From Factory to Customer, Doeville. Tennessee.

SHORT-WAVE BROADCAST STATIONS—Complete list of those on air and ordinarily receivable; also complete list of Short-Wave Commercial Stations, including Aircraft, Police and Identifying Stations, contained in Radio World issue of Dec. 3, 1932. 15c a copy. Rado World, 145 W. 45th St., New York, N. Y.

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Having assembled 2,000 diagrams of commercial receivers, power amplifiers, converters, etc., in 1,200 pages of Volume No. 1 of his Perpetual Trouble Shooter's Manual, John F. Rider, noted radio engineer, has prepared Volume No. 2 on an even more detailed scale, covering all the latest receivers. Volume No. 2 does not duplicate diagrams in Volume No. 1, but contains only new, additional diagrams, and a new all-inclusive information on the circuits covered.

Volume No. 2—Perpetual Trouble Shooter's Manual, by John F. Rider. Shipping weight 8 lbs. Order Cat. RM-VT @ $5.00

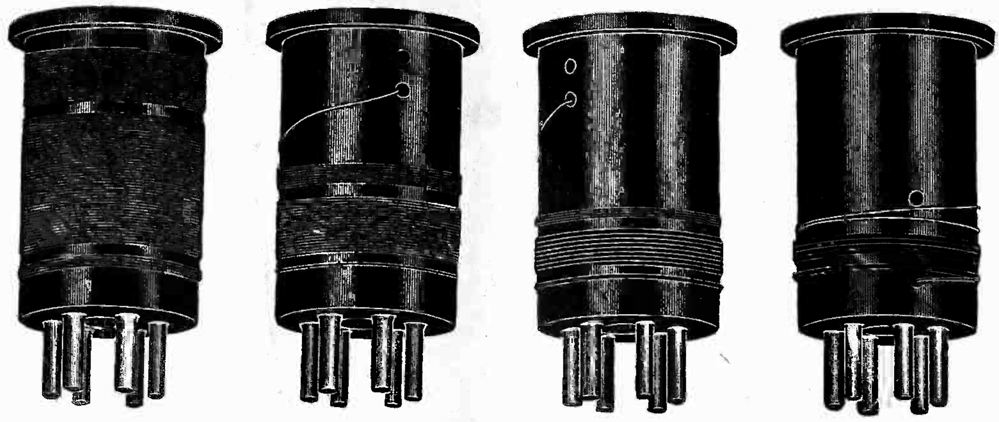
Volume No. 1 (8 lbs.). Order Cat. RM-VO @ $5.00

We pay postage in United States on receipt of purchase price with order. Canadian, Mexican and other foreign remittances must be in funds payable in New York

RADIO WORLD, 145 W. 45th St., N. Y. City

SHORT WAVES

14 to 200 Meters



Use 0.00014 Mfd. Capacity

SIX-PRONG PLUG-IN COILS FOR DETECTOR STAGE

PLUG-IN COILS with six-prong bases that fit into six-pin tube sockets (used as coil receptacles) provide three separate windings: primary, secondary and tickler. The three-circuit coil is most efficient in detector sockets.

Either of the two following uses applies:

(1)—As detector input from a tuned radio frequency stage, with primary in the plate circuit of a screen grid tube;

(2)—As detector alone, where there is no r-f amplification ahead of the detector, primary in the antenna-ground circuit.

See coil connections illustrated below.

The form diameter is 1.25 inch, with gripping flange.

THESE coils have proved their effectiveness in many circuits and lend themselves to all types of circuits save those with moving-coil ticklers.

The coils are designed for use with 0.00014 mfd. tuning capacity to tune from 200 meters to below 14 meters. The higher frequency coils have secondaries wound with very thick wire.

The bakelite coil forms are seasoned so that the inductance will not be affected by moisture-content of the forms.

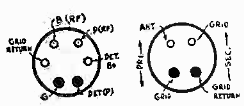
The base pins are strong and durable and the coils will last for several years.

Four coils sent free with 6 months subscription (26 weeks) @ $3.00. Order Cat. PRE-SWBP.

FOUR-PRONG PLUG-IN COILS FOR ANTENNA STAGE

When a short-wave tuned radio frequency set is built with a stage of t-r-f, the antenna coil should be of the four-pin, two-winding type. Centers of cores should be 6 inches apart or more to prevent back-coupling. No shielding should be used in either case. Coupling between coils makes a circuit tricky to tune. Shields reduce sensitivity too much in t-r-f short-wave circuits.

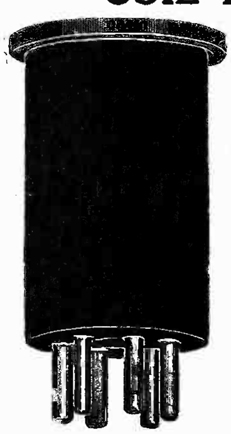
The four-pin coils are wound with secondaries for 0.00014 mfd. and these match the secondaries of the six-pin coils.



The diagram at left shows connections to make to the sockets of both the UX (four-pin) and six-pin coils. The bottom views of socket connections are shown. The primary of the UX coil connects to Ant. and ground (Grnd.). Follow these connections carefully. If oscillation fails when desired, reverse connections of the secondary (transpose grid and grid return.)

Four UX wound coils sent free with 6 mos. subscription @ $3. Order Cat. PRE-SWAP.

COIL FORMS



Those who desire to wind their own plug-in coils may use the same forms that prevail in the factory-wound coils detailed above. These coil forms are obtainable in three types. A set of coils of any type consists of four forms.

Any set of four coil forms (not wound) will be sent free for an eight-weeks trial subscription at the regular price, $1.00.

UX forms (four) order Cat. PRE-CFUX.

UY forms (four), order Cat. PRE-CFUY.

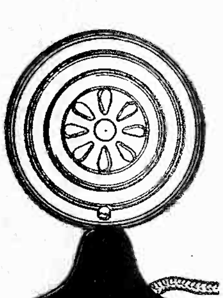
Six-pin (four), order Cat. PRE-CFSX.

TUNING METER

Some short-wave enthusiasts like to tune in stations by the meter method. Thereby they can watch the meter needle for greatest deflection to ascertain resonance. A sensitive milliammeter serves the purpose. One of 5 ma full-scale deflection may be connected in series with the plate feed to an r-f, or intermediate tube, or in the common screen lead of several tuner tubes, or in any other circuit where the steady value of current does not exceed 2 or 3 milliamperes. In all tuner amplifier stages the needle will show higher readings at higher signal levels (modulation is upward) and therefore if only a few milliamperes flow in such circuits the meter may be used. The meter may be used for any d-c current measurement in its range.

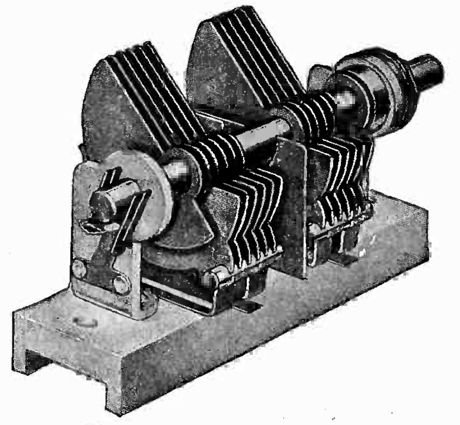
The 0-5 milliammeter is of the panel-mount type and is sent free with a six-months subscription (26 weeks) at the regular price of $3. Order Cat. PRE-TUM.

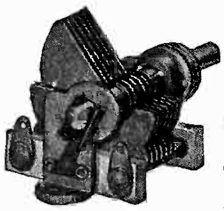
MICROPHONE



A general utility microphone for home use, that enables you to use the audio amplifier in your receiver and "broadcast" in your home. This microphone is of the high-resistance single-button type, and is useful not only for serious work but also for playing pranks. No battery required. With the microphone are supplied socket templates and directions for connections to detector tubes of various types of receivers. Good results are enjoyably obtained. The microphone will be sent free on receipt of $2.00 for sixteen-weeks subscription (16 issues), the regular price. Order Cat. PRE-MK.

CONDENSERS





The Hammarlund junior midline short-wave condensers, 0.00014 mfd., work exceedingly well with the coils offered above, but also may be used to advantage in any short-wave set, with any other coils intended for that capacity. These condensers have Isolantite bases, thus enhancing the low-loss construction that prevails throughout.

The condensers illustrated are the single 0.00014 mfd. mfd. and the dual 0.00014 mfd. The shafts are ¼ inch. A vernier dial should be used. See vernier dial offers, for a-c and battery sets, on another page.

Single condenser sent free with three months subscription, (13 weeks) at regular price of $1.50. Order Cat. PRE-H14. PRE-S-14.

Double condenser sent free with six months subscription (26 weeks) at regular price of $3.00. Order Cat. PRE-DU-14.

Manual trimmer (40 mmfd.), free with trial subscription, 8 weeks, $1.00. Order Cat. PRE-MNT.

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

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