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THOMAS F. MEAGHER TUNING IN DX. SEE PAGES 14 AND 15 FOR HIS LIST OF STATIONS RECEIVED
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Why Didn’t Anybody Think of These Things Before?

By Homer Comfort Pelletier

THERE are many properties of vacuum tube amplifiers self-evident yet that escape the attention of everybody for a long time. Then when someone does discover one of them everybody else exclaims: “Why didn’t I think of that?”

A case in point is illustrated with the attached diagram. Fig. 1.

This diagram shows the tail end of a receiver in which the filament of the power tube is heated with AC, and which derives its grid and plate potentials from an eliminator.

The grid bias is obtained from the voltage drop in resistance R. This is the usual connection; and thousands of amplifiers have been built with it, and scores of manufacturers of battery eliminators, resistors, transformers, choke coils and condensers have shown this connection.

At the same time all these manufacturers have enough higher amplification and better quality as a result of following some diagram containing this connection. Particular emphasis has usually been laid on the marvelous reproduction of the low notes.

For a tube of the -71 type the value of resistor R is approximately 2,000 ohms.

Effect on Frequencies

Some, but not all, of the manufacturers of parts and writers on the subject connect a condenser C across the resistor, and the value of the condenser recommended is either 1 or 2 mfd. Condenser larger than 2 mfd. is rarely recommended, but often one less than 1 mfd. is suggested.

Now, what about the connection, anyway? First, the resistor cuts down the amplification of the tube tremendously and the second, when condenser C is used across R the audio notes particularly are stressed. In other words, the combination R and C as usually recommended often defeats both of the claims made for it—increased amplification and the accentuation of the low notes.

The theory of the effect of R alone on the amplification shows that when the load on the tube is non-reactive and is adjusted for maximum unfiltered output, and when R is used in addition to the useful load then the amplification in a 71 type tube is 6/7 instead of 2. That is, the tube has been changed from a voltage amplifier to a voltage losser.

Analysis of Load

When the load on the power tube is inductive, which it is in all practical cases of broadcast reception, the loss in voltage is greater on the low notes than on the high, because then the inductive load impedance is comparatively higher than the resistance of R. Hence even without condenser C the low notes are handicapped.

When condenser C is connected across the resistor R the effective impedance of R and C is reduced more for the high notes than for the low. In fact for the higher audio notes the impedance of R and C in parallel is negligible in comparison with the impedance of the inductive load, and there is no reduction in the amplification as a result of R. But on the lower audio notes the impedance of R and C is about the same as the impedance of the load, and there is a great drop in the amplification. The result is poor quality of reproduction even when the very best coupling media are used in the audio amplifier.

Assuming particularly a transformer coupled audio system, as the capacity of the condenser C is increased the impedance of R and C becomes lower, and if the condenser is large enough the impedance of R and C will be negligibly small in comparison with the load impedance even at the lowest audio frequencies and the amplification will rise. Even 0.1 mfd. will have a noticeable effect. But if the audio is resistance coupled, then C must be at least 4 mfd. before there is any appreciable increase in the intensity of the low tones. While it must be of the order of 20 mfd. before frequencies of 50 cycles get an equal chance with the higher frequencies. The human ear detects scarcely any difference above 4 mfd. When the condenser is so large the quality becomes very good, provided that the coupling medium in the amplifier is capable of good quality.

Circuit the Factor

This diagram illustrates the effects of the grid bias resistor on the quality of reproduction, and it indicates the preferred connections of by-pass condensers and the loudspeaker to minimize the effects.

THE NEXT PAGE CONTINUES...
designed for a fairly high voltage. If the condenser should break down under the electric stress, the loud-speaker winding would very likely burn out.

From the points of view of safety and economic radio, drawn up and signed by delegates to the International Radiotelegraph Conference which concluded its sessions here last week, is expected by the chairman of the United States delegation, Herbert Hoover. Mr. Hoover, who was also president of the International Conference, declared that a summary of the treaty is being prepared for presentation by the Department of State to the United States Senate. That body, he said, will probably accept the document as it stands, but the negative ends of the filament of all the preceding tubes should be connected in a manner appropriate to this change.

When the filter condensers have been connected in this manner, the AC component of the current from the last tube passing through the grid bias resistor is very small, due to the effective by-passing of the medium and large condensers in the filter. The DC component of the plate current still flows through the resistance and hence it is effective in giving the grid a bias. Condenser C across the resistor will still help to reduce the AC current in R but its use is not absolutely necessary now.

The amplification would be so much stronger that it might require cutting out one audio stage to keep the output tube within its operating limits.

When this connection is used it is possible to use the drop in R, or part of it, to give the other tubes in the circuit a bias. The grid returns are connected to the appropriate point on R to give the requisite bias.

The Four Points

For best quality the grid bias should not be obtained through a drop in a resistance at all, at least not when R carries part or all of the plate current of the tube, but a grid battery should be used. Nevertheless some prefer bias through a resistor.

Hence it is necessary to make the best of the situation.

First, the choke coil L should have a low DC resistance and a very high inductance at the current flowing through it; second, condenser C1 should have a large capacity and a high voltage test; third, connection No. 2 as shown in Fig. 3 should be used, fourth, condenser C across the grid bias resistor R should be large. It need not be designed for high voltage since the electric stress across it will never exceed 100 volts. A fifth condition may be added, and that is that the drop in R should never be connected for bias on any of the other amplifiers in the receiver unless all trace of AC has been balanced out of the resistor. The whole problem of rectified AC or utilized line DC for B and A supply is so dependent on constants of individual circuits that general rules need explanatory addenda. For instance, the speaker return in the filtered output should be to No. 1, excepting that the circuit may require grounding of No. 2 to eliminate a peanut whistle. Connection of the speaker return to No. 2 would then be the objectionable cause of reintroducing the whistle, so No. 2, the ground potential, necessarily would have to be selected.

Optional Method

Another method of connecting the filter may be used to advantage, and this method has been mentioned in passing. Instead of connecting all the by-pass condensers to the negative side of the rectifier

The Fenway DX-er is one of those things which nobody thought of. But the genius of Leo Fenway developed it. And now many DXers have themselves: "Why didn't I think of that trick?"

The DX-er, used for the first time in the Fenway concertola, consists of a parallel tuned circuit connected between the positive side of the detector and the tube preceding. The condenser is a midget and the coil is a radio frequency choke of 25 millihenrys. When this circuit is tuned to the carrier wave it is equivalent to an extremely high resistance connected from plate to ground. This resistance so connected feeds back energy from the detector plate to the primary of the transformer, connected to the preceding tube, and if the frequency of the transmitter has been properly this feedback will cause regeneration.

If the resistance is not too high, oscillation will result just as if a tickler coil were used.

The amount of regeneration in the Concertola is controlled virtually by the condenser across the coil. When the condenser is open the impedance between the two plates is mostly inductive and no current of radio frequency can pass through it. Hence there is no regeneration. When the condenser plates are meshed more radio frequency current can pass and the regeneration begins. This control of the regeneration is smooth in action and allows a high amplification without clipping over.

Smooth, Easy Control

Since the control of the regeneration with the Fenway DX-er is smooth and steady it is possible and easy to attain critical regeneration with it. That is, to obtain the highest possible radio frequency amplification without oscillation that can be obtained with the particular tuning system and tubes used. This does not mean an increase of from 50 to 100 percent over the amplification possible in the usual way. It means a manifold increase.

It is well to call attention to the fact that one of the best oscillators known is similar in construction to the DX-er. That is, to say that the energy causing oscillation is fed back through a parallel tuned circuit. The advantage of this oscillator is steadiness of frequency generated and purity of wave form in the output current. These advantages are directly applicable to the DX-er. The condition which makes the steadiness of frequency also accounts for the possibility of critical regeneration in the receiver. The condition is a sort of purity of waveform in the oscillator plate which insures against harmonic distortion in the output of the regenerative detector.

WASHINGTON, December 17, 1927

No opposition to ratification was offered in the United States Senate by the Senate Committee on Finance, sending Senator Warson (Rep.) of Indiana, and Senator Smith (Dem.) of South Carolina.

The delegation of this country to the conference, headed Senator Warson (Rep.) of Indiana, and Senator Smith (Dem.) of South Carolina.

Respective neoplytenes of the 79 countries represented at the Conference attached their signatures on November 25 to the convention, which provides that it shall remain in force in the event of withdrawal from the United States and one copy given to each government signatory thereto.

The convention itself will go into effect beginning January 1, 1929, and shall remain in force under its own provisions, for an indefinite period and until one year from the day wherein a rejection shall take place.

Legislatures of all other signatory countries must also ratify the document as has been done in Fig. 1, they are connected to the point marked X, that is, to the positive end of the grid bias resistor. There would be no other change in the circuit in so far as the last tube is concerned, but the negative ends of the filaments of all the preceding tubes should be connected in a manner appropriate to this change.

RADIO WORLD
Some Surprising Facts About Harmonics

By H. B. Herman

Acoustical Expert

December 17, 1927

RADIO WORLD

5

That the Harmonics of a Plucked Cello String Are Not Exact Multiples of the Fundamental Can be Proved With the Aid of a Vacuum Tube Oscillator. Tune Oscillator to Exact Unison with the Fundamental of Plucked String. Then Compare the Harmonics of the Oscillator with the Harmonics of the String. Beats Will Be Heard. To Avoid Confusion It May Be Necessary to Suppress the Fundamental of the Oscillator to Make the Comparison.

The statement that harmonics are always exact integral multiples of the fundamental is often made. It is made in high places with the weight of authority behind it, and it is not wholly true; it is not even half the truth. Sometimes the harmonics are exact multiples of the fundamental, but in most cases the harmonics differ, sometimes widely, from being exact integral multiples.

The term harmonic is here taken in its mathematical sense, which makes the fundamental the first harmonic. By the term overtone is meant here a harmonic higher than the fundamental, and the first overtone is the second harmonic. These definitions are not accepted universally, either in musical or scientific circles, but they seem the most logical.

Harmonics are not always simple harmonics either in music or in mathematics, that is, such that the various overtones bear an integral multiple relationship to the fundamental, not even approximately so. In drums the ratios are very complex.

Let us first consider the vibrations in a piano string. It is usually said that the harmonics are exact multiples of the fundamental in this instrument. This is only approximately true. The only condition under which the harmonics of the piano string could be exact multiples of the fundamental is that the damping on the string be zero. But that can never be, or no sound would come from the string.

Difference Depends on Damping

As long as the string is radiating sound there is considerable damping and the harmonics differ from being exact multiples of the fundamental by an amount which depends on the degree of damping.

The same thing holds true of all stringed instruments in which the strings are struck or plucked and then left to vibrate. In some cases the harmonics are so far off that the sound emitted lacks "harmony." A case in point is the sound emitted by a plucked cello string.

The peculiar quality of the xylophone is also due to great damping of the reeds and the consequent lack of exact harmonic relationship between the harmonics.

In the case of bells, drums and cymbals the harmonics are not even approximately integral multiples of the fundamental, even when there is no damping. The lack of musical quality of these instruments is directly due to this fact. The harmonics are mutually discordant.

In the case of sustained vibrations the situation is different. The sustaining force neutralizes the damping so that when a string is vibrating with a constant amplitude the harmonics are exact integral multiples of the fundamental.

Properly bowed strings and properly excited organ pipes give off complex sounds in which the harmonics are exact multiples, but only when the amplitude is constant, or when exciting force remains constant.

Holds in Electricity, Too

The harmonics radiated in a damped electric circuit also differ from being exact multiples of the fundamental frequency, and the deviation depends on the amount of the damping, just as in the case of the damped vibrating string.

But the harmonics generated in an electric vacuum tube oscillator are exact multiples because the vibration is sustained and the damping neutralized. The harmonics generated in a detector tube or amplifier tube also are exact multiples of the fundamental frequency impressed on them, because the action is sustained.

But it is probable that while the amplitude of the impressed frequency changes up or down, that exact relationship does not exist between the fundamental and the harmonics. The same undoubtedly holds also in the oscillator while the oscillations are building up or dying down, or while changing from one amplitude to another.

It is not necessary to rely on mathematical nities to show that the harmonics are not exact multiples of the fundamental. It can be proved experimentally quite easily.

Can Hear Difference

In some cases it is possible to hear the lack of harmony between the various harmonic components of a complex sound, such as that radiated from a plucked cello string or a struck piano string. A more exact way of testing it is to set up an electrical oscillator employing vacuum tubes. This can be tuned to exact resonance with the fundamental of a certain musical string by the method of zero beat.

But it does not. A beat is heard though the two fundamentals are in exact unison. In the same way the higher harmonics can be compared also and found to differ.

Electric Examples

The stepping up of low frequencies by the harmonic method in radio for measuring radio frequencies is done under conditions which make the harmonics exact multiples, and hence the values obtained are correct. A hundred cycle tuning form is often used as the source of the fundamental. The sound from this is impressed on an electric harmonic producer which multiplies the frequency by 2, 3, 4 and so on up to as high a value as is desired.

If a plucked cello string or a struck piano string is used for calibrating an electric oscillator and direct comparison is made with the harmonics of the standard used, the higher frequency calibration of the electric oscillator will not be correct.
A Universal Tester of

Handy Device Also Gives Audio Transformer Ratios. Tell; When a Valve Should Be Discarded and Quickly Solves Trouble Shooting Problems

Which are performed by the device:
1. DC Voltmeter test for A, B, C batteries and for A, B, C eliminators and trickle chargers.
2. Tube tester: measures the direct plate current consumption of the tube when it oscillates at radio frequency, and thus gives the actual efficiency of the tube in a relative way.
3. Circuit tester: for open, shorted and grounded circuits on coils, condensers, transformers, choke coils, rheostats, loudspeakers, etc.

In a large number of trouble-shooting cases the meter will find ready use. The testing procedure involved in obtaining the characteristics of vacuum tubes in order to ascertain the particular use for which the tubes are best suited has been boiled down to a very simple method which has been found infallible.

Gives Practical Information
Where the laboratory requirements are exacting it is advisable to use the round-about method of finding the amplification constant, the plate impedance, the mutual conductance and other important characteristics. In other words, the meter described in the following paragraphs gives only the information which would be required by the practician and not by the laboratory engineer anxious to find out the number of electrons which leave the filament every second, or to learn the extent of electrolysis in the glass bulb when the tube is operating at definite voltages and frequencies. The meter answers a purpose very nicely in that it gives the exact relative value of the tube and denotes its particular use as an amplifier for radio or audio frequencies or use as a detector.

The 99, 01A, 12, 71 and other such tubes can be tested. The panel, which is of Micarta, is laid out according to the sketch. Care should be taken not to mar the beautiful polished surface by scratches. The large holes are cut either with an extension bit or else with a small scroll or coping saw. This task, too, must be done with pains, else the mistakes will prove costly.

The meter is fastened in place by three small machine screws and nuts. The push buttons are forced in their holes, fitting snugly. The binding posts are locked tightly and the rheostat, which is a Carter 50 Ohm Midget, the phone jack and the cam switch are mounted in the single-hole mounting manner. Two machine screws hold the socket in place.

What Holds Multiplier
What parts are not mounted on the top of the panel are fastened to it on the under side. In a word, all the parts are placed together in one single unit, making the device very compact and adaptable for quick check-up.

When the instruments and parts have been placed on the top of the panel, the radio frequency inductance coil, the radio frequency choke coil and the 1 mfd. bypass condenser are mounted by means of the fiber strip and brass strip respectively.

A type 112 amperite is attached to the under side of the panel by means of a small machine screw.

It will be noted from the photograph that the multiplier for the meter is held in position by the connecting wires which pass through its central core. Thus, all strain is taken off the coil connections and accidental breakage of the fine wire leads from the multiplier resistance is prevented. Soldering lugs have been provided for every terminal, so that all connections and joints can be properly soldered. No mechanical means of making an electrical connection should be relied on, for continued handling may loosen these connections and give cause for trouble.

The parts have been arranged so as to provide the shortest leads consistent with proper disposition.

Supply Voltages Measured
Before the instrument is placed into service the wiring should be checked and as a final precaution, rechecked. This will avoid needless spilling of tears when the meter is accidentally burned out by a nice fresh B battery because the multiplier had been left out of the proper circuit, or avoid the loss of a tube due to some incorrect connection. As the in-

A PHOTOGRAPH OF THE FINISHED PANEL OF THE ADELMAN UNIVERSAL TESTER.

By Leon L. Adelman
Chief Engineer
A. M. Flechtheim & Co., Inc.
Associate, Institute of Radio Engineers

THERE is an almost endless assortment of types of meters used for test purposes in conjunction with radio receivers and apparatus. Each meter has been designed for a specific function or group of functions and no doubt fulfills its duty with entire satisfaction. Often it is possible to use an instrument in a number of different tests, but often, too, it is not possible to use it for more complex and intricate tests.

Working on the assumption that one single meter can do as much as three or more, the author, in collaboration with A. R. Marcy, chief engineer of WFBL, evolved a circuit which more than exceeded all expectations. Owing to the flexibility of the device—the numerous tests that can be made with it—every set builder, service man and radio technician should be interested.

What the Meter Will Do
The instrument is compact and portable. There are three distinct functions which are performed by the device:

1. DC Voltmeter test for A, B, C batteries and for A, B, C eliminators and trickle chargers.
2. Tube tester: measures the direct plate current consumption of the tube when it oscillates at radio frequency, and thus gives the actual efficiency of the tube in a relative way.
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THE CIRCUIT DIAGRAM OF ADELMAN UNIVERSAL TESTER.
**Tubes and Sets**

Instrument itself is wired, it is quite impossible to do any damage to it or to any instrument connected with it, if the proper procedure is followed.

The panel has been engraved with the letters A and B. These denote the A and B battery connections. Since the meter range is 6 volts for the A battery and up to 120 volts for the B battery, you can see where the difference is made.

If in doubt as to the output voltage of a B tube, test it step by step by using the detector, then the amplifier and finally the load. If the meter reads 3.3 volts, for that is the proper current output of a battery.

You will notice the needle start to move very slowly at first and then accelerate with every small increment in filament voltage. The meter consumes 6 milliamperes and thus the plate of the tubes when testing them, especially the tubes with 45 volts on the plate and B battery connections.

Tubes can be tested quickly, accurately and safely. Let us first consider the type 99.

First connect a source of filament voltage to the B terminals. Then connect the negative lead of the telephone cord to the lower terminal of the A battery. Then turn the cam switch to its "on" position. Note the meter reading. It should be anywhere from 1.5 to 2.5 milliamperes for the 99 type tube.

Rule Is 45 Volts

Keep in mind to use 45 volts on the plate of the tubes when testing them, except only the 71 tube. If a higher potential is employed, say 90 volts, the tube may be found to be so exceptionally sensitive that at 6 volts the meter consumes 6 milliamperes and thus the resistance of the meter must be 1,000 ohms.

Following the same line of thought, the resistance of the multiplier, in order that the full scale reading of the meter be 120 volts, is 19,000 ohms. It will be seen, therefore, that the meter consumes very little current and is thus capable of giving a very accurate measurement of the voltage output of an eliminator or trickle charger.

Tubes can be tested quickly, accurately and safely. But if you believe it, it should be placed in the audio frequency amplifier circuit.

Plate Current Reading

It will be noticed, too, that no grid leak and grid condenser is used, nor even a by-pass condenser across the secondary of the radio frequency inductance. These conditions have a tendency to enhance the severity of the test, so that if the tube oscillates under these conditions, it certainly will work properly when placed in a regular radio circuit, be it the radio frequency amplifier, audio frequency amplifier or detector circuit. Just where or in what position the tube will function best will be taken up shortly.

Now when it has been ascertained that the tube is properly fed with the required voltages, do not touch anything else, but turn the cam switch to its "on" position. Note the meter reading. It should be anywhere from 1.5 to 2.5 milliamperes for the 99 type tube.

If the reading is very low, the tube is evidently a poor one and should not be used as a radio frequency amplifier or detector. Even as an audio frequency amplifier it may not function with much success, but if it must be used, it should be placed in the audio frequency amplifier circuit, preferably the first stage.

Test of Oscillation

This completes the discussion of the proper method of testing the ADELMAN UNIVERSAL TESTER.

(Concluded on next page)

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**LIST OF PARTS**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>One Micarta Panel 3-4x6 7-16x1-8</td>
<td></td>
</tr>
<tr>
<td>One Combination Roller-Smith meter</td>
<td></td>
</tr>
<tr>
<td>0-6 volts, 0-120 volts, 0-6 millamps.</td>
<td></td>
</tr>
<tr>
<td>One Carter jack switch</td>
<td></td>
</tr>
<tr>
<td>One Hammersland No. 85 R.F. choke.</td>
<td></td>
</tr>
<tr>
<td>One Bunte No. 69 R.F coll.</td>
<td></td>
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<tr>
<td>One Carter jack</td>
<td></td>
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<tr>
<td>One standard socket</td>
<td></td>
</tr>
<tr>
<td>One Carter 90-ohm rheostat</td>
<td></td>
</tr>
<tr>
<td>One Type 112 ammeter and mounting</td>
<td></td>
</tr>
<tr>
<td>One Cabinet 8 1-2x7x7 3-8 inches</td>
<td></td>
</tr>
<tr>
<td>Four Metal binding posts</td>
<td></td>
</tr>
<tr>
<td>Two Pearl-head push buttons 5-8 inch diameter</td>
<td></td>
</tr>
<tr>
<td>One Roll of Acme Celatsite wire</td>
<td></td>
</tr>
<tr>
<td>One Fiber strip 2-1x1 inch</td>
<td></td>
</tr>
<tr>
<td>One Brass angle &quot;L&quot; 1x1-2x1-2 inch</td>
<td></td>
</tr>
<tr>
<td>One Brass strip &quot;L&quot; 3x1-2x1-2 inch</td>
<td></td>
</tr>
<tr>
<td>One Weston plug</td>
<td></td>
</tr>
<tr>
<td>Three Single Flexible 6 foot Phone Cords (Spade tips at one end and plug tips at the other)</td>
<td></td>
</tr>
<tr>
<td>One Flechheim 1 mfd. by-pass condenser</td>
<td></td>
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<tr>
<td>One small bakelite knob for rheostat</td>
<td></td>
</tr>
</tbody>
</table>

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**THE PANEL LAYOUT OF THE ADELMAN UNIVERSAL TESTER.**

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December 17, 1927

RADIO WORLD
tion may result from an improper connection of the plate coil in the oscillatory circuit. Try reversing the leads to the plate coil and then take the RF reading. When the tube is oscillating, the RF reading can be quickly determined by placing a finger on the grid terminal of the inductance coil and allowing the meter reading to fall off appreciably when the finger is placed on the high potential post. If it doesn’t fall off appreciably, you can be reasonably sure that the tube is not oscillating.

One thing to be kept in mind is that one can increase the RF reading by increasing supply voltages at the binding posts on the transformer. Yet it must also be remembered that an increase of 10 per cent in filament potential results in a marked decrease in the life of a tube. Thus, if the filament potential is adjusted to 5.5 volts for a type 01 tube, it would be found that the current may be increased 50 per cent or more, than when operating the tube at 5 volts.

The radio frequency choke coil and by-pass condenser, augment the chances for self-oscillation in the circuit and keep the radio frequency currents out of the meter and batteries. This insures accurate tube characteristic readings.

**Chart Gives Rating**

The wavelength at which the tube is made to oscillate is approximately 130 meters. In the case of the coil used, the winding together with its self or distributed capacity, which is extremely low, affords an extremely high frequency range (about 2,300,000 cycles) at which the tube responds. This value of oscillation is far greater than that at any frequency within broadcast range.

Since the meter range is but 6 mils, and since the type 12 tube makes a very good test, when operated as the proper characteristics, do not connect 90 volts of plate current to test the tube, because the needle pointer of the meter may rise too far and get beyond the glass shield. Rest assured that if the tube proves to be a good detector, it certainly will operate very efficiently as an audio amplifier. Use 45 volts with the 12 on test. As for the -71, use only 22½ volts when testing this tube.

Here is a chart which gives information concerning tubes generally used and what should be expected from them when tested.

(Please see the chart given on page 2."

**The Three Steps**

Here are the steps which will solve even the most complex cases of seemingly innumerable difficulties.

**FIRST.-**Ascertain whether the source of supply of current to the receiver is proper and of accurate voltages. Test either the batteries or eliminator or both, as the case may be. The first thing, then, is to be sure that the battery is down, or the B eliminator is defective or whether or not the supply is functioning properly.

**SECOND.-**The tubes should next be tested. A visual inspection of the tube prods and socket contacts should be made. Take no chances with the little things. They are the big things in a radio set.

**THIRD.-**Turn the receiver on and disconnect one terminal of the loudspeaker. The connection should be made and broken a few times. If a loud click is audible, then, since no signals are repro-duced, there must be something wrong with the wire of the set. Possibly a connection is broken. If there is no loud click in the speaker there is room for all kinds of trouble. A broken cord lead or a burned-out speaker.

**Means Something**

No longer will the layman who wants to buy a tube or a set of tubes have to listen to the man behind the counter proclaim in seemingly unanswerable terms the value of mutual condens, amplification constant, plate impedance and whatnot, which really mean nothing to either. The meter can tell—in one syllable—how good the tubes are.

**THE ADELMAN UNIVERSAL TESTER OPENED UP AND READY FOR USE.**

A type 112 amperite has been incorporated in the circuit. This is used to provide the proper amount of filament current when testing the type 112 and -71 tubes. Naturally, the rheostat arm is turned to its maximum position, so that no current will traverse the resistance wire. Otherwise, one-half ampere through the wire may burn it out.

The experienced trouble shooter, merely by listening to the perfect reproduction of a defective radio receiver, sometimes can tell the cause of trouble. But often he cannot tell until he tries the first thing, then another. Or again, if the tubes don’t light, or there is no sound in the reproducer, or one of the thousand and one possibilities of trouble manifests itself, the Universal Tester finds immediate use and renders invaluable service, where it would be a matter of guess-work otherwise. And wise service men don’t guess.

A systematic method of procedure in testing a radio circuit is always the best, and, regardless of the type of circuit, the same general idea should be carried out.

**Continuity Test**

Test the windings for a ground and for interconnection between them. A continuity tester facilitates this test, for it takes longer to describe than to make the test.

All the fixed condensers, grid, by-pass and filter should be tested for leakage, for shorts and grounds. If a sudden but very slight deflection is noted when testing fixed condensers, it should be guessed that the phenomenon is merely the condenser charge.

The direct current resistance of radio frequency inductances is practically negligible, hence the meter will read full scale only when the primary and secondary of these units are unbroken and there is no resistance, for a mechanical accident is no doubt responsible for an electrical discrepancy.

**Shorts and Opens**

Connect an A battery or, if not available, the source of an A battery voltage used by the receiver, to the A terminals of the meter. Then gradually turn the rheostat lead and momentarily touch the long flexible wire leads together. If a full scale deflection is obtained, then everything is all right. Remember that test, for shorts reflection means six (6) milliamperes through the meter. Quite sensitive, and effective for all practical purposes.

The audio frequency transformers should be tested first. The primary and secondary readings are taken. Comparing these readings it will be possible to obtain in a fair manner the ratio of the transformer assuming the same size lead is used for each, which is usual. If a full-scale deflection is obtained, then the winding—primary or secondary—may be shown to be open or to be more or less an open circuit. It is possible that the leads from the transformer are touching, or else, a fixed condenser across the winding may be defective.

**The Solder Problem**

One of the most troublesome sources of difficulty is the solder. Sometimes it is very often appears to be a perfect connection but is in reality a high resistance contact. The trouble here may arise from very hard to remedy, especially when the joints are overlooked in the hasty visual inspection given elsewhere.

There can be no doubt as to the efficacy of the meter test, but the human element plays an important part in determining what seems to all the radio set.

**Service Man’s Tasks**

Before taking the set out of its cabinet, see that the antenna and ground connections are good. Also, test the current supply voltages at the binding posts on the receiver itself, to insure whether trouble is being experienced from broken leads. When these precautionary tests have failed to coax the set into operation, and further maladroit comment is of no avail, take the chassis gently out of its cabinet.

To the man who knows radio, all sets are not alike. This means that what is necessary for alignment for one type of set does not at all common to another. Thus, give the set a thorough visual inspection to see that there are no broken lead or loose connections. See to it that the variable condenser plates do not touch at any time during the operation of the set. The plates are evenly and uniformly centered over the entire range. Remove all dust. Visual inspection is to locate mechanical trouble in a radio set. Even a short-circuit is classed under this heading, for a mechanical accident is no doubt responsible for an electrical discrepancy.

December 17, 1927
Weak Sets Strengthened

By Paul R. French

THERE are thousands of receivers in use which do not give satisfactory service because they have not been designed for present conditions. Many of these are designed for use with a high outdoor antenna and with a great deal of regeneration. These are usually not sensitive enough nor sufficiently tuning range of regeneration used, and if they are used on short antennas they are selective enough but lack volume. Some of these receivers work very well in one home but fail utterly when moved to another.

For example, one such receiver gave good results on an indoor antenna when connected to the third floor of a stone building, where there was little interference. When it was moved to the first floor of the same building and connected to a similar indoor antenna it failed to bring in any stations but one which was only a few blocks away. In this case the disadvantage was mainly due to countless other antennas all around the receiver.

It is better Higher Up

When this receiver was moved up one flight in the same concrete building and connected to an indoor antenna exactly like the one that failed on the first floor, it brought in all the local stations with fair volume. But reception was not satisfactory because too much regeneration had to be used on the more delicate stations. More straight radio frequency amplification had to be introduced into the receiver before reception would be satisfactory in that location, or else an outdoor antenna had to be erected.

Neither an outdoor antenna nor another method of regeneration because of the inconvenience which they would introduce. Hence a radio frequency amplifier was added in the manner shown in Fig. 1.

The connection between G and A was first cut and G was connected to the 45 volt tap on the plate voltage supply. The antenna terminal on this coil was connected to the plate of the added tube and the antenna binding post was joined to the grid of the new tube. An anode 1A was made in the negative leg of the filament to control the heating current.

The resistor R should have a high value—1 megohm or over—because the volume is greater when it is not used at all. The only object of using it is to prevent the possibility of grid blooming. Since the signal level is at this point is very low and since the antenna has some leakage to ground, the probability of blooming is small, and a very high value of leak can be used.

Great Increase in Volume

By this arrangement the volume was increased by a factor of 5 or 6, a sufficient gain to give satisfactory reception on all local stations without the use of any regeneration. In one case it was found impossible to throw away with the volume control.

The circuit became more selective, for the same amount of regeneration, than it was before, because the antenna was no longer a part of the primary circuit of the first R.F. transformer. The tuning did not become any more difficult since no extra tuner was added.

An attempt was made to employ a loop in the grid circuit of the added tube and to tune this with an external condenser. The result of this was that the volume boosted to a satisfactory level by the addition of an untuned stage as shown in this drawing. The added stage is enclosed in the dotted lines.

If the volume is not great enough in your set, it can be increased to a satisfactory level by the addition of an untuned stage as shown in this drawing. The added stage is enclosed in the dotted lines.

High Mu Tubes as Detectors

By John Murray Barron

Contributing Editor

The subject of high mu tubes is so important and so wide in its scope that it deserves a special and complete treatise. But we shall not undertake such a pretentious discussion at this time. It will be enough to indicate why a high mu tube is a better detector than a low mu tube, and under what conditions advantage can be taken of the greater detection efficiency.

It has been shown mathematically, and the theory has been verified experimentally, that high mu tubes are more effective detectors than are low mu tubes. Thus E. L. Chaffee in a paper in Proc. I. R. E. for November, 1927 calculates the voltage detection coefficient of various tubes and shows a circuit whereby the coefficient can be measured accurately. He gives experimental curves which closely check the theory, between the voltage detection coefficient and the effective grid bias.

The curves show that for maximum detecting efficiency the effective grid voltage is rather critical, both for plate circuit rectification (grid bias detection) and for grid circuit detection (with grid condenser and leak). For both types of detection, experiment and theory show that the high mu tube is superior to the low mu tube in detecting efficiency.

It is also shown that, contrary to general experience and belief, the negative bias method of detection is effectively superior to the grid leak and condenser method. This comparison was made with both methods adjusted to a maximum detecting efficiency and with due regard to the decrease in the detector input voltage due to the flow of grid current when the grid leak and condenser method is used.

It is definitely shown by the curves for both methods of detection that the high mu tube is greatly superior. But the greater voltage detection coefficient of a high mu tube is not always made use of in a circuit. To take full advantage of it the load impedance on the tube must be high. This fact can be readily demonstrated in receivers, particularly in a super-heterodyne receiver. Insert a high mu tube in the first detector socket. The volume goes up a little as compared with the volume of a UX-201A tube.

Then put a high mu tube in the final detector socket in place of a general purpose tube. The volume shoots away up. The difference is due to the fact that the impedance of the audio transformer connected to the second detector is much higher than the impedance of the first intermediate transformer. The difference is not always so great because the intermediate frequency is high and it does not require much inductance to make a high impedance. But the volume goes up in both cases.

The greater detecting efficiency of the high mu tube is particularly noticeable when the coupling between the detector tube and the first audio amplifier is a high resistance. The gain in volume is very great.

In making the test suggested above be sure that the tube used is high mu in fact and not merely by assumption. We have tested some tubes supposed to have a high amplification constant which did not amplify as much as a general purpose tube of mu 8 when used under conditions favoring the high mu tube. Make sure of the constant of a tube by substituting it in a resistance or impedance coupled stage in which a tube of known high mu has been operating. Increase in volume shows that the mu of the tube is high.
Now Push-Pull Stages a

By J. E. Anderson
Technical Editor

On some sides one hears surprised comment that push-pull amplification should have staged a comeback. Why did it pass out of vogue if it was as good as claimed to be, and why is it now coming back if it did not satisfy the public taste when it was with us before? These are some of the pertinent questions tossed about.

The ebb and flow in the popularity of push-pull have many underlying causes. The promise of unexcelled tone quality and high volume attracted many to the push-pull a few years ago. The lack of fulfillment of the promise turned most of them away from the system. The distortion actually met in the push-pull amplifiers and the depression in volume turned still others away from it. The high cost of getting the distorted signals also turned some away.

And all that deserted the push-pull were attracted to other forms of amplification which held out more desirable qualities at a lower cost. Some of these systems of amplification were resistance, impedance, and double impedance coupled systems of amplification.

Some of these were attracted to other forms of amplification which held out more desirable qualities at a lower cost. The distor tion actually met in the push-pull amplifiers and the depression in volume turned still others away from the system. The high cost of getting the distorted signals also turned away from the system.

Push-pull all the even harmonics introduced by the tubes are balanced out, or nearly so. The odd harmonics are not. If anything, they are accentuated a bit. The signal desired is made up of many harmonics, odds and evens. But these evens are not balanced out by the push-pull stage. When the signal reaches the grid circuit of the push-pull stage every component, odd or even harmonic, becomes the first harmonic as far as the final stage is concerned. If the stage is faithful, all the components come through in just the same proportion they went in. No additional harmonics are introduced.

Harmonics Appear

But in every practical case some harmonics are introduced by the last stage. Each tube introduces all the harmonics there are. Suppose a pure tone goes into the grid circuit of the push-pull stage. In the plate circuit of each tube the harmonics of this tone appear. The first few are strong. Only the first harmonic is desired.

Now if the push-pull stage is really well balanced all the harmonics in one tube are balanced by the even harmonics in the other tube. None appears across the terminals of the output transformer, or in the secondary of that transformer.

The Output Is Increased

But the odd harmonics are not balanced out, because they act in opposite directions. One tube pushes the odd harmonic currents around the output circuit and the other pulls them around in the same direction. In other words, the effects add up for the odd harmonics.

The total input voltage was divided equally between the two tubes; in the plate circuit they are added again. But only the odd harmonics are added, the evens are bucking each other.

Accurate Balance Is Necessary

In wiring up a stage of push-pull it is not sufficient to use commercial units and rated values haphazardly. The actual values are not the same as the rated values. Commercial units with the same designation are not identical. To take full advantage of the push-pull system they must be identical. The plate, grid and filament voltages on the two tubes must be the same. The input voltages to the two grids must have the same value. The tubes themselves must be as nearly identical as it is possible to find them.

If the two sides of the symmetrical amplifier are not equal, the even harmonics will not be completely eliminated. But it is not difficult to build a push-pull amplifier in which the sum of the odd harmonic currents is small as compared to the sum of the odd high-frequency currents, that means a considerable improvement.

It has been stated that if a vacuum tube is operated at the proper point on the grid voltage, plate current characteristic, and the even harmonics will be generated.
Phenomenal Comeback—Why

A push-pull circuit illustrating how disturbances in the power supply are balanced out. The arrows indicate the direction of the changes in the currents or the potentials due to a disturbance. Note that the current arrows in the two halves of the primary of the output transformer are in opposite directions. Hence the disturbance does not appear in the secondary. It makes no difference whether the disturbance appears in Ec, in Eb or in Ea.

Some Hints on AC Tubes; Don’t Use Bias Detection

(From E. T. Cunningham, Inc.)

To compete successfully with battery receivers it is essential that sets employing AC filament tubes compare favorably with the battery operated tubes in all important operation characteristics including tone quality, volume, sensitivity and selectivity and in freedom from hum, power line disturbance and service troubles.

With respect to tone quality and volume the AC filament supply does not introduce any new problems so far as the output tube alone is concerned, since type CX-371 or CX-112 will give the same performance in the output stage whether the filaments are operated from battery supply or from alternating current. The tone quality may be affected by other factors such as the presence of hum, a subject which will be discussed below.

The sensitivity and selectivity of the radio frequency stages is essentially the same with CX-326 tubes as with type CX-301A tubes. The higher mutual conductance of the AC tube is partly offset by the necessity for using a grid bias.

When type C-327 is used, grid leak detection is practical so that equal detector sensitivity as compared with high operated receivers is obtained. When it is necessary to use grid bias detection the AC operated receivers is at a disadvantage because the sensitivity is greatly reduced. This latter method of detection gives only about 20 per cent of the audio volume given by the grid leak method.

With respect to the freedom from hum, the combination of CX-326 tubes for the amplifiers, the C-125 for the detector and the CX-371 or CX-112 for the output affords very satisfactory results if the proper precautions with respect to the circuit design are followed.

To obtain freedom from line disturbances precautions must be taken to prevent the direct pick-up of line disturbances by the tubes and associated equipment. Power transformers should be shielded if placed inside the cabinet with the receiver; and an electrostatic shield between the primary and secondary windings of the transformers is also necessary.

The rugged design of both types of AC tubes insures freedom from service troubles as far as the tubes themselves are concerned.

In accomplishing the elimination of all batteries and devices requiring corrosive liquids the possibility of corroded connections disappears and it is evident that with proper care in circuit design, and the use of high grade materials and parts, a greater measure of freedom from service troubles can be secured than has been possible with previous designs.

With respect to the cost and bulk of components this combination of AC tubes is particularly satisfactory since the use of a heavy A filter system or A supply unit is avoided.

Instead the only accessory required by the AC tube is a few extra turns of wire on the B eliminator transformer or a small separate transformer to supply the low voltage AC for the filaments.
For those who have a radio receiver with the 12 volt plate supply, the constructor believes gives good tonal reproduction and plenty of volume, but who wish to improve the quality of reproduction, and for the fan not satisfied with reception as now obtained, due to his audio amplifier stages overloading or distorting, the G. R. Push-Pull Amplifier and Power Supply was designed. It has many desirable features. These include simplicity, compactness and small cost.

Push pull amplification is used. By this means two power tubes in the last stage permit far more distortionless amplification than the usual standard method of employing one tube in this stage, or by connecting two tubes in parallel. The tubes in push-pull are connected so that their power outputs are added. However, the fan must remember that while connecting the tubes in such a manner does not increase the signal strength, it does allow a greater input without delivering a distorted signal at its output.

How Quality Is Improved

Distortion in the last stage of an amplifier is usually caused by impressing on the grid of the last tube a voltage high enough to make the grid positive, thereby making the tube rectify, instead of amplify. That distorts the wave form. By using the push-pull method of amplification, the grid voltage swing resulting from the impressed signal is divided between the two tubes. This is done by center tapping the secondary winding of a transformer (second stage) and bringing this center to the required grid bias, while the two outside ends connect to the respective grids.

Another desirable advantage of this type of amplifier is that when using alternating current for filament supply, but voltages cancel out to a great extent and make the amplifier itself quiet in operation.

The unit to be described is intended to be used with the CX-371 or UX-171 power tube, CX-112 or UX-112 or the CX-171 or UX-171. It is possible to use the UX-226 or CX-326 type of tube.

The Transformer

In the completed unit is a power transformer with three windings—the primary, which is to connect to the 110 volt AC mains, a secondary, delivering 7.5 volts to operate the filaments of the power tubes, stepped down to 5 volts if necessary, by inserting a 3 ohm fixed resistor in series with the filaments, and a high voltage winding tapped at center and delivering 225 volts on each side of center.

After the transformer steps up the voltage and current to the required value these must be converted to direct current and voltage, which is done by the 85 milliampere rectifier tube. From the tube the current passes on to the filter system, composed of two high inductance choke coils, both in one container, and several large capacity condensers, in one unit.

After the voltage is filtered and is suitable for receiver operation, it is divided into lower values so that each relative portion of the receiver can get the correct value. This is done by connecting a series of variable and fixed resistances across the output. The variable resistors are used for adjustment of these voltages assuring the maximum of satisfactory operation. Another small bank of fixed resistances give us several grid bias voltages that may be required by the receiver. The C bias for the power tubes is obtained from a 6,000 volt variable resistance placed in the return of these tubes and by manipulating this, the C voltage may be varied from 9 to 45.

The 441 Already Assembled

The push-pull amplifier is purchased in complete form. This is on a metal baseboard and contains the tapped input transformer, the two sockets for the 711 or -712 and -26 type of tubes, a 1.5 ohm variable filament rheostat and a center tapped across the filament terminals. The unit is completely wired and the connections to it are made through the binding posts on the base. The complete unit may be placed away from the set and can be concealed in a cabinet.

First procure a wooden board measuring about 9 by 17 and about 1/4 inch thick. Plastic rubber or felt pads are provided in each socket to 100 to 200 to scratch and polished surface. Better still, the parts can be mounted on a Micarta 3/16 inch panel measuring about 9 x 11. One can place the support strips along the edges. This enables the fan to do some of the wiring beneath the panel.

On the extreme right hand side of the baseboard, mount the push-pull amplifier unit. The binding posts should face the left side of the board. To the left of this, leaving about ½ inch of space, mount the choke coil unit. This is to be placed in back and should have its terminals facing away from the amplifiers.

In front of the choke coil unit and to

List of Parts

1. L1, L2—One General Radio type 366 Filter Choke.
2. T—One General Radio type 365 Rectifier Transformer.
3. P. P. 6,000, 6,000 ohm Potentiometer.
4. One Polymet No. F 1,000 volt Condenser.
5. One General Radio Buffer Condenser, Type C (1 mfd. and 1 mfd.).
7. R1, R2—Two Centralab F. P. 6,000, 6,000 ohm Fixed Resistor, 3,464 ohms.
10. Eight Eby Binding Posts, marked (See Text).
11. R6—One 330 ohm Fixed Resistor (De jure).
12. One General Radio Type 441 Push-Pull Amplifier, already wired.
13. One Sterling R1, 300 Voltmeter.
14. Two rolls Corwico Braidite (1 red, 1 black). A.
15. One Bottle Silva Flux.
16. One Box Silva Solder.

Use of Two Colors

Flexible Braidite wire is used throughout to wire the unit. The constructor will follow a good plan if he uses the Braidite wire in two colors, such as red and black, and uses red wire for all high voltage leads and the black wire for all the low voltage leads. This will make it easy to check the completed unit. The fan must be careful and see that all joints are correctly soldered. We used a soldering fluid and solder that
Amplifier and Power Supply

seemed to make the task much easier. We noticed that the iron would not clog and that the joints were quite strong and electrically good.

From the 7.5 volt AC winding of the power transformer run two wires twisted together to the A-, A plus terminals of the amplifier. The 3 ohm fixed resistor is placed in series with the A plus post. The twisted wires can be tacked along the edge of the board.

When wiring the rest of the unit, the fan should remember first to study the layout and mentally place where the different leads are to be run. This way he can be sure that the wires will be short and the completed unit will look neat.

The binding posts on the strip are marked and from left to right read, B Neg., B45, B67, B90, B135, Cl, C2, C3.

Voltmeters

When the unit is completed connect to the house current and insert the rectifier and power tubes. Before connecting to receiver, with a 0-300 volt high resistance voltmeter, the negative lead of which is connected to the B-post, connect the positive end to the 45 volt post and adjust the control of R1 until the voltage reads about 60 volts. Do the same at the other B terminals and set them to a value about 20 volts over the marked voltage.

An 0-10 volt AC voltmeter will come in handy to check the terminals voltage of the filaments of the power tubes. This should be kept at 5 volts.

As Hatry Sees It

A jibe is directed at the writers of advertisements for the new AC radio receiving sets, by L. W. Hatry, in the Hartford, (Conn.) Times. Mr. Hatry be-

moans the fact that the advertisements convey the idea that the AC set is a sort of magic box, containing nothing more than a few tubes and a little wire, which miraculously extracts concerts and anything imaginable out of the ether, by way of a wall plug. This despite the fact that the AC operated set is fundamentally no different than any other set.

He says some ad writer could have poetically expressed it:

A book of calls underneath the set. A light-socket, a tube or two—and yet, Bride me singing to the neighborhood, Is KFI. That's paradise, I bet!

It might seem strange, at first thought, that he should use the call letters of KFI, but not when it is realized that the powerful western station is tuned in almost at will from coast to coast, and has become the favorite DX station in the country.

Caldwell Explains Change

The recent shaking up of the stations in the 600-1000 kilocycle band was not made for the sole purpose of bettering distance reception, stressed Orestes H. Caldwell, Federal Radio Commissioner, in a recent statement. Instead, it was made for the improvement of reception of local stations and to provide more stations to the listeners in, especially persons living in rural districts.
By Thomas F. Meagher

ALL who will read this article are not troubled with the one bad disadvantage that I am saddled with, for I live in a hot bed of local stations. My home is in Glendale, in New York City. I haven't anything up my sleeve nor do I carry any confederates, I tell the street and house number—765 75th street, Glendale, N. Y. City, but even in this hobbled I can do tricks with my radio set. To begin at the beginning.

For the past four years or more, fans who live in New York City have been able to attend one or more radio shows a year where they can feast their eyes upon many radio sets and parlor ideas and learn where and how and on what they can spend some more money.

I visited New York's show, this year, as usual, in search of something new, and something else, that certain something for which my DX heart yearned. I did not want to sit up half of the night to get far-distant stations.

Meets the Magnaformer

After casting about for something new I ran across some Magnaformer 9-8 descriptive literature. I was (to state it my way) again on the road to being burnt with a 1928 model radio circuit. I was told I couldn't get burnt, that this circuit would do this and that and the only thing it couldn't do was get two stations at once.

Now, when I left that show I was so sold on Magnaformer that, after collecting every piece of printed matter I could lay my hands on during four hours, I found I had left all the circulars in some display booth. I felt that I had lost everything. But Magnaformer stayed in my head.

For the next few days I kept saying to myself: "Wait. Take your time. Don't rush." But even when I got into a radio store to buy some equipment I heard: "My Magnaformer this," and "My Magnaformer that." Magnaformer was singing in my ears. Every radio magazine printed articles on it. Magnaformer worked on me like a drug. Well, I terminated the old search and bought the Commander—Chief of the set.

The first literature and demonstration of the transformers were in a reading of a part of "Brewster's Millions." I read this by myself and then collected it.

The set is really acrobatic. Friends come in and suggest facts they scarcely deem possible, but my Magnaformer, like the good performer it is, performs. Folks visiting me think it is a 1928 edition of Aladdin's Lamp. First you rub it, then you wish and then collect.

Built His Share

I've built many radio sets, all the way, beginning with Frank Tinsley's set, up to this, but this is the only one that packs the three essentials necessary into a he-man's set. And there are selectivity, quality and volume. When I think of them I am again reminded of "Brewster's Millions." I will try to amass each essential separately.

I live three-quarters of a mile from WABC; WRL is about a mile away; WBOQ, Woodside, is about half a mile away; WWRL is less than that distance off. WMJZ is a mile away and WMIC two miles away. Then there are stations in Shingling and Long Island City, two or three miles away. Four or five miles are all that separate me from certain stations on Manhattan Island.

In my home I have four other sets. One is a 4 tube, one a 5 tube and the other a 6 tube.

But any and of all of them on an outdoor antenna won't do what my Magnaformer 9-8 will do on a loop!

Gets In Between

Now, keep in mind that with stations WNYC, WEAF, WWJ and WFIL working, I can get WOO or WIP, both Philadelphia; WNYC and WEAF both working, I can go between WOR and WRC, WSB or KRLD, Fort Worth. Next I go between WOR and WJZ and then you 'wish, and then collect.

The author decided to build a certain receiver, and here you see him soldering the last joint before "hooking her up."

Herewith is another radioist's report on the Magnaformer 9-8. Thomas F. Meagher's report is absolutely accurate and has been verified by Radio World. Last week a seven-page article on the construction of the receiver, with a report on experiences also, was published. It was "My Three Months With the Magnaformer 9-8," by J. E. Anderson, Technical Editor.
The author, a DX Hound, lives within three-quarters of a mile of the WABC Transmitter. He listens with delight to programs from that station, but when the DX urge comes upon him, what would he do? Did he not have a Super-Selective Receiver, one that could tune out a neighboring station of 2,500 watts power to bring in channel neighbors from remote distances? The photograph shows the transmitting plant of WABC.

The circuit as a whole has been tried and proved. The intermediate frequency coils—the Magnaformers—are the heart of the circuit. The Magnaformers are really the result of years work on the part of the best engineers. The results of their work stand out like a national hero.

Difference of opinion will always arise here on volume and quality because ears are like radio tubes. No two pair of them are exactly alike. I think you will agree with me that the quality and volume certainly are not anything to snicker at. No two pair of them are exactly alike. The same holds true for the WOR chain and WSM with WEAF programs are just as loud and with the program you must take a different point on the oscillator dial.

One thing that makes the construction especially simple is that the official diagram is printed in X-ray form. When looking at the under side of the sub-panel diagram all the parts physically mounted there are shown in full lines, as are all the parts which are not concealed by the sub-panel.

Tips on Soldering

It is strongly advised that all the connections which are not securely fastened with nuts be soldered, and soldered well. It is not sufficient to touch the bare wire terminal to the soldering lug and then expect a little solder to hold the two together.

Strip the insulation of the connecting wire far enough that it can be wrapped around the terminal lug, and then flow the solder around the hole.

Will Try for Japan

In conclusion let me promise you that sometime when I get caught up on my sleep I will sit up long enough to try for JOAR Japan.
TIME WAS WHEN RADIO CHRISTMAS GIFTS COULD BE HUNG ON THE TREE. NOT SO TODAY, WITH EVEN REPRODUCERS BEING OF GENEROUS SIZE AND WEIGHT. FANCY A POWER PACK DANGLING FROM THE TOPMOST LIMB!

How to Read Time Signals As Sent by Arlington

By W. A. Schudt

The Arlington Time Signal Service sent out daily by the United States Government through the medium of the powerful Naval radio station, NAA, at Arlington, Va., is the most accurate check on time that can be had. However, the fact that these time signals are transmitted on a frequency of 112 kilocycles makes their reception impossible on the average broadcast radio receiver.

Realizing the great demand for an accurate check on time, some few years back, when radio broadcasting was very young, A. H. Grebe & Co. conceived the idea of rebroadcasting these signals on a wavelength within the broadcast band. At that time the new service was started over WAHG, later, to be continued on WABC and WBOQ of the Atlantic Broadcasting Corporation. At present many thousands of radio fans, ship radio operators and amateurs tune to either WABC or WBOQ daily to correct their timepieces.

The Naval station at Arlington has a distinctive and characteristic system of time signal broadcasting.

Time signals are transmitted twice daily, beginning at 11:55 A.M. and 9:55 P.M., Eastern Standard Time, and consist of a group of dots each transmitted to represent the length of one second.

The string of audible dots begins at precisely 9:55 P.M. and 11:55 A.M., ticking off the seconds until the 28th is transmitted. At this point there is a silence for a duration of one second following which the string of dots again starts, entering the second half of the first minute. Dots are transmitted at intervals of one second until the fifty-fifth second is sent. Following this there is a five second stop before the second minute is transmitted. The next three minutes are sent out in exactly the same manner as the first, just described.

So it is seen that the last five seconds in each of the first four minutes preceding the hour is silent.

The last minute is sent by the same system except that there is a ten second stop just before the dash, which represents the hour, is transmitted. This dash is exactly three seconds in length.

The beginning of the last dash occurs at exactly 12:00 noon or 10:00 P.M. Eastern Standard Time.

In the operating room of WABC at Richmond Hill, New York, a receiver capable of receiving the wavelength on which the Arlington station is transmitting was installed for the sole purpose of time signal reception. The receiver at all times is kept tuned to 112 kilocycles.

The output of the receiver, which under ordinary conditions would be connected to a loudspeaking device or a pair of telephones, is connected through a small transformer to the input amplifier of the powerful WABC transmitter, where it is sent out on 970 kilocycles (300.1 meters).

Thousands of persons set their clocks by the retransmitted signals.
WLWL LOCATES IN MARSHES AND USES 5,000 WATTS

WLWL, PAULIST FATHERS' STATION, HAS OBTAINED PERMISSION FROM THE FEDERAL RADIO COMMISSION TO USE 5,000 WATTS. THE TRANSMITTER IS IN ARLINGTON, N. J. AT THE LEFT WE SEE ELECTRICIANS INSTALLING THE POWER LINES ON PERMANENT SUPPORTS BECAUSE THE LAND IS MARSHY. CENTER PHOTOGRAPH SHOWS THIS, WITH MAINS IN BACKGROUND. ONE OF THE HUGE BASES WHICH SUPPORT THE MASSIVE ANTENNA MASTS IS SHOWN ALSO. AT RIGHT IS THE TRANSMITTER, WITH AERIAL PLAINLY VISIBLE. THE NEW TRANSMITTER IS NOW IN USE.

Senator Couzens Suggests Board of Communication

Washington.

Senator Couzens (Rep.), of Michigan, member of the Senate Committee on Interstate Commerce, announced that he will introduce a bill proposing the creation of a Communications Commission having jurisdiction over radio communications, telephone, telegraph, and cables.

The Senator declared it is his belief that the regulation of radio by one body and of the telephone by another, as at present, is an inefficient method, particularly so in view of the interrelation between the two means of communication in the case of nation-wide hookups involving the use of both the telephone and radio.

WHEN DETECTOR BLOCKS

A high shriek in the loudspeaker is usually caused by blocking of the detector grid. It is caused by too great bias to the detector, and it may be due to the signal or to an oscillation at radio frequency. The cure is to stop the oscillation, reduce the amplification at radio frequency, or to put in a grid leak with a higher conductance, that is, a lower resistance.

GRID LEAK FUNCTION

Grid leaks permit excess electrons to escape, hence prevent detector tube block-

A POWER AMPLIFIER AND B SUPPLY, WITH PHONOGRAPic PIPUP[PHONOVOX] INTRODUCED IN A SPECIAL WAY. HAS BEEN DEVELOPED BY LOUIS G. PACENT. AN ADVANCE VIEW OF THE EXTERIOR IS SHOWN. SOON THE CONSTRUCTION WILL BE DESCRIBED. THE TUBES USED ARE ONE 281 (RECTIFIER) ONE 227 OR KELLOGG OR MCCULLOUGH, AND ONE 210. IT IS ESPECIALLY ADAPTABLE FOR HOUSING IN PHONOGRAPHs.
A Thought for the Week

BURGLARY was committed. The housebreaker had a forty minute start of the police in Kansas City. A description of him was broadcast. Twenty minutes after his description had been sent out, he was reeling, quite unhappily, in the arms of two lucky policemen.

O, Sherlock Holmes is thy prototype! O, facetious club, where is thy sting!

Sixth Year

Radio World

The First and Only National Radio Weekly

Radio World's Slogan: "A radio set for every home."

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Carlin and McNamie
Pick Football Team

Phillips Carlin and Graham McNamie, football announcers for stations WAVE and WJZ, have selected all-Eastern football team, based on their observations at the games which they have announced. The selected men are: Eben, Scott, Yale; and Bost, Army, tackles, Pratt, Harvard, and Sprague, Army; guards, Webster, Yale, and Hammack, Army; center, Charlestown, Yale; quarterbacks, Barrack, Princeton halfbacks, Caldwell, Yale, and Flanagan and Notre Dame, and fullback Wittmer, Princeton.

Once a Year—or Perennial?

Christmas is coming again. Yes, its Spirit once more envelops us in its atmosphere of peace and goodwill. I have been told that it had or as good as we, we take on new life and meaning. All of which is a nice way of commencing an editorial on Christmas. Radio World has asked me to do a piece about Christmas. They want me to wait to you to enjoy a right smart merry Yuletide.

I'm supposed to write something that will delight you as much, as much as a certain little red automobile is delighting a little youngster, who is walking up and down the sidewalk across the street from the window of my office. I'm sitting here in the window, playing with this typewriter. Really. I can look out over the avenue and see that little kid, with his little red auto. Lucky devil.

I'll bet he isn't a day over six years old. Certainly he doesn't look older than that, as he drags his little toy across the pavement. See, he smiles at everybody. Some of them smile back at him. Some of them don't. Anyway, it's nothing in my life, because I'm writing an editorial for Radio World.

Spirit the Year 'Round

At least they expect me to devote this space to telling you, and you, and all that this talk about Christmas coming, but once a year is the bank. They mean it's the bank if you own a radio set. I'm supposed to pass along to you the thought, that long after the red berries have fallen from the holy wreaths, the Christmas Spirit will still be with those who have made it a radio Christmas for others. Give your pa or your ma or your sister or your nieces a radio set for Christmas—that's the idea.

What'll you use for money?

Ho, hum. That little kid across the street is hanging around a big hole that leads down and down and down into the earth. Some guy is digging a huge tube or tunnel under Eighth Avenue. Yeah, it's a subway. Boy! That's the place to be in when you're loaded to the muzzle with Christmas bundles! I mean, down in the subway. Try to picture yourself down there trying to train through the door with a Christmas tree! You squirm this way and that way, all the time edging the tree further and further into the car. Suddenly your Christmas bonnet pokes some guy in the eye—be nonchalant. Light a cigarette, the cigarette, mild and mellow, the finest you've ever smoked, some guy in the eye and that way, and that way, and there the time edging the tree further and further into the car. Christmas bundles!

DX as Near as Your Dials

Three hundred and sixty-five days—not one day only—can be devoted to good cheer, good humor, warm glow, and perfect radio reception if you build or buy a set before December 25. Receiving conditions were never so good as right now. Air is full of wonderful things you should not miss. DX is no farther away than your dials. Without a thought edging the tree further and further into the car. DX is no farther away than your dials.

A three tube set, a four, five or twenty. What's the difference at Christmastide? So long as it is a set. Again that kid, how he's leaning over the vestibule! Some guy ought to grab him by the collar. The unconstrained, natural ease in the manner of the man of good breeding. He never seems to feel uncomfortable, right-fitting, easy-to-grasp collar—some one should pull that kid away from that subway entrance. There someone did pull him away. His mother. He's crying now. Some guy ought to grab him by the collar. The unconstrained, natural ease in the manner of the man of good breeding. He never seems to feel uncomfortable, right-fitting, easy-to-grasp collar—some one should pull that kid away from that.

It's one Christmas gift that lasts—one that says "Merry Christmas" on December 25 and means it, and conveys that cheery message throughout the fifty-two weeks of the year. A Christmas Gift Subscription to Radio World, even for one year—even to only one of your friends—will carry it all the gaiety, happiness, cheerfulness and glow for which Christmas stands.

RADIO WORLD, even for one year, is a Christmas gift for you. It's one Christmas gift that lasts—one that says "Merry Christmas" on December 25 and means it, and conveys that cheery message throughout the fifty-two weeks of the year.

A Christmas Gift Subscription to Radio World, even for one year—even to only one of your friends—will carry it all the gaiety, happiness, cheerfulness and glow for which Christmas stands.
Gifts Well Worth Receiving
But That Can’t Be Brought In On Any Set
By Cassem Drielba

If it were not for the ordeal of selecting appropriate gifts for family and relatives, Christmas would be 100% happy. But "What shall we get for him or her?" is an annually recurring question which must be answered before the Christmas cheer is complete.

This ordeal will be lightened just a bit by including radio parts and accessories in the list of possible gifts. There are hundreds of pieces of radio merchandise which are appropriate gifts to every member of the family, or to the family as a whole, gifts which are useful or ornamental or both.

Not Sentimental

There is not much sentiment in a vacuum tube, but certainly it would make a useful gift. If that tube were accompanied with a change in the circuit which would improve the quality and increase the quality it would be much more useful and welcome. A set of frequency transformers of the latest and best design, if properly installed in an old receiver, would constitute a splendid gift and a welcome one. Similarly, a resistance compensator or correct design would make a welcome gift, provided the donor would also see that it was in proper working condition.

A good B battery eliminator would constitute a suitable gift to a family living in an AC neighborhood and which did not have that modern accessory. But the gift would not be welcome unless the giver saw to it personally that the eliminator worked perfectly with the receiver for which it was intended. If the family already has an eliminator, a replacement rectifier tube would be suitable and useful.

Welcome Speaker

A loudspeaker of the best type would be most welcome, particularly if that speaker is doing duty in a moving train. But the gift would have to exercise his judgment as to the suitability of the speaker for the set it was intended for. The best speaker will not be welcome if it is connected to an ancient receiver.

A complete radio installation is a dandy gift, especially if any part of it is home made. Any troubles with that receiver would be blamed on the giver and not on the manufacturer or the operator of the set. Make such a gift if you pretend to know anything at all about radio, or if the beneficiaries think you know something. That gift would make you a steady service man.

If you know the family which you would remember with a Christmas gift has a radio receiver but not a suitable table for it, that would be a useful and appropriate gift. Similarly, a cabinet for a poorly housed receiver would make a useful gift, if it could be given diplomatically.

Filter Suggested

A tone filter enabling the beneficiary to employ a power tube for greatly amplified volume and improved tone quality would be welcomed in most homes, especially if the giver attended to the necessary alterations in the receiver. Just as a tone filter is useful so is a ripple filter when the family is troubled from ripple noises in his receiver. This filter may constitute a single condenser of large capacity, or a combination of high inductance, or a combination of the two, or a combination of several choques and several condensers. Whatever the giver thinks will remedy the trouble he knows to exist in the home of the object of the Christmas spirit is a suitable gift.

Ah! Those Meters

Every man or boy will no doubt welcome measuring equipment—a voltmeter for measuring the filament voltage, a high resistance voltmeter for measuring the output of a battery eliminator, a DC milliammeter for measuring plate current, an AC voltmeter or ammeter for measuring the voltages and currents in AC filaments and heaters—anyone of these would put the recipient in a merry mood that would last indefinitely. That he would most welcome is obvious from the fact that nearly everybody who tinkers with a radio set or an eliminator is continually saying "I wish I had a meter."

Reception on Trains

Prophecies by Hiler

Why should an individual enroute from one point to another and traveling by train be without his evening radio entertainment? Football reports, musical concerts, etc., are of as much interest to the individual when traveling, as when at home. Perhaps even more so, to relieve the monotony of a long and tedious journey.

Experiments are now being carried out to perfect the installations for use on trains, according to E. E. Hiler, the inventor of the tuned double impedance system of audio amplification.

"We are in the experimenting," says Mr. Hiler, of the Eiler Audio Corporation, "in the experimental work and have completed several installations tuned double impedance audio amplification on railroad trains. The time is not distant when every through limited train will carry a radio installation in every passenger car, and even every compartment will be individually equipped.

"With the large number of broadcasting stations in operation and the high powered transmission, a moving train is always within the zone of some good broadcasting station and very satisfactory reception is available."

Farmer Badly Needs Good Radio, says Pickard

There is no reason why the farmer and the small town listener-in should not get the same service as his city brother. According to Sam Pickard, member of the Federal Radio Commission.

"The business centers and densely populated districts where many stations are located, listeners get good service," Pickard stated. "Outside the larger cities, however, where distant stations must be relied on, particularly in the Middle West, reception often has been poor."

"To the farmer, radio means more than entertainment. Most farmers depend upon radio market reports, weather forecasts and other information that they receive without interference."
Board's Order Improves and Increases

By Richardson

The order of the Federal Radio Commission clearing the band of frequencies from 600 to 1,000 kc (300 to 500 meters) from all heterodyning went into effect and has already resulted in an improvement in broadcast reception.

The Commission considered the facts that about 50 per cent of all the inhabitants of this country live in rural communities and in small towns and cities having no local broadcasting facilities, that these citizens must depend on reception of radio programs from remote points, and that reliable radio reception is just as vital to these persons, if not more vital, than in the case of residents of cities.

The larger and more attractive broadcasting stations are always located in or near the larger centers of population so that their programs will reach the greatest number of people in the best possible way.

This distribution of stations leaves many rural sections uncovered by first class radio transmission, and all those who live in the country must depend on distant stations.

The Structure Collapsed

Ever since the control of the radio situation was adjudicated not to be a lawful duty of the Department of Commerce there has been chaos in the ether. No one living at a remote point from a broadcaster could receive many, if any, stations without heterodyne interference. Even some of those living close to the stronger stations could not receive clear signals from those stations without heterodyne disturbances.

The order of the Federal Radio Commission which went into effect Dec. 1 has changed that situation regarding the 600 to 1,000 kc belt. A clear ether from 600 to 1,000 kc was the object of the order, and that means that in that frequency band there will be practically no interference from heterodyne whistles. Slight possibilities of interference still exist but they are not serious.

Virtually the order restores the situation in this belt that existed before the structure built up by the Department of Commerce broke down in 1926. Stations operating in the same district within the belt are now separated by at least 50 kc, and no two stations are operating simultaneously on the same frequency unless they are separated by long distances. This applies to the "cleared" band from 600 to 1,000 kc but not to the bands above and below that band. Thus in New York city and vicinity there are WEAF on 610, WJZ on 660, WOR on 710, WINS-WQAO-WAP on 760, WMCA-WLW on 810, WGBS on 860, WPCH-WBMS on 920, and WABC-WBOQ on 970.
In every case the separation is 50 kc. or more.

Examples of Clearing

In other congested localities the same arrangement has been carried out with another series of frequencies within the 600 to 1,000 kc band. This arrangement prevents direct heterodyning in one district, provided reasonably selective receivers are used; but it does not prevent heterodyning between stations if two are operating at nearly the same frequency at the same time, though they may be separated by hundreds of miles.

But in the "cleared" band no two stations are allowed to operate on the same frequency at the same time unless they are so far separated that no serious interference can occur. Thus WGBS in Astoria, N. Y., WIP and WOO in Philadelphia on the East coast share time on the 860 kc. channel and stations KYVO at Bristow, Okla., KJR and KXA at Seattle, Wash., share time on the same channel in the Southwest and the Northwest. The legs on the triangle connecting these districts are so great that even when one station in each district is operating on the 800 kc. frequency there will be no serious interference within the regular service areas of these stations.

The Oklahoma station KYVO is operating on Central Standard Time, which gives listeners one free hour between that station and any one of the Eastern stations operating on 800 kc. The Seattle stations are on Pacific Time, which is three hours later than Eastern Standard Time, and thus the listeners are free from possible interference for at least three hours as far as the stations on the Atlantic and the Pacific coasts are concerned, assuming that each station is operating on the same schedule but on local time. Thus KYVO is operating on the same schedule as before.

How It Works Out

A practical outcome of this arrangement is that all listeners, no matter where located, will be assured against heterodyning during the hours a single station is operating. It also insures the listeners east of a station a period of clear ether for tuning in WEAF in New York.

The 800 kc. channel was merely taken as a sample of clearing. The same applies to all the other channels in the cleared band as far as it is geographically and mathematically possible to carry out the scheme. Thus WEAF at Bellmore, N. Y. and KGW at Portland, Oregon operate on the 610 channel.

These two stations may heterodyne at midway points, but at these points both would be so weak that few persons would be interested in either of them in preference to closer stations. In the regular service area of the Western stations the signal from the other stations would be so weak that it would not cause an objectionable or even audible heterodyne.

Then, as was explained above, the Eastern station is operating on a time schedule three hours ahead of the Western. It signs off in absolute silence three hours earlier, on an average, than the Western station, and thus fans throughout the continent will have free access to the Western station. During the hours when the schedules of the two stations overlap, the sun has been down long in the West and transmission is not so good. That reduces listeners to WEAF and KGW free from interference.

Signals, Not Squeals

What applies to stations WEAF and KGW also applies to stations WOR, Newark, N. J. and KPO, San Francisco, Cal., both of which are on the 610 kc. frequency, thus leaving many channels available.

Another case is that of WRNY, New York and KOF, Denver, Col., both of which are on the 920 kc. channels. These two stations are not separated as far as the majority of the previously mentioned pair, but about 1,000 miles less, and their time separation is only two hours, since Denver is on Mountain Time. This leaves KOA only two hours clear after WRNY signs off. But WRNY is radiating only 500 watts, and it will therefore not interfere seriously. Steps have been taken, though, according to Hugo Gernsback, owner of WRNY, to synchronize his station with KOA so that all heterodyning will be eliminated, the work being done by the Bureau of Standards with the cooperation of several trained listeners in the Central West territory.

Thus everybody is assured of clear reception in the band 600 to 1,000 kilocycles—500 to 300 meters—and any one in the rural parts with a set sensitive enough to pick up signals from remote stations can select one without interference from heterodyne whirls. Altogether there are 35 cleared channels.

Board's Ruling

The reason given by the Commission for not extending the "cleared" belt to 550 kc was that the 550 to 600 kc channels are already spoiled by code from ships and that clearing up a little heterodyning would not help much.

The band between 1,000 and 1,500 kc. is present in chaos. But it is gradually becoming clearer. There are so many small stations on this band that it is impossible to clear up heterodyning. Many stations divide time to enable several stations to operate in the same district, but this does not eliminate heterodyning since there are many stations that operate simultaneously at great distances apart.

The only way to eliminate the heterodyning is to eliminate some of the stations. And that the Commission has decided to do. It is planned to begin the elimination of all unnecessary stations on March 15. It is not expected to continue it until the interference has been cleaned up in all channels, or until the present status of the Commission expires on March 15. The deletion of stations, about 300 in all will not be done with one sweeping order, but will be done gradually by the refusal of renewal of the short term licenses under which the stations are now operating. According to a statement by the Commission, it is planned to clear next the band between 1,000 and 1,200 kilocycles.

What Map Shows

The map shown on other page illustrates four of the channels in which interference has been eliminated. The long straight lines connect stations from one end of the country to the other connect stations which transmit at the same time on the same frequency. The great distances represented by these lines insure freedom from interference because the signals of either station are so greatly attenuated that when they reach the regular service area of the other they are not strong enough to cause a ripple of audible intensity.

Note that one of these lines extends from New York to Portland, Oregon, connecting WEAF and KGW both on 610 kc. Another line extends from Washington, D. C. to Los Angeles, California, connecting stations WRC and KFI, both on 640 kc. Still another connects stations WOR, Newark, N. J. with station KPO, in San Francisco, Calif., which operate on 710 kc. These three pairs of stations are three hours apart due to their difference in longitude.

Another line extends from Miami Beach, Florida to Seattle, Washington, connecting stations WQAM and CNRW, both of which operate on the 780 kc. channel. These stations are one hour apart in time on the same frequency. The great distance between stations WEAF, and KGW both on 610 kc. and KFI. Then, too, all East Coast listeners have about an equal chance of getting the West Coast—KFI, KPO, KGW etc.

Engineers Like Plan

Radio engineers and others who understand the radio situation generally agree in accord with the Commission on the necessity of eliminating at least 300 broadcasters before service will be satisfactory and reception free from heterodyning. They hold that this offers the only immediate solution to the congestion in the ether.

However, in some quarters the hope is expressed that the reduction in the number of stations will not be too extensive because a certain measure of relief can be expected from the operation of chain stations carrying the same program on the same frequency, thus leaving many channels available for other broadcasters. That the operation of two or more stations simultaneously on the same frequency is feasible has been demonstrated in a number of cases, and particularly in the case of WRB, Springfield, Mass., and WRBZ, Boston, Mass. But just how many stations can be operated on the same frequency at the same time is not known.

Dr. Lee De Forest, inventor of the three

(Concluded on next page)
RADIO SLEUTHS DO SNIFFING WITH LOOP

(Underwood & Underwood)

THE "DETECTIVE CAR" OF THE DEPARTMENT OF COMMERCE, FITTED WITH RADIO DETECTING APPARATUS FOR DISCOVERING USERS OF UNAUTHORIZED WAVE LENGTHS. THE CAR IS THE ONLY ONE OF ITS KIND IN EXISTENCE, AND HAS THE RIGHT OF WAY OVER ALL OTHER TRAFFIC.

(Concluded from preceding page)

element vacuum tube which has made broadcasting possible, favors a reduction in the number of stations to about one half of the present number.

More on One Wave

"I am confident," he said, "that both cities and rural communities, which are greatly interested in programs of a local nature as well as in entertainment from large centers of population, could be adequately served by not more than 300 broadcasting stations.

On the other hand, a large number of stations can be operated on one wavelength and carry the same identical program, although the present congestion relieved somewhat. However, we should not lose sight of the fact that the present number of stations in this country is absolutely not needed.

Hogan and Grebe Views

John V. L. Hogan, a pioneer radio inventor, past president of the Institute of Radio Engineers, said: "One of two things must certainly be done—either a general reduction of the power of stations all over the country or a material reduction in the number of stations. The operation of chain stations on one wave is possible, having already been done successfully by WJZ and WBZA, at Springfield and Boston, Mass., but for a large number of stations it would be a very expensive experiment.

Alfred H. Grebe, president of A. H. Grebe Radio Company of Richmond Hill, L. I., said: "It looks to me as if a major operation will be necessary to alleviate the trouble from the broadcasting system, that is, a substantial reduction in the number of broadcasters in this country."

Broadcasting stations throughout the country, however, are not entirely satisfied with the results of new allocation according to a telegraphic symposium conducted by the Freed-Isenmann Radio Corporation.

There is no solution except reducing the number of stations so that more than one station of 5,000 watts or more shall operate on a channel, although the present situation is much improved over former commission assignments," said Frank W. Elliott of WOC, Davenport, Iowa, former president of the National Association of Broadcasters.

Mentions Cold Weather

WOWO, Fort Wayne, Ind., one of the Columbia Broadcasting System stations, reported: "Cold weather permits stations above and below us to increase interference.

"Outside of a seventy-mile radius a station with less than 5,000 watts power and exclusive channel cannot be heard to be of any practical value. For any station to be of natural service and value with any degree of consistency it must have high power and exclusive channel. We could increase our service if granted license with more power and exclusive channel."

John Shepard, owner of WNAC, Boston, said: "A change of about twenty kilocycles in our present wave length would be desirable to allow us to operate further away from WJZ. Favorable action by the Radio Commission on our application for 5,000 watts would also be of assistance, but because of conditions in New England, a high wave length is essential."

Interference in West

Western reception is still being interfered with by heterodyne howls, KIF, Los Angeles, Cal., reported.

WHT, Chicago, which is on a lower wave length, said: "Early indications show that reception is apparently improved because of new wave lengths, especially on distance.

We are particularly anxious for intensive coverage in a 300-mile radius and will judge eventually the desirability of present power and wavelength on that basis."

WJR, Detroit, Mich., "now experiences some interference from heterodynes, but believes that with all stations adhering to assigned frequencies we will be happy with our present allocations, otherwise our former wave of 217 meters would be preferred."

The Public's View

The listening fans already have experienced relief since the order of the Radio Commission went into effect. Scears with whom the staff of Radio World have spoken about the change are enthusiastic about the DX possibilities and the greatly improved reception at points in the frequency scale where stations crowded each other too closely before the change.

One fan reported that he had received so many distant stations without interference that he grew tired of counting them; and he said they were comparable to local stations in respect to volume and quality. All who had formed any definite opinion on the subject agreed that many of the stations should be made to sign off permanently in order that better reception could be had from the remaining stations.

Great Chance

The DX fans in the eastern territory got an unusually good opportunity for pulling in distant stations during the late afternoon and evening of Sat. Dec. 3 when most of the stations in the East signed off for several hours on account of an SOS. The East was not only clear of local stations during those hours but the reception conditions were otherwise also very good. The result was that many who had sensitive receivers were able to reach out beyond the Middle West and pull in the stations there as if they were locals.

Amateur's Call for Help Saves Girl In Alaska

Anchorage, Alaska

Assistance for Bessie Howe, Government school teacher in the isolated native village of Ninilchik, 115 Miles west of Anchorage on Cook Inlet, came through the air while a terrific gale was blowing which prevented rescue by sea. Bessie Howe accidentally shot herself in the abdomen while she was cleaning a rifle. No physician nor expert medical attention was available in the little native Indian village, and there were no regular channels of communications between it and the white settlements.

Makes Landing

Government radio men at Anchorage and Seldovia caught weak amateur signals of distress asking for immediate aid. These signals evidently originated from a spark of a oil boat. No boats were available in the nearest port, would set out for Ninilchik, the face of the raging storm.

A. D. Haverstock, Government physician, and Pilot Russel Merrill decided to take a long chance and set out for the Indian village in a plane equipped with skis. Their trip was successful and Bessie Howe was brought back to Anchorage.

In a Bad Way

The wounded girl is now in a critical condition in the hospital, with a fighting chance for life against blood poisoning which had set in. She arrived in Alaska in September from the Middle West, and her home is thought to be in Kansas.
ORIGIN OF HETERODYNE INTERFERENCE

The diagram illustrates a method for synchronizing two broadcast stations A and B, located several hundred miles apart, so as to eliminate heterodyne interference. A receiver R. is brought five miles from B and connected to it with a telephone line, is permanently tuned to the normal frequency of the two stations. It primarily picks up the signals of B, but if the frequency of A differs from that of B by an audible amount, the beat is heard in the receiver. This squeal, together with the signal, is transmitted over the land line to station B and the operator of that station is enabled to change the frequency of B until the squeal disappears. This eliminates the squeal between the two stations in all receivers tuned to the frequency of the two stations A and B. The adjustment now is manual but engineers are working out an automatic adjustor which will not permit a deviation of frequencies more than 10 cycles. The heterodyne frequency will probably be made to actuate a relay which will in turn control the temperature of the oscillating quartz crystal which controls the frequency of station B.

The method of heterodyne interference elimination is popularly exactly analogous to the tuning for zero beat between a transmitting station and an oscillator. Practically everybody who has played with a regenerative set has done exactly the same thing that the synchronizing operator does.

For example, a radio listener is trying to tune in WGY with a regenerative receiver and he is so far away from the station that he is compelled to use maximum regeneration to get the signals. The regenerative tube breaks into oscillation, and the fan tries to tune the receiver accurately to the incoming signal by means of zero beat. He succeeds in setting down the condenser so that there is no audible beat between his own oscillator and that of the transmitting station.

As long as he is able to hold the zero beat adjustment he does not hear any squeals; neither do his neighbors, unless one of them is operating an oscillating receiver and has not tuned to zero beat. But the operator finds great difficulty to hold the zero beat adjustment. The circuit seems to break into oscillation without provocation. In fact the adjustment is so unstable that he has to keep adjusting continuously in order that the beat may keep at zero.

Variety of Causes

Now this instability may be due to one of many causes, or to a combination of many causes. The fluctuation may be caused by a variation in the carrier frequency from the transmitting station; it may be due to a variation in the frequency of the oscillating receiver, or it may be due to changes in other circuits in the vicinity of the oscillating receiver, which are really changes in the receiver, so that there are only two main possible causes of the variation. There are countless contributory causes at each end, and they are the same at both the

The heterodyne frequency will probably be made to actuate a relay which will in turn control the temperature of the oscillating quartz crystal which controls the frequency of station B.

SOME SPECIAL TESTS WITH VACUUM TUBES

CHRISTY MATHEWSON, JR., SON OF THE FAMOUS BASEBALL PITCHER, IN THE LABORATORY OF THE GENERAL ELECTRIC COMPANY, WHERE HE IS EMPLOYED AS A STUDENT ENGINEER, MAKING SOME SPECIAL TESTS WITH VACUUM TUBES.

LITERATURE WANTED

Robert F. Weiss, 140 East 13th St., Cleveland, O.
B. Vearnower, 37 East 101st St., N. Y. City.
Walter Stoecklein, 503 West 175th St., N. Y. City.
R. O. Morley, 802 Pacific St., Vancouver, B. C., Canada.
E. R. Young, 2141 Singleton St., Indianapolis, Ind.
J. L. Stevens, 634 Hookin Ave., Winnipeg, Manitoba, Canada.
Ray R. Moore, Mitchell, O.
F. W. Enterline, 2300, Jarrell, Houston, Texas.
Buster Davis, 301 Joe Ave., Golden, Ala.
George Burnham, 419 Main St., Gloucester, Mass.
John Corba, 432 East 60th St., Chicago, Ill.
John J. O'Neil, 3186 Terrace St., Oakland, Pittsburgh, Pa.
J. C. Graybill, 110 Tremont Court, Massillon, O. E. Post, 872 Trademark, Bank Building, Oklahoma City, Okla.
Robert Kelley, Browning, N. Y.;
L. W. Printz, 104 Wayne St., Warren County, O.
Ralph Toleris, 43 2nd Ave, N. Y. City.
Thomas A. Toper, Box 100, Madison, Wis.
P. Schmidt, 304 Princeton Pl., N. Y. City.
E. J. Koester, 682 Grant Boulevard, Milwaukee, Wis.
Harry L. Allton, Box 847, Lake Linden, Mich.
Harold D. Allton, 88th Co. Signal Branch, Quantico, Va.
Stephen J. Kula, 21 East 30th St., N. Bayonne, N. J.
M. B. Campbell, 320 Marion Court, Louisville, Ky.
Paul Murray, 109 Stone Ave., Brooklyn, N. Y.
James Saidman, Box 4893, Lake Linden, Mich.
L. A. Neff, 394 W. 26th St., Brooklyn, N. Y.
L. W. Linsky, 208 West 26th St., Brooklyn, N. Y.
Harry G. Sylvestor, P. O. Box 872, Orlando, Fla.
Complete Official Call Book and Log

Herewith is the complete list of stations in the United States and its possessions, corrected up to December 15. All the changes ordered by the Federal Radio Commission effective December 1 have been included. Changes ordered effective December 15 are anticipated, hence included. The stations are arranged inversely according to their frequencies and directly according to wavelengths. The call letters and location also are given. The dashes underneath the frequency and wavelength are for the dial setting, thus making it possible to keep a complete log of the stations received. This is the first national publication of this up-to-date complete, official call book and log.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Call Letters</th>
<th>City, State</th>
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</thead>
<tbody>
<tr>
<td>550 kc.</td>
<td>KDAR</td>
<td>Dallas, Texas</td>
</tr>
<tr>
<td>560 kc.</td>
<td>KFRA</td>
<td>Kansas City, Mo.</td>
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<tr>
<td>570 kc.</td>
<td>KJRC</td>
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Radio University

When writing for information give your Radio University subscription number.

When writing for information give your Radio University subscription number.

**FIG. 584**

THE PICTORIAL DIAGRAM OF THE EVERYMAN 4, AS REQUESTED BY GEORGE FRANK.

1. DESIRE to build the Everyman 4 as described in the December 3 and 10 issues of Radio World. In the December 10 issue, there appeared data telling how to correct the December 4 diagram so as to get better results. Would you please show a picture diagram of the set with all the necessary changes made?

2. I have a 3-stage resistance coupled audio amplifier. The plate resistors have a resistance of 1 megohm. The first grid resistor has a resistance of 1 megohm; the next grid resistor, .1 megohms, and the last grid resistor, .25 megohms. The stop-

3. SOME INFORMATION is requested regarding the addition of an extra stage of radio frequency amplification.

1. Would it be advisable to use a coil which had a large primary, say 20 turns? You can fix this up yourself. Procure a 2 inch diameter tubing and wind twenty turns thereon. Then insert it in the stator tubing holding the primary and secondary windings. You can use No. 22 double cotton covered wire for this extra winding. A space .5 inch can be allowed between each 10 turns for the insertion of a shaft.

2. Is it necessary to use the rheostat in series with the ballast of the first radio frequency tube? What is its value?

3. Yes. The primary of the radio frequency coil should be variable, though. You can use No. 22 double cotton covered wire for this extra winding. A space .5 inch can be allowed between each 10 turns for the insertion of a shaft.

4. Yes, this is all right.

5. Yes. These are lights attached to the controls which are used to brighten up the numbers on the scales. However, plain dials with no lights can be used. This should have a resistance of 20 ohms.

6. Yes. Would the 1A and 12 Amperes serve the purpose?

7. Is GS a 400 ohm resistor? What is its value?

8. Is it necessary to use the rheostat in series with the ballast of the first radio frequency tube? What is its value?

9. Is it all right to use 20A tubes throughout this set?

10. Yes. The primary of the radio frequency coil should be variable, though. You can use No. 22 double cotton covered wire for this extra winding. A space .5 inch can be allowed between each 10 turns for the insertion of a shaft.

11. Is it necessary to use the rheostat in series with the ballast of the first radio frequency tube? What is its value?

12. Is it necessary to use the rheostat in series with the ballast of the first radio frequency tube? What is its value?
December 17, 1927

**RADIO WORLD**

**FIG. 585**

**THE CIRCUIT DIAGRAM OF THE 4-TUBE REGENERATIVE RECEIVER REQUESTED BY WILLIAM SENTER.**

---

the RF tubes, of which there will be two and the first audio tube to a common 675 volt post, post of GERALD M. ANTONUS, 3237 Park, Rapids, Ia.

(1) It would work better if the primary were variable and contained that number of turns.

(2) Yes, this will work out all right.

---

IS IT all right to control the volume in a receiver wired up for the AC heater type tubes, while the other one is to be hooked up to another drum control.

---

I WAS given a 5-tube set about two months ago. The set worked satisfactorily until last week, when the signals suddenly became weak. I tested my A, B, and C batteries, as well as the tubes, antenna and ground, and found them all right. I found, however, that the large fixed condensers across the plus B and the minus A posts were opened circuited. There are three of these: one connected between the plus B and the minus A, one between the plus A and the minus A, and one between the plus B and the minus A. I think that the trouble is right here.

---

I WISH to build a 6-tube set, using three stages of tuned radio frequency amplifiers and a non-regenerative detector to control the volume in a receiver wired up for the AC heater type tubes, while the other one is to be hooked up to another drum control.

---

I HAVE a couple of three inch diameter tubing, some .00025 mfd. variable condensers, two 3 to 1 ratio audio transformers, a 1 inch diameter tubing, an 85 mili- henry radio frequency choke coil, a 10 ohm variable rheostat, a 30 and a 100 henry choke coil, and a 2 mfd. and a 4 mfd. fixed condenser. I would like to have some information, if you will.

---

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---

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Street __________________________

City and State ____________________

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To their long list of excellently made apparatus, Remler Division of Gray & Danielson Manufacturing Company, 200 First Street, San Francisco, Calif., added the Remler Universal twin rotor variable condenser. This condenser is a modification of the Remler S. L. wavelength twin rotor condenser. It uses a novel adjustment by means of which the dial shaft can be made to rotate in either a clockwise or counter-clockwise direction for an increase in capacity. The Universal condenser is particularly intended for use where two Remler No. 110 drum dials are used, and when the condensers are driven from opposite sides of the dials. By setting the shaft of the condenser at the right, for instance, for counter-clockwise operation, both dials are made to rotate in the same direction for an increase of capacity.

Complete Reconsideration

The result of this meeting, held recently (with the Association represented by the Chairman of its Engineering Division, H. B. Richmond, of the General Radio Company) was that a complete reconsideration is to be given to the existing codes of standards and their variances. An agreement was reached that all items on which there is no conflict shall be announced as radio industry standards.

On items on which there is a disagreement the American Engineering Standards Committee will endeavor to analyze the situation, hear all evidence, and establish the industry standard with the understanding that any conflicting standards will be brought into harmony and agreement with the radio industry standards as rapidly as possible. The Association will not publish any standards of its own, but will distribute to its members and adhere to the national radio standards as determined and approved by the American Engineering Standards Committee.

**The Big Thrill of DX, and at very Small Cost to You**

Everybody who owns a radio set likes to tune in far-distant stations now and then because not only is there a thrill in hearing a voice or instrument thousands of miles away but one verifies the fact that he has a powerful receiver and that it is in good condition, if it is able to pick up these weak signals. Now that the broadcasting stations are more suitably distributed as to strength or frequency, fans are in a better position to tune in distance. Besides, the weather is in its favor these days. But what kind of a set shall be used? You know very well that if the set can tune in distance stations, you can develop sufficient skill to make it tune in far-distant stations very easily, virtually every night. Then when you have tuned in the stations you need not insist upon the DX qualities of your set but simply tune the receiver and let them listen to stations thousands of miles away. You must forget to have a receiver capable of responding to your distance-getting desire. You also want this set to have delicate tone quality, so that you can critical ears cannot detect even a single flaw in the reproduction. Indeed, music lovers who may be guests at your home will comment admiringly upon the bewitching tone of your receiver. Then, you know you have the ability to get distance and to reproduce the original music without distortion depends largely on the circuit design, and you will find that the Diamond of the Air, either the 4-tube or the 5-tube model, will live up to your highest expectations. Now are you going to know which to build? Carefully inspect the textual data as well as the blueprints that fully expound the theory, operation, characteristics and amplification of these two outstanding receivers that differ principally in the type of audio amplification.

**The 5-Tube Diamond**

Can be constructed in a couple of hours. The authorized blueprint plan, the speed and efficiency possible are just off the press and will be shipped as one set, together with the new booklet of full textual expansion of construction, including the winding of coils, how to connect terminals, what values of condensers and resistors to use, etc. The receiver consists of a stage of tuned radio frequency amplification, a specially sensitized detector, power transformer audio and next two stages of resonance audio. It is easily adapted to playing phonograph records through the set and on your speaker. Get acquainted with this new delight.

**The 4-Tube Diamond**

represents the most that is obtainable from four tubes. A stage of tuned radio frequency amplification, a specially sensitized detectors, power transformer audio and next two stages of resonance audio. It is easily adapted to playing phonograph records through the set and on your speaker.

Look over both of these blueprints and read the text in both cases before choosing the receiver you are to build.
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But 3 Men Move Them

Los Angeles

Igor Friedman, concert pianist, who recently gave a program over KFI, carries three concert grand pianos with him on his tours, as well as a special bench. Four handlers care for them.

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He tells in plain words and illustrations how it is that, when the parts are called that are the few usual troubles and how to fix them. Then he lists 100 troubles that sometimes happen and tells how to detect and fix each one.

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It will save you many a repair man. It will save you hours of guessing and fumbling. It will help you to keep the tone of your set always sweet and strong. It will keep you from losing many programs. And, best of all—

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agages are up to normal. If either is down, a new tube or set of tubes will not improve reception much. A voltmeter cannot be used safely to measure the grid voltage unless that voltage is supplied by new batteries.

A milliammeter having a range of about 0-25 is the second most useful instrument. With it you can test the tubes for plate current, the audio amplifier tubes for overloading, and in a roundabout way you can also use it for testing the grid voltage.

A hydrometer is a convenient instrument for testing the condition of charge in a storage battery. It is inexpensive.

The electrolyte in a storage battery is extremely active chemically. If spilled on the carpet, on the furniture, in the clothing, on the skin, it will burn a hole unless it is immediately neutralized. It is of no avail to dilute it with water if the diluted acid is permitted to remain. The burning will simply be a little slower but it will be just as serious and extensive.

The electrolyte, which is the sulphuric acid, can be neutralized with ammonium hydroxide or potassium or sodium hydroxide. These substances are found in every home in the form of ammonia water and lens. Do not use too much or too strong a neutralizer.

Motorboating is caused by the impedance of the B battery eliminator and by common impedance in the plate or grid circuits. It is an oscillation and not a case of blocking of the grids. It is most common that blocking results from the oscillation.
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