another MRL Handbook... HB-13

RADIO NOTES

NO. 2

By Elmer G. Osterhoudt.

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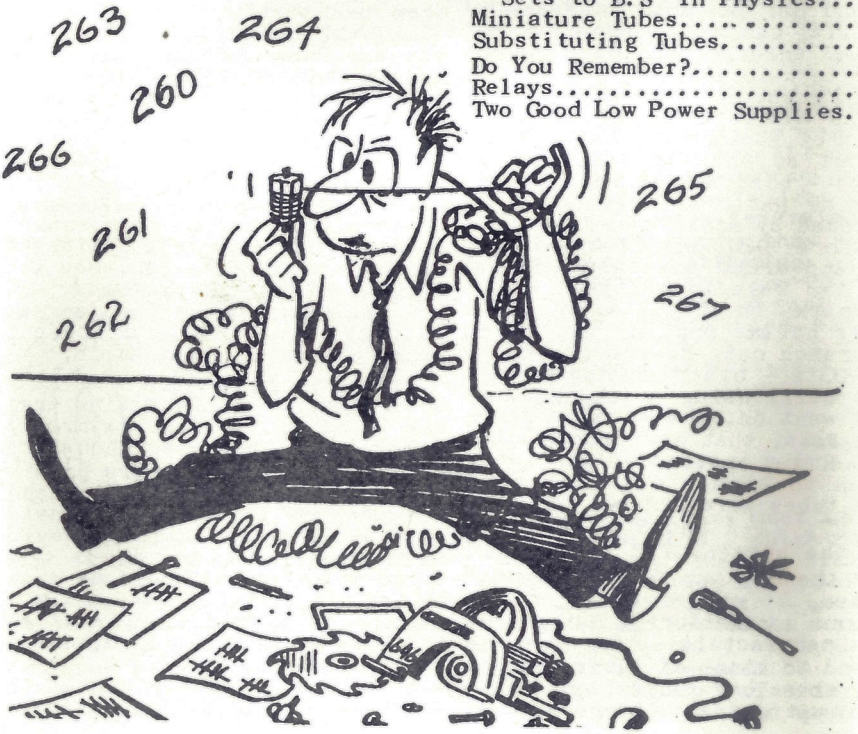

Elmer G. Osterhoudt
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F O R E W O R D

This Handbook replaces MRL "Radio Builder" numbers 26, 30, 31 and 32. The most interesting material has been completely revised, enlarged and made up-to-date to help you.

This second number of "MRL Radio Notes" covers quite a field of Radio. Radio has branched out so much in the last 50 years - that almost any assortment of Radio articles will be welcomed by most Fans.

Before 1920, Wireless was well cut-and-dried and there seemed but two ways to transmit - arc or spark. In the 20's, when the tubes became popular, it began to branch out. However, even in the 30's - older Chinese ships were still using spark. But, as time went on, the more progressive Fans, that now experimented with Radio instead of Wireless, began to branch out. For some time, tubes were limited to 01-A, 26, 27, 71-A and 80. DeForest put the screen grid in and out came the 24- and "away we went!"

Then, by experimentation and various manufacturing methods of tube manufacture - there now is no end to kinds of tubes and the many uses. They range from minute types up to transmitters several feet high. Some are so big they must be water-cooled to keep them from burning up.

Instead of trying to standardize tube bases connections - the makers, to gain more sales, have juggled connections. For instance, an 8 prong can give over 64 different variations, plus a grid cap connection, - so a tube will work only in one place. The makers even say other tubes may be substituted with some socket changes. Many may be substituted directly with no change. See the article "Substituting Tubes" and you can easily make changes. We estimate some 20,000 different types of tubes in the World.

Transistors are in the same boat. Many have quit making them due to so many types. Nature is never consistent - so thousands of different readings are possible. Look over a TRX catalog and see how many types. Nobody could sell all the types. They should be concentrated on about 100 types and everyone would be much better off.

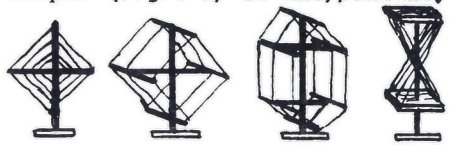
Above is a good example of an industry getting itself out on a limb and sawing it off.

We hope this Handbook will be an asset to your Radio library.

BUILDING AND OPERATING A LOOP.

A loop is an interesting piece of Radio equipment, as well as a practical one. With transmitters becoming more powerful, it is possible to play most stations with but a few feet of wire for an Aerial. Years ago, a loop, to be practical, required several stages of amplification after the detector. Even tho the loop is only 1/10th as sensitive as an outside Aerial of equal wire, it has many good points.

There are two general types of loops. (Fig. 1-A) is the pancake,

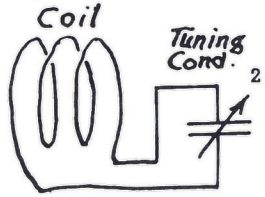


1. Types of Loops.

spiral or flat type. (1-B, C, D) are the solenoidal, or box types most commonly used. Loops may be from a few inches to 15 ft. sq., depending on their use and space available. Wires are generally in a concentrated field, and may be formed circular, square or be triangular in shape.

OPERATION OF A LOOP.

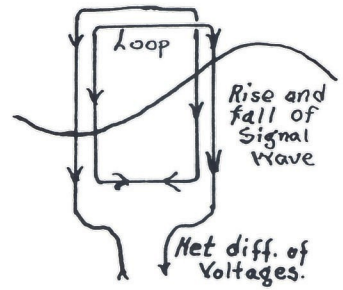
A loop operates just like a big coil and condenser (Fig. 2),



2. Fundamental Loop Circuit.

with which induction from a distant transmitter is picked up.

Why does a loop (or coil) work better when pointed toward an EMF source? Any loop, whether it is round or square, has part of its wires running up and the remaining ones down (Fig. 3) just

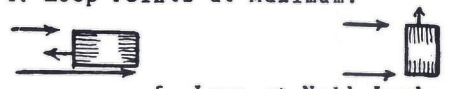


3. Currents in a Loop.

like a coil. One side goes one way; opposite half go back up the other way. Waves strike the nearest side and generate a directional current. An instant later, it strikes the far side and does the same. These currents flow toward each other and meet. The nearest current goes farther than the far side, which makes the two sides "out of phase." The loop operates on the difference in potential principle. That is, the greater the difference, the greater the output of the loop. So you can see - the larger the loop, the more the sides become out of phase - and the greater the signal. you have all noted how a larger loop picks up more. Were it possible to build a loop so its sides were separated by one/half wavelength, they would be as big as a battleship.

Now we rotate the loop 90 deg. (Fig. 5). Here the signal hits both ends of the loop at the

4. Loop Points at Maximum.



5. Loop at Null Angle.

same time - and they meet in the center of the coil - which makes a "null" point. This is like Ur winding two coils, in opposite directions, placing them next to each other and hooked in series. You will get a null, or dead pt. and signal is deadened.

Because a loop tunes louder and broader, pointing toward a

station - in Direction Finders (DF) it is placed at right angles so they get the null point. This is a lot sharper so it is much more accurate.

Pancake loops (1-A) may be of several forms, as for instance, in the back of a portable receiver - where they are glued to a flat surface, or slot-wound like a spiderweb coil. They are also directional, as you have already noticed.

Box type loops may also be in different forms. A coil could be classed as a box type. Also the familiar Loopstick now in use. Note how it becomes directional as you rotate the set in different directions. Because the Loop stick has a powdered Ferrite core, its inductance is greatly increased. For this reason they are used in most Transistor portable receivers. A box-type loop may be a large solenoid coil - or a bunch of wires taped together in a hank.

The box-type loop gives greater volume than the spiral type because the opposite sides are out of phase more. Also, a box-type has less voltage drop between turns. Box loops must be at least 15" on a side if sufficient inductance is to be obtained. Boxes with 4 ft. on a side work very well. In the old RCA station, KET, at Bolinas, Calif. in the early 20's, a box loop, of this type was used to work KIE, Kahuka, Hawaii, where the static problems were very bad on long waves. You could hear static all over the room - but had to put on the phones to hear signals. They had miles of wire Aerials all over the hill which pulled in lots of static.

BUILDING THE LOOP.

(Fig. 1-B) is a good one to start. Use wood for the frame, but make the 6" cross pieces from Bakelite, Lucite, etc. Do not slot them until you are satisfied with wire spacing later. Be sure to make a rotating base as this is essential. Height of sides (1-D) should not be more than twice the width of loop.

Frame inches	Sq. inches	Turns
14 x 14	196	22
16 x 16	256	20
18 x 18	324	18
20 x 20	400	17
25 x 25	625	14
30 x 30	900	12
35 x 35	1225	11

6. Dimensions for 1-B Box Loop.

Table shows number of turns altho they may vary, depending on final inductance, distributed capacity, etc. Just like tuning varies with a coil of fine wire on 1" diameter form against one of large wire on a 3" form. 85 ft. is about right for total length, but you'd better get 100 ft. and add a few more turns to the table. It takes a little more wire for (1-C).

In loop design, we are between two fires. If we put the wire up close together, we use less wire with more inductance, less distributed capacity, better selectivity and less pickup. If we spread the wires, we need more wire, get broader tuning, more pickup and less distributed capacity. For a 2 ft. square loop, the spacing should be about 1/8" between wires; 4 ft. square it's about 1/4" for best results.

Try tuning with a .00035 variable condenser for a few days, while you juggle the spacing back and forth - and possibly remove a turn or so. If you want sharper tuning - use a 2-gang .00035 with stators in parallel. When you've reached the correct number of turns and spacing, you notch the crosspieces with your hacksaw. Tighten up the wire and lash it down to binding posts. Keep BP as far from each other as possible. Never connect loop to a duplex cable as this will spoil its use as a loop.

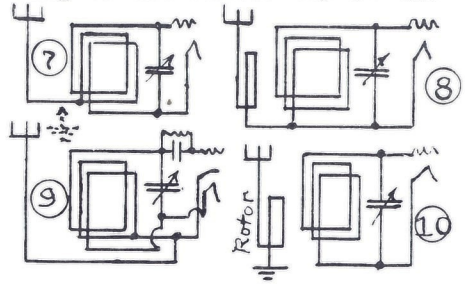
A tap switch may be mounted on Bakelite and fastened to center upright, but this will make loop less efficient as dead-end turns are detrimental. Shorting turns makes matters even worse.

Loop wire has about 19 tiny strands to make it flexible and lots of surface. Heavy, solid wire may be better for S.W.

THE LOOP IN USE.

The loop picks up better on SW - from 2000 Kc. to higher frequencies. A smaller loop must be used for SW - so you can add a good bit of condenser. A loop will pull in less static than a long Aerial. For wavelengths, near the natural frequency of the loop - results are very unsatisfactory. The tuned wave must be at least 3 times the natural period of the loop for efficiency. That is, a low-inductance/high-capacity circuit is desired for sharpest tuning.

(Fig. 7) shows an Aerial running to the center tap of the



7-10 Aerial to Loop Circuits.

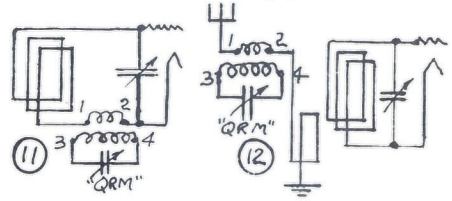
loop for an RF stage. This will not throw it off balance. If you prefer, you may put the ground here instead - it works similarly. Be sure it isn't an AC-DC set, with chassis grounded to 110 or you're in for fireworks! In this case, you may hook a .1 x 600 bypass condenser between ground and tap. This tapped loop will increase the volume but reduce selectivity somewhat.

(Fig. 8) shows a smaller loop, coming from the Aerial, which'll increase pickup on your loop. Pulling the primary loop away will increase selectivity to the desired point.

(Fig. 9) shows same as (Fig. 7) except it is for an AC detector tube coupled to Aerial.

(Fig. 10) shows a rotor to work inside the loop with the same effect as (Fig. 8).

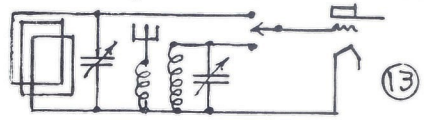
(Fig. 11) shows an MRL QRM Coil used as a wave trap, in series



11-12. Wave Traps for a Loop.

with the loop, to cut out unwanted stations. (Fig. 12) works the same, except it is in series with the primary in the usual manner.

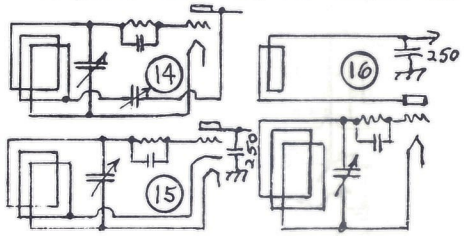
(Fig. 13) shows a SPDT switch to throw grid to either the loop



13. Optional Loop & RF Tuner.

or the regular Aerial input system. In this way, you can note the difference in operation. And by swinging the loop, you can help identify the station by its direction.

Regeneration may be worked on



14-16. Regeneration with Loop.

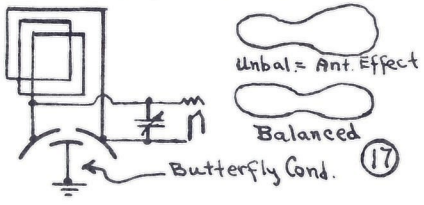
a loop, as per (Fig. 14). Just run a tap thru a .00035 variable condenser, over to the plate of detector tube, and the squeals start coming. (Fig. 15) shows a 1-turn tap, on the loop, to run to the Cathode of tube, similar

to our Type C Coils. (Fig. 16) is a separate loop that is swung near the regular loop to control regeneration. Be sure to get the tickler windings in right polarity or it won't regenerate.

Loops do not work effectively inside steel-framed buildings. It may help to feed a little HF energy in from the outside to the loop. Likewise, with a midget set with built-in loop - hook Ur Aerial lead to a metal pie pan and place under the set. A loop, operating in the same room as a receiver hooked to outside Ant. and ground, will not point effectively. It will have more volume, however.

Only the vertical side of loop receives signals from a Xmtr. Horizontal sides may receive reflected sky waves from the Kennelly-Heaviside layer, especially at night. This is called the "night effect." Bearings taken near sunset or sunrise may also be erratic. I've had stations, being copied at sunrise, fade completely out and come in good in an hour or so.

The "Antenna effect" is another peculiarity of the loop. Disregarding its directional effect - it is still a bunch of wires and acts as an Aerial in a small way. In this case, it is not usually possible to completely tune out a station. The null pt. may be blurred. (Fig. 17) shows how this may be overcome by use



17. Balancing Legs of a Loop. Patterns for Loops.

of a butterfly condenser to balance each leg to the ground, as one side is usually nearer to ground than the other. Graphs show how a balanced loop reading looks. Grounding the loop, in the center, as (Fig. 7,9) may help the Antenna effect.

Polarization of certain waves have been found, so that some vertical waves are hard to get an accurate check on direction. This may be offset by adding a small coil to the loop, or by use of another loop ahead of the regular one. In the latter case, the signal is lessened but perfect balance is obtained.

Aboard ship, the masts, rigging, etc. have individual oscillating points, which lessen accuracy of a DF. The DF set may be checked by sailing around a transmitter and checking with a compass or the stars.

I happened to be Opr. on the S.S. "J.A.Moffett" of the Standard Oil Co., in 1922, when the first DF was installed in the SOCo. fleet. My skipper (who couldn't sleep) had me up at all hours, fog or not, getting DF bearings from 8-9 stations on the coast, as we passed them. Dr. Kolster, of the Federal Tel. Co., who recently died, and with another Engineer, installed it. However, the loop receiver and loop control were in the wheelhouse, and the Opr. wasn't supposed to "mess" with it - me being just an Opr. to Dr. Kolster. Hi. They took a trip with us and adjusted for Antenna effect, etc. It was very accurate. We'd come from Puget Sound to San Pedro - with nothing in sight but fog and seagulls - and by the DF, depth soundings and dead-reckoning - hit the dock right in the middle!

Ships obtained cross bearings and the navigator plots it on the map. We used to work on 800 m. but believe now they take the bearings from BC stations, or from stationary beacons, and get their cross bearings.

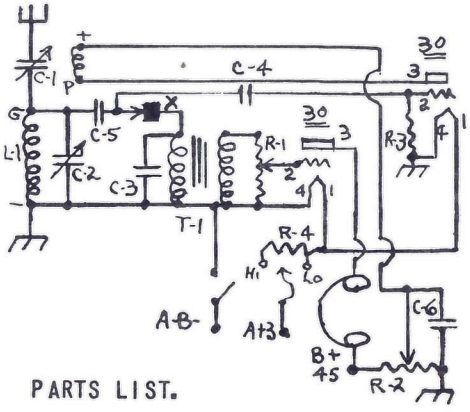
Stationary beacons, for ships and planes, may be heard with MRL Long Wave Coils. Mostly made up of 2 letters, which are easy to make out in code. If you hook a 2-gang .00035 in parallel, and across the .00014 - you'll get away up there. Beacons operate on about 1000 meters (300 kc.).

Bearings, taken part over land and water may vary. If we were too close to shore - the station would not give us a bearing as being accurate. A navigator may error as much as 30% if he attempts to plot thru 180 deg. of a bearing. 0-360 is North.

When at Sea in 1923, the station at KFS, San Francisco, used a loop for receiving ships. In this manner, it was possible to work thru heavy interference in the evening rush by swinging the loop. This always worked, unless interfering ships were in the same direction!

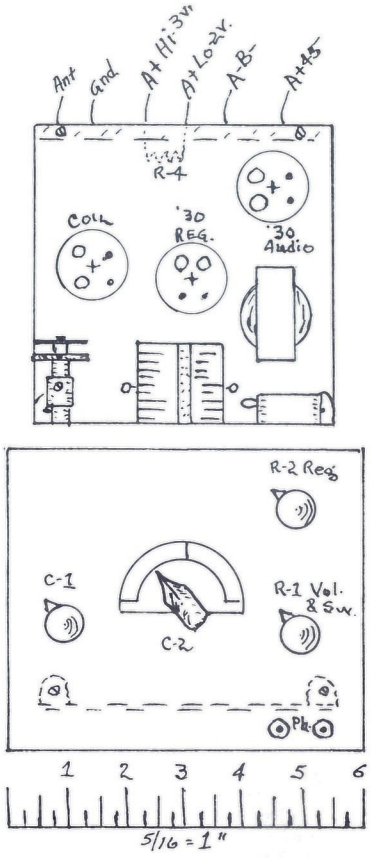
So, fellows, build a loop- and have a little fun. You can tell which direction a signal is coming from - (or is that blamed station 180 deg. in the opposite direction?). Hi.

A GOOD CIRCUIT FOR DX.



PARTS LIST.

C-1 2-plate Antenna condenser.
C-2 .00014 variable cond. (or) .00035 plus 25-280 trimmer.
C-3 .005 mica or ceramic cond.
C-4 .0001 do
C-5 100-500 mmfd. trimmer cond.
C-6 .00025 mica condenser.
R-1 500K vol. control & switch.
R-2 100K " no switch.
R-3 5 meg. ½ watt resistor.
R-4 10 ohm wirewound resistor.
1 5x6 Compo. panel.
1 4x5 tin shield for panel.
1 5x5 Compo. base.
1 3/4 x 5 plywood back strip.



18. Herman's Separate Oscillator DX'er.

3 4-prong wafer sockets. If 5-pr coils, sub. 1 5-prong socket.
1 3:1 audio transformer.
2 Phone tip jacks.
1 1¼" bar knob and scale.
3 Small pointer knobs.
2 ½ x½ angle brackets.
2 #30 tubes.
1 Xtal diode or fixed Carborundum crystal.
2 1½ v. drycell batteries. 45 v. of B-supply power.
1 Type A or 5-A Broadcast coil. (See text)
Wire, hardware, etc.

George Herman, Chicago, used this circuit for over 5 years.

In that time he played African and Australian stations with ease. At certain times of the year he got London on a speaker. He was using but a 30 ft. Aerial and no ground.

He says nothing is critical in construction. The only critical adjustment is C-5 - but we have simplified this by using a trimmer so you can make the best adjustment easily.

We have made a few minor rearrangements that we thought the builder might appreciate.

The circuit is a dual-detector - that is, the Carborundum, or Xtal diode and the top #30 tube gang up as a regenerative detector. In other words, the 30 acts as a separate oscillator.

The other 30 is definitely a straight audio power stage. You may use a 33 tube here if you want more power, as it gives off 1.4 watts output.

The drawings show panel and base layouts, which may be changed to suit your option. Note we are using our latest idea showing scale so you can get all the measurements with dividers.

Drill holes in panel and then mark the tin shield and cut out holes in it. Rivet shield to the back of panel with tiny nails. Run all grounds to it that you can easily reach. This prevents hand capacity when SW DX stations are being received.

Mount the Antenna condenser C-1 on metal bracket at back of panel. Be sure insulated shaft runs thru the panel to knob.

We have eliminated the 10 ohm rheostat as they are hard to get and the filament is not critical in these tubes. When the A-batts. are new - using 2 in series for 3 volts - you use the 10 ohm in series to protect your tubes. As batts. run down - just jump to the other A-plus lead as shown. You can check regeneration control - when it lacks life, it'll be a good sign your A-batts. are getting weak. 45 volts of B is OK, whether from batts. or power supply. If you use a 33 tube - run it up to 90 volts.

Wire set up with #18 or 20 stranded hookup wire for best efficiency. Make all leads short - especially the coil-to-condenser leads. Be sure to get good soldered joints to prevent raspy and poor reception.

If a fixed Carborundum Xtal must be adjusted - just push the catwhisker to one side until the signals get loudest. Make the adjustments on DX or the weaker stations only. Try reversing the polarity of the Xtal for best results.

For DX reception - the higher wire is always better than the lower, short one - to keep it above buildings and trees. Use of a ground depends on your location if proximity to loud interfering stations or not.

A Hi-frequency broadcast coil covers the BC band pretty good, if using a straight .00035 variable condenser. If using a 25-280 trimmer in series, or .00014 SW condenser, you'll have to use a Lo-frequency BC coil to cover lo-F side of band. HF coil is 84 turns #28 enamel on 1¼" form. A tickler is 14 turns same wire. Lo-F coil is 170 turns #34 enam. with 25 turns for tickler. Other SW coils may be added as desired later on.

Let's build up this little rig and see what you can get.

"Hey, Pa! There's People in Here!"

SOME NOTES ON GOOD DRILLING

Locating a good table on drill sizes is usually a hard job- especially if you want it in a hurry. The Radio texts are very lax in this information and consider it unimportant. We have dug up this table - and suggest you copy it on a card and hang it on the wall near Ur bench. Everything may vary a little - but you'll find this table is accurate enough.

For instance, if you want to tap a hole for a 6-32 screw, you use a #35 drill. If you want to make the screw fit loosely - use a #26 drill. Starrett, and others make a metal guage for measuring drills and wire sizes. Many put out drill stands with the sizes

Screw Size No.	Threads per Inch	Dia. in mils	Drill # for Tap	Drill # to clear
2	48	86	50	42
2	**56**	86	**49**	**42**
2	64	86	48	42
3	40	99	47	38
3	48	99	45	38
3	56	99	44	38
4	32	112	43	31
4	36	112	42	31
4	**40**	112	**41**	**31**
5	30,32	125	40	29
5	36	125	38	29
5	40	125	37	29
6	39,**32**	138	**35**	**26**
6	36	138	33	26
6	40	138	32	26
7	28	151	32	21
7	30	151	31	21
7	32	151	30	21
8	24,30	164	30	17
8	**32**	164	**29**	**17**
9	24	177	29	13
9	28	177	28	13
9	30	177	27	13
9	32	177	25	13
10	24	190	25	8
10	30	190	22	8
10	**32**	190	**21**	**8**
12	20	216	19	1
12	22,24	216	17	1
12	28	216	15	1

19. Handy Drill Table.

near each hole. Sizes may often vary a little with different manufacturers. Some may designate sizes in 64ths or 16ths of an inch. Carbon drills are cheaper, and usually make up into lower-priced assortments. We advise to pay more and get high speed type drills. They all break eventually but hi-speeds are better.

METAL DRILLING.

When drilling steel, use a light lubricating oil on drill. Brass, aluminum and cast iron are drilled dry. Be sure to use a center punch for starting. It is usually best, for accuracy - to use a fine drill first and then enlarge to correct size. Burrs may be taken off by holding a large drill in your hand and turning it around against the burr. If you have a hi-speed press hold the work down with a pair of pliers or clamps if you value your fingers! A slow-speed press is better for metals.

BAKELITE and other PLASTICS.

These take a dry drill, or at most, a little lard oil. It is best to flatten the drill some so it doesn't dig too fast. On holes up to ½" in diameter, you may use hi-speeds of 1500 rpm. They dull drills very fast so must be sharpened often. If work is done on a hi-speed drill, the hole may be found a little smaller than the drill, especially if it gets hot. To prevent breaking thru on the bottom, hold a block of wood under it - or preferably clamp it. This is especially true of Bakelite tubing. Like metal, it is best to start with a smaller drill and enlarge it later. Wood, or Compo. give no problems - but be sure to clamp a piece of wood at the back. New flat bits are best for larger holes in wood or Compo.

GLASS.

Plate glass, from 5/16" up may be drilled if done slowly and with care. Use emery dust, wet with turpentine as a lubricant and abrasive. A drill is ground

off perfectly flat, and fed the dust and turps. as needed. Rotate a few hundred per minute. Glass is really worn down instead of being drilled.

LAYING OUT.

When laying out panels or bases - get a larger piece of cardboard and arrange parts into the smallest space. Then figure size of your panel or base. Center punch thru into work, and the rest is easy.

MRL Handbook 12

gives lots of data on drilling and other shop work.

AUDIO AMPLIFIER COUPLING METHODS

When amplifiers are worked in several stages, they are said to be operating "in cascade." When this is done, it is important to have a low gain for each stage when more than one is used. If only one amplifier stage is used - then it may be to your advantage to use transformer or impedance coupling.

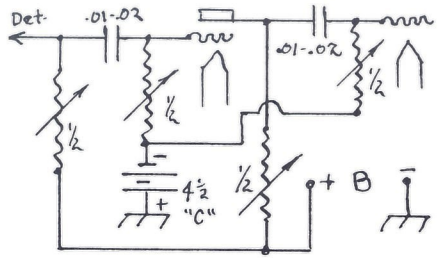
Improperly designed audio amplifiers may give distortion. We find three types of distortion. First may be frequency distortion, when some frequency is amplified more than others. As an instance, higher tones may be distorted but low tones are OK. If coupling condenser is too small, the lower tones will be less accented.

The second is phase distortion - where the output wave differs from the input due to amplification of complex waves.

Amplitude distortion is the last, and results from overloading of the grid in an amplifier tube. A smaller grid leak will usually take care of this.

RESISTANCE-CAPACITY (R-C) COUPLING.

This is the most used of any amplifier, due to its simplicity and economy - from two resistors

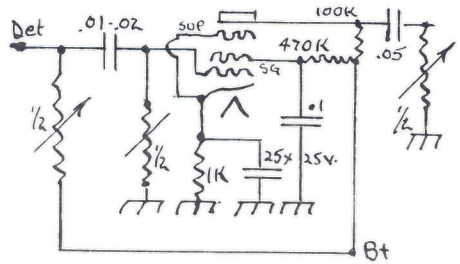


20-A. R-C Coupling. DC Triode.

and a capacitor, for about 30¢, compared to an audio transformer at $1.50 up in price.

No amplification is had in the R-C amplifier alone - the amplifying being done in the tubes only. This is the reason more stages are required for R-C. The screen grid tubes have more gain than triodes. We used to figure 3 R-C stages equaled 2 of audio transformer. For low-signal voltages, the amplification is fairly uniform for different frequencies, which makes it ideal for television.

When designing an R-C amplifier, it is a good idea to try variable resistors (volume controls) as shown in (Fig. 20-A, B). When you get the correct operating points, measure, and replace with carbon resistors. As stages are added, the amplifier becomes more critical and smaller grid leaks are required to get rid of excessive loading. More B-supply must be used on R-C coupling than transformer, due to drop in plate resistors. Too large grid leaks may cause "motorboating" or overloading.



20-B. R-C Coupling. AC Pentode.

R-C generally gives poor reproduction on both high and low audio frequencies. Loss, at low frequencies is due to loss of voltage across the capacitor. We have to compromise, because small capacitors cut down hum and prevent overloading. For Hi-Fi work - the resistance of the grid resistor is found by dividing the condenser capacity into 25,000. For instance, if condenser is .05 - then leak is 500K. A good rule to remember. Use as low plate resistors as possible.

The blocking, or coupling condenser should have a hi-working voltage rating, as they usually break down with AC surges. As a rule, we always replaced them on shop repair jobs. Manufacturers, for economy, often use 200 w.v., but we'd like to use 1000 w.v. to be sure. Its insulation must be very good - and always a dry type as paper, mica or ceramic — never an electrolytic! When this condenser breaks down - it cuts off signal or makes it mushy.

Norman gain, from triodes (20-A) runs about 10 to 70, depending on tube. Pentodes (20-B) may vary from 60-250. Triodes are better in the output stage if U are going to use phones, as distortion and hum are less, and less plate voltage is needed.

AUDIO TRANSFORMERS.

These are now used mostly for coupling an R-C stage to the push-pull output stage, and called an input transformer. Output transformers are also called audio transformers. If the input has a C-Tap secondary, then the primary of the output must also have a C-T. (21-B)

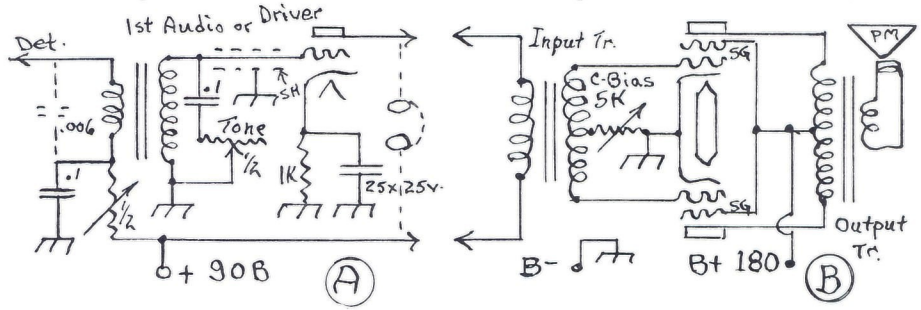
If properly matched, the audio transformer has many good points in tone and gain. However, we'll discuss some of their points.

When Radio was young, and tubes had very low amplification - we had to use audios to get enough power to work a speaker. However, big audios are heavy and very expensive. If used in TRX sets - the old audios would be as big as the entire set! Hi.

Remember the old $7.50 audios, with about 10¢ worth of iron in them? Also their tinny response? Remember Coto-coil, Freshman, Erla, etc.? By leaving out the iron, they cut off the low frequencies and made it tinny.

Also, because they were small, the amount of primary wire was reduced so impedance was lessened. #40 enamaled wire was generally used - and carried about 1.85 amps.

Audios should be rated 1:3 instead of 3:1, as primary is smaller than secondary - giving a step-up ratio. You can check the resistance, with an ohmmeter and see which is primary. If 3:1, the primary will measure 1/3rd the secondary. It was always considered that 3:1 gave better tone, but we often found very little difference between 1:1 or 5:1. Early audios were 3:1, 5:1, 10-1 normally. RCA-712 was 7½:1, but



21-A. Transformer Coupling. AC. 1st Audio or Driver.
21-B. Push-pull Amplifier Output Stage.

had lots of iron and with a good tone. Most wanted higher ratios to get more volume! No telling how many thousands of All-Americans and 3:1 Jefferson audios were sold in the 20's. Jefferson primaries burned out so fast you could almost make a living installing them! We never figured how many Air Kings we paid $1 for and got $4 installed and balanced up in our Los Angeles' store. Because very few bypass condensers were then used - the trouble was either audios, tubes or batteries.

If you get squeals from an Audio - reverse one side, as it's working as an oscillator! Also, we used to put .006 micas across the primary or secondary for the squeals and tone, to bypass the Hi-frequency notes to ground. (Fig. 21-A) shows a .1 x 600 v. condenser and 500K tone control across the secondary. Values may vary with some transformers.

If you get microphonics, with an audio stage, run grid lead thru a shielded wire, or coaxial cable - with outside grounded.

Audios may pick up 110 hum from power line or other transformers. When building a set, swing it around and note the hum before mounting in a neutralized position for hum.

An audio is good for cw. work, when running from regenerative detector to triode and phones. You can peak the audio with condensers and run the code in OK.

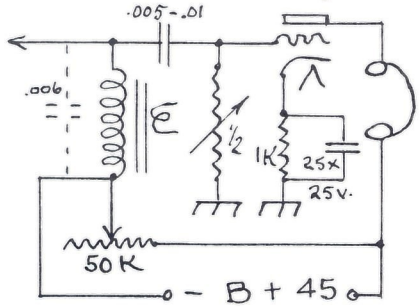
Always looking for a buck - in the 20's, many went around to Radio shops and "shot" the burned out audios for 25¢ each. A Hi amp. welding-type transformer was used, to cause an arc between broken turns. With a little sizzle - it'd weld a path - often thru several layers! Hi. If it didn't work - nobody lost anything. They seemed to work as good as new ones - altho we preferred the new ones.

We used to get lots of "intermittent" audios, in the 20's - signal coming off and on. To decide if they were burned out- we would shoot 22½ v. across them. If erratic- they'd blow out, but if OK - nothing would happen. One nite a fellow called me over and I "blew" his audio. He pushed me out the door, saying "you big crook! Before, it would work now and then - now, nothing, on account of you." Well, according to that, he'd probably figure on fixing it for nothing, anyway!

IMPEDANCE COUPLING.

This is often called choke coupling. While this is seldom used - its gain is about double that of R-C coupling, even tho it is lower than transformer.

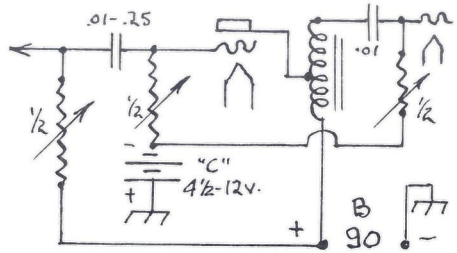
Principle is the same as R-C, except you use a choke, or impedance coil for plate resistor. The impedance admits more current to the plate than if a 100K resistor was used. Resistance to DC is very low, but at audio frequencies the impedance becomes very high. This tends to match the tube's internal resistance



22. Impedance Coupling. AC.

closer than a resistor. Impedance becomes greater on higher notes, so this gives almost perfect amplification. This may be reason why it used to be used by Hams. You may use one side of an audio transformer for the choke - but we prefer the secondary.

Further control of B-supply often helps in proper adjustment in regenerative sets. The best grid leak can be determined from diagram, and replaced with fixed. Try a .006 mica across choke for better tone.



23. Autoformer Coupling. DC.

AUTOFORMER IMPEDANCE COUPLING.

Also called step-up impedance. This was once used by several companies to get more gain. This used a tapped impedance, or coil - or may be modernized with a tapped Ferrite coil. The tap is used to make part of the coil act as primary and the whole to work as a secondary. You may have heard of the autoformer. A good modern example is the tuned coil with a tap running to the Aerial - so that it also has a stepping up effect. Coils may be made smaller than impedance chokes. A center-tapped transformer winding may be substituted if you wish.

The Experimenter may find this an interesting field. Combinations may be worked out to suit you. For instance, a stage of R-C coupling may be used; then a stage of impedance or transformer. If you get overloading, or "motorboating"- cut resistance of your grid leaks down.

****

A new customer, writing on a postcard "Please send me your Modern Radio Laboratory!"

Because we always try to give them what they want, our reply: "Will send Laboratory if you'll send $112,200 for postage."

DAFF-I-NITION

BUG - (1) an instrument for making dots and dashes.. (2) an insect that bites.. (3) a Radio Bug that gets bit, by the Radio bug!

IMPEDANCE MATCHING FOR MORE DX.

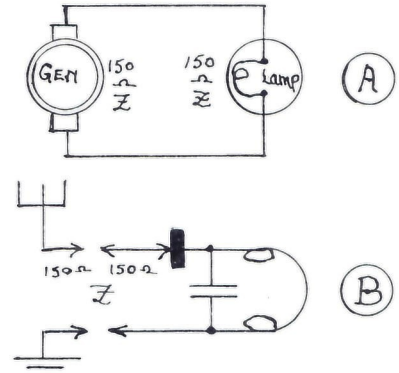
BY VERN YEICH

Broadcast Engineer

I regret that I haven't more time to experiment with crystal sets. They have a fascination for me because of their independence of power supply. Also, because of the extreme degree of efficiency that a careful builder can attain with one.

However, in tube sets, using power from the mains, the energy from the transmitter is used to control "valves" which regulate the current supply to work the speaker. This explains the fascination which the crystal set holds for so many. It operates solely from transmitted power.

For the ideal case, we'd want every bit of energy to flow into our phones, that we could get from the Aerial. Moreover, when we connect up our set to the Antenna system, we do not want to upset the current/voltage relationships which exist in the Antenna naturally, before connecting to the set. This depends on an old law of Electricity. A generator will deliver maximum power to the load, if the load is of the same impedance as the

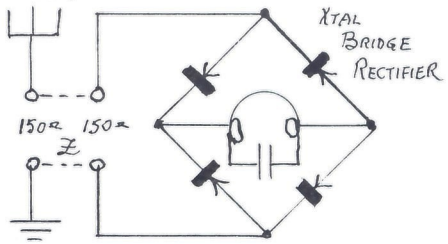


24-A. Generator-lamp Balance.
24-B. Likeness to Crystal Set.

generator. In other words, input and output impedances must match.

(Fig. 24-A) shows a generator and lamp that match. (24-B) is a crystal set with same idea. The latter shows setup for maximum transfer of energy from Ant. If the impedance of the headset is approximately equal to the backward resistance of the crystal, then maximum sound could be expected in the phones, provided set and Aerial are resonant to but one frequency.

(Fig. 25) shows a bridge rectifier, which increases the efficiency of the Xtal part of the set. This provides more power to the phones because current flows thru phones on each half cycle. All that is left is improving the sensitivity of our headset. This can be done by using well-built sets with lots of iron.

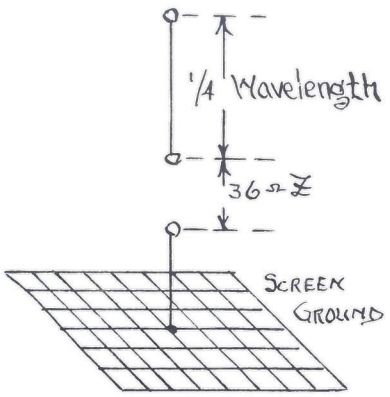


25. Substituting Xtal Bridge.

Of course, we assumed the best possible Antenna system when we started. Our only consideration, so far, was that of accurately matching the impedance of our Ant. and set. Every Ant. has its own characteristic impedance. They vary greatly for different types - and even Aerials of the same type will vary because of different surroundings. This impedance can be determined by using a Radio frequency bridge (not commonly available to the Experimenter), or approximated experimentally.

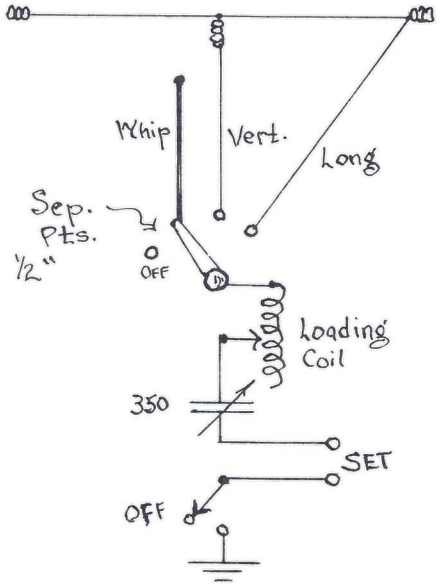
Perhaps the most satisfactory all-directional Ant. for DX, is the quarter wavelength vertical Aerial, where length is figured:

$$\text{Length equals } \frac{246}{\text{Megacycles}}$$



26. Vertical Aerial Dimensions.

The characteristic impedance of the quarter wave vertical Ant. is in the neighborhood of 36 ohms. For best performance, a good ground system should be constructed at the foot of the Aerial. A 20x20 ft. acreen of chicken wire can be soldered together and buried a few inches underground. (Fig. 26)



27. Aerial Combination Primary Tuning Circuit.

As you've noticed - most BC stations use vertical tower Aerials, which are non-directional. So, for your own use, why not go for a vertical Aerial? Due to limitations in height - you can bring in the shortwaves better as it is nearer their fundamental frequencies. Also, it will be sharper on BC bands. Above 50 mc. it is called a "whip" Aerial - but above 500 mc. it is called a "stub."

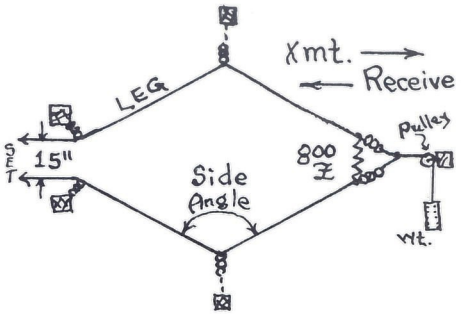
(Fig. 27) shows a practical scheme for making a vertical Antenna that can come in handy. Use the top for an inverted-L for longer waves or BC. Put an insulator in the center and run the leadin to a switch point on your panel. Other 3 switch pts. go to "off," whip and flat-top. An auto whip may be added near bench or on eaves and adjusted for length at will, for Ur high frequency experiments.

Then, rig up a 100 turn loading coil of 22 DCC. on a 2' form and tapped every 10 turns and run to another switch lever. Run lever to .00035 variable condenser, with a dial scale. Add a 3-point lever for off, chicken wire and other ground as desired. The inductance makes your Aerial longer; the capacitor cuts it down in size. So, you can tune to the exact incoming frequency and thereby increase your volume immensely.

(Fig. 28) shows a Rhombic, or diamond Aerial layout. If you want to work in one direction, and have lots of room - this is IT. Sometimes the increase is up to 20 times the volume of a vertical Aerial. It also gives less static. It will bring in transoceanic stations when others may fail.

While it is purely directional - wire lengths are not critical, as it works on almost any band. However, proper cut lengths for each side will increase power on that band.

The resistors make it directional and aperiodic. Resistors point toward receiving and the

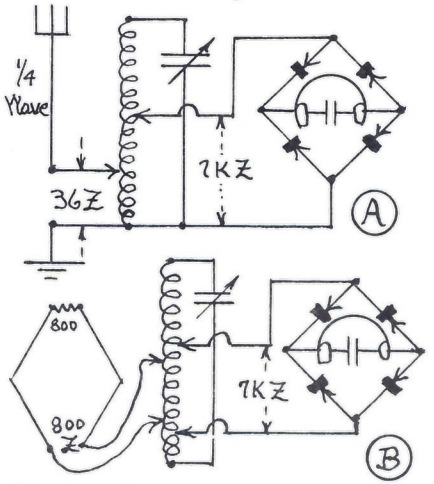


20 mc. ~ 49.2' Ea. Leg
10 mc. ~ 98.4' "
Others ~ Proportional.

28. Rhombic Aerial Layout.

transmitting directions. While special resistors are made - you may use (6) 5K ohm by 2 watt carbon resistors in parallel for medium-power transmitters. They will dissipate 30-45% of the emitted power between 7-30 mc.

It is important to have leadin impedance match the internal impedance of the Aerial. Do not use TV leadin wire, but use spacers so the #18 wire can be kept 15" apart for matching.



29. Impedance Matching to Crystal Detector from (A) Vertical, (B) Rhombic.

Another important spec. is the side angle. We suggest you place a pulley at the end so it can be let up and down. Pulling centers apart lessens the side angle, but cuts down the gain.

As mentioned before, the best gain is where input and output impedances match. Tank circuits (coil and capacitor) must be added to get selectivity. Depending on the "Q" - a tank may give impedances up to 100K ohms. The two following circuits are the closest approach to perfection in crystal set tuning. (29-A) is a set hooked to a vertical, or other Aerial. (29-B) is for the Rhombic. However, such arrangements are never as satisfactory as an Antenna with the same natural period as the station doing the transmitting.

Editor. The original article has been revised considerably.

EFFICIENT PAINT SPRAYING.

Most trouble with Aerosol cans is the drying of paint in the nozzle hole. Pull nozzle out and leave in bottle of lacquer thinner overnite. Then clean hole out with fine wire and it's ready for use. We found most nozzles fit other cans OK. You can tell if more paint is in the can by shaking it.

Use only lacquer on panels where currents may leak - like between switch points, etc. We have tried 125 v. DC. in series with a 1/25 watt Neon and found no leakage between needle points when using lacquer. We are dubious about using "enamel" on your panels or bases.

HANDLE DIODES & TRX WITH CARE.

Due to melting of wax, etc. in Diodes and Transistors - it is always good to hold the lead with a pair of long-nozed pliers as a heat sink. Hold it between soldered joint and Xtal.

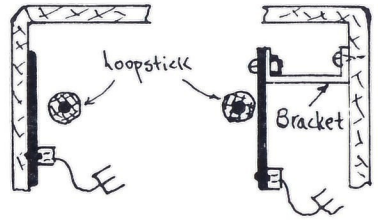
When mounting a TRX, in a congested area, always use a 3-lug tie point anchored to base. When all leads are made to tie point, then solder TRX onto it last.

IMPROVING JAPANESE MINIATURE RADIOS

Most of us have picked up one or more of these tiny Radios as extra Radios. There are several ways you can improve them.

TONE. Ours used a tube as pentode output. Diagram showed a .0002 across primary of output transformer- but none was there! So, we put a .1 x 600 v. where it should have been. This made the tone 100% better.

AERIAL. Most use a loopstick for Ant. coil and aerial pickup. You've noticed how the volume is increased when you placed your hand next to it. If you add a pickup wire to the loopstick, it will overload the set, as they are peaked to efficiency. This may also cause a decrease in volume. We cleared this up in good shape. A piece of tin was wrapped with paper and taped and placed inside the cabinet and alongside the loopstick. A small Fahnstock clip was fastened to back of tin to take the Aerial.



30. Coupling Aerial to Loopstick.

Be sure you cover tin so it will not touch chassis as latter may be "hot." If tin touches chassis it will also decrease volume.

Not much increase in volume on locals was found, but it sure brought in the DX. The inductive coupling between tin sheet and loopstick also eliminates the directional affect, which is a big advantage. We brought in stations 500 miles away - on a set that barely got 150 miles without an Aerial. We got KFBK, Sacramento, 125 miles away and

while loud local 10 Kc. away was blasting away. Being a superhet, - it has gotten lots of stations - since rigging it his way.

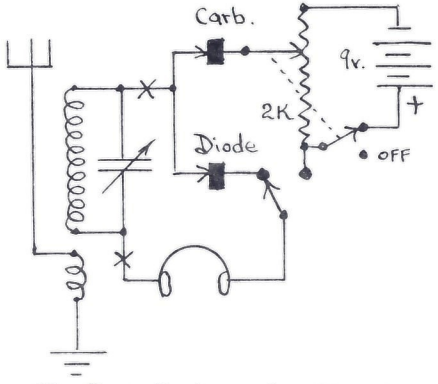
NOISY VOLUME CONTROL. These often have to be replaced as sets are made in a hurry.

A friend had one like ours but he got a burned out tube and an output transformer but probably due to constant use. However, what can you expect for a few dollars?

SOME CRYSTAL SET EXPERIMENTS

We have made some recent experiments with fixed and mounted Carborundum crystals. Instead of the usual 1½ v. cell - we use a 9 v. Transistor battery.

We use a 2000 ohm volume control and switch hooked to the battery as shown. Switch cuts off the batt. when not in use, as resistor is continually running down the battery. With the 1½ v. cell, we find the Potentiometer is about clear on for the best results. However, when using the 9 v. TRX battery - we find the midpoint is about right for operating. You can test up and down and readily note the difference in volume as well as the various peaks, etc. Do not adjust Pot. on loud locals, but find a weak or DX station. This will aid in studying a crystal.



31. Best Carborundum Circuit.

Much more info. in MRL HB-3 "Crystal Detectors" on page 7. Carborundum has been used with up to 10 v. in series, so we do not believe you can injure one of them, like a Diode or Galena.

If you notice a "fuzziness" - reverse Xtal connections or readjust the catwhisker for best point and sound. Each Xtal will be a little different in adjustment - due to method Nature has of throwing things together.

Rig up the unit (Fig. 31) for use on various tuning units by hooking at (X). Note one side of SPDT switch goes to Diode or to other crystal, which is used without a battery current.

An Experimenter reports from 20-25% more volume with 2 Xtals in a push-pull circuit, than with just one. He expected more. He used an 0-1 DC Milliammeter in series with the phones. (An 0-50 microammeter will give much closer readings.)

An Experimenter, with an MRL #2 crystal set reports .32 m.a. when hooked to a radiator for an Aerial, on loud 1000 watt local. With an attic Aerial he got .84 m.a., or almost 3 times as much. You can see the proportion you would get on an outside Aerial.

One fellow, in Missouri, hooked 250 ft. of wire to a box kite as used in life rafts during the war. He hooked an MRL #2-A to it and couldn't stand the phones on local stations.

Another fellow asks about a crystal across phones as used in assembled stands and crystal. The station, that most matches the Aerial in frequency, will be the loudest in volume. It is necessary to use a loading, or tuning coil and condenser to tune in the others with good volume.

An Experimenter asks about the best hookup wire for Xtal sets. We prefer #22 stranded, plastic covered for switch point leads. For balance of sets - we like larger wire to carry HF current.

Often a crystal set will really "throw" an Old Timer. Some of the simplest things can give the most trouble. Most that we find

is the builder fails to tighten up all parts so they don't jump around. Also, poor soldered connections may often act up. Jerk on the lead, after you solder it and save yourself a lot of time later. When phones and Xtal are hooked up near a leaky 110 line, you may get a hum but low signal - like I did once with an attic Aerial. If you get nothing at all - start checking with phone and battery from Aerial, thru set and back to ground, for bad connections. The advanced Experimenter, with a good Ohmmeter, can usually spot trouble at once if he checks right. Another favorite spot of ours, is to look for shorted condenser plates. Hook a 50 watt lamp in series with 110 and test clip, and hook to stator of condenser. Hook the other 110 lead to frame, and run plates around slowly. The metal filings will burn out. We test all our kit condensers like this before boxing them, - we find it sure does pay. Another point on condensers - many have stator leads running out both sides for ease in wiring. Be sure you hook one side of coil to stator and other to frame, or you'll have a shorted coil.

One old Experimenter, after wearing out many of our Handbooks, and building all kinds of Xtal sets - has now gone into business for himself. (See MRL HB-11 for more details.)

If you have a small space, and access from the street, why not put up a little sign "Crystal Sets Built?" You'll be surprised how many will stop and listen to your "selective Crystal Set." Most, including Radio dealers, still believe you can only get one station on a Xtal set. If people hear them - they'll usually have someone who would appreciate one built for them. We have lots of professional people who build them as a one-night project. There is still a big field here - and we should know, it is our mainstay in business! But, be sure you have a good selective rig before you start.

Some talking points of crystal sets are low upkeep; no need for batts. or power; use at night at bedside to keep programs to your self; to awaken you in the a.m.; take on camping trips; better tone; more selective with proper circuits; and easy to build.

You can't build a good crystal set with a small coil, like used in tube sets with lots of amplification. The large 2" low-loss celluloid coils are the thing, and they'll bring in the DX if you build them right.

A 30 YEAR CAREER FROM XTAL SETS TO B.S. IN PHYSICS.

Peter Szeman, New Mexico, began crystal sets with MRL about 1934 (30 years ago!), and this launched him on a fruitful career in Electronics.

He was on a farm then in Pennsylvania, and spent many long nights building and operating Xtal sets via MRL. Radio servicing became his next profitable step in his career.

1942 - enlisted in the U.S. Army as Radioman.

1945-48 - went to RCA Institutes and graduated from their Radio Engineering course.

1948 - worked for Allan B. Du Mont Labs. Built first TV station in Pittsburgh (WDTV - now KDKA-TV). Worked at station for 5 years. Went to Univ. of Pittsburgh on the side.

1945 - graduated from Univ. of Pittsburgh with a B.S. in Physics. Went to work at Los Alamos, New Mexico, in the Theoretical Physics' Division.

1957 - became an Electronic Engineer for the U.S. Air Force. Later established Microwave Lab. in Albuquerque.

He has a 1st class Radiotelephone License, plus advanced Amateur W5IBQ (off air now).

He still remembers our mimeographed sheets and Blueprint #17 of 18 crystal set circuits and he says it "was really blue!" Hi He still likes to drag out the old crystal sets and tinker with them. He warns us "what CAN happen to a youngster building Xtal sets." We're glad we had a hand in his wonderful career. We have hundreds of letters telling how our little Xtal ads started them off into fruitful careers.

How about you??

MINIATURE TUBES

FOR 7-PIN MIN. SOCKETS.

Here is a quick-reference for many small glass-base, miniature tubes, for use in small spaces:

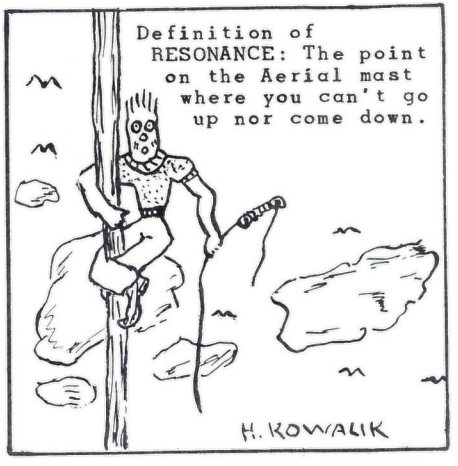
Type	Fil.	Use in circuit
1A3	1.4	Det.; FM Discriminat.
1L4	1.4	RF Amplifier.
1R5	1.4	Converter
1S4	1.4	Pentode Power Ampl.
1S5	1.4	Diode Pentode Ampl.
1T4	1.4	RF Amplifier
1U4	1.4	do
1U5	1.4	Diode Pentode Ampl.
2E30	6.	Beam Power Amplifier
3A4	*1.4	Pentode Power Ampl.
3A5	*1.4	HF Triode Amplifier
3Q4	*1.4	Pentode Power Ampl.
3S4	*1.4	do
3V4	*1.4	do
6AG5	6.3	RF Amplifier.
6AJ5	6.3	UHF RF Amplifier
6AK5	6.3	HF RF Amplifier.
6AK6	6.3	Pentode Power Ampl.
6AK7	6.3	RF Amplifier.
6AL7	6.3	UHF 2-diode detector
6AN6	6.3	2-diode Detector
6AQ5	6.3	Beam Power Amplifier
6AQ6	6.3	2-diode; HI-mu Triode
6AR5	6.3	Pentode Power Ampl.
6AS6	6.3	RF Pentode.
6AT6	6.3	2-diode triode RF Amp
6AU6	6.3	RF Amplifier.
6AV6	6.3	2-diode Triode
6BA6	6.3	RF Amplifier.
6BD6	6.3	do
6BE6	6.3	Converter.
6BF6	6.3	2-diode triode Ampl.
6BH6	6.3	RF Amplifier.
6BJ6	6.3	do
6C4	6.3	HF Triode Power Amp.
6D4	6.3	Gas triode.
6J4	6.3	UHF Gnd grid; RF Amp
6J6	6.3	2-triode; mixer.
6N4	6.3	UHF Triode Amplifier
12AL5	12.6	2-diode Detector.
12AT6	12.6	2-diode triode Amp.
12AU6	12.6	RF Amplifier.
12AU7*	6.3	2-triode Amplifier.
12AV6	12.6	2-diode Triode.
12AW6	12.6	RF Amplifier.
12AW7	12.6	do
12BA6	12.6	do
12BD6	12.6	Pentode amplifier.
12BE6	12.6	Converter.
12BF6	12.6	2-diode Triode.
26A6	26.5	RF Amplifier.
26C6	26.5	2-diode Triode.
26D6	26.5	Converter.
35B5	35.	Beam Power Amplifier
35W4	35.	Half Wave Rectifier.
45Z3	45.	do
50B5	50.	Beam Power Amplifier.
50B6	50.	do
9001	6.3	Converter; Amplifier.
9002	6.3	Det.; Ampl.; Oscil.
9003	6.3	RF Ampl.; Mixer.
9006	6.3	UHF diode Detector.

(*) means filament may be connected in series at twice this parallel voltage. However, you get less output if connected in series. Also, tube may last a little longer in parallel.

Answering our ad: "Please send me your Crystal Set called "Catwhiskers." (m e o w)

Sign in Radio window; "Radio Technision."

Kid wrote underneath: "Painter's mistaik."



SUBSTITUTING TUBES

Sylvania shows how to make a quick-change drawing when substituting tubes and sockets. Note the new tube is on the inside; tube to be replaced on outside. I'd make just one connection change at a time to avoid error. Individual tube drawings are at the top - so you can readily trace connections.

RCA used to put out a Pin-dex, which was a book with pages split across. You'd find one at the top and look for other on lower half. Worked good. Then you just compare the two drawings.

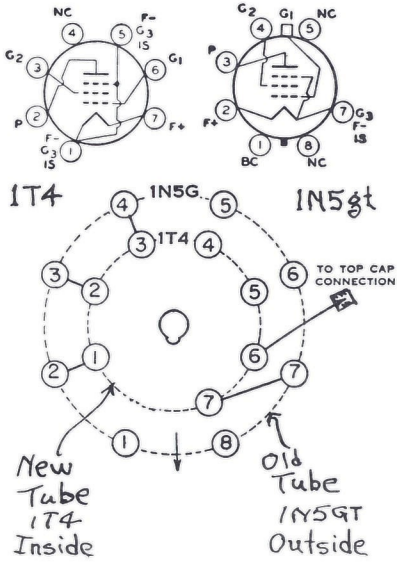
Be sure substituting tubes are of same voltage and amperage or it will be necessary to allow for this in your hookup.

If you'll check, in your tube manual you'll find 1T4 and 1N5gt both are 1.5 v. and .05 amps.

In switching connections, take P on one socket and draw it to P on other socket. Continue with other connections as shown.

AMPLIFIERS

TYPE 1T4 REPLACING TYPE 1N5GT



32. Quick Substitution Chart.

DO YOU REMEMBER?

Most Old Timers get a bang out of reminiscing about the Good Ole Days. During the 20's - almost everyone had their fingers in Radio - either building them or listening to their neighbor's sets half the nite. Certain DX stations were often heard "for the first time" - by someone in the neighborhood- and this spurred everyone on.

Austin Windsor, Ill. says: "Ur literature took me back to my first single-slide tuner Xtal set - built in my Sophomore year in 1921. Coil on a 5" cardboard tube 10" long, #20 enameled wire wound tight. Later I added a secondary of #30 wire on a 4½" tube that slipped inside for a loose coupler. As I progressed upward thru multi-tube sets - I never got the kick out of any like the old slider - tuning in stations 50 miles away.

"I had a Radio shack about 12 by 16 and a 4-wire flat-top 100 ft. long and 40 ft. high and enough ground metal to build an automobile.

"I kept my Iron pyrites xtal wrapped in cotton when not in use. I refused $1 for it. I have catalogs of the old E.I. Co. (Gernsbach Electro-importing Co.); Rasco (Radio Specialty Co.); Wm. B. Duck Co.; AMCO (the Adams-Morgan Co.); MESCO (Manhattan Elec. Supply Co.)."

Doc Loomis, Oregon, reported: "In 1922, when 16, I was assistent to assemblyman in the old Empire Radio Corp., but made and sold sets on my own in my spare time. Tubes were just coming in, using storage batts. (200-A at $5 each). I sure enjoyed our old home-made variocouplers, honeycombs, spiderwebs wound on slotted phonograph records, etc. Also massive tuning coils with two sliders on the primary and sec. ondary sliding inside - whole mess as big as a stovepipe. A Murdock 43 plate table mounted variable condenser at $5 each. A real big phone condenser for 75¢, etc. 6-wire barrel Antenna. Magnavox horn speakers, etc. But now with my big modern set - I still get the crystal bug now and then."

Editor. I remember them all. I used to get the magnifying glass and try to count the turns on a coil. My first coupler was a salt box - enclosed in a neat Redwood shake box! Secondary slid out at the right with a rotor switch of 10 points to divide the secondary of #30 DCC. (Oh, to think of all that dead-end effect!).

A crystal was used, but later changed to an Audiotron with a spare filament wired in. These were hard to get at $7 used.

Transmitter at 6NW (1919) was a Ford spark coil working from an AC bell transformer - which changed tone during transmission as the points got hot! Later a ½ K.W. transformer from Sears, Roebuck. With my first "handsome homemade rotary spark" - just one press of the key - and juice jumped to the shaft of the motor - and I never did get that motor to running again! Later, I got a new rotary spark gap - and proceeded to jam up the air.

30 miles was good DX, altho we received Hams, ships and other stations from all over the West. The same wattage would now easily work around the world.

Even with the dead-end effects - you'll notice these old couplers tuned both the primary and secondary circuits for higher gain. We needed it- as tubes were slightly better than the crystal for sensitivity. Pulling the secondary out - loosened the coupling between circuits - and there never has been a better way to control selectivity between two coupled circuits. Present sets cut down Antenna turns to get selectivity, and jack up the volume to get the gain.

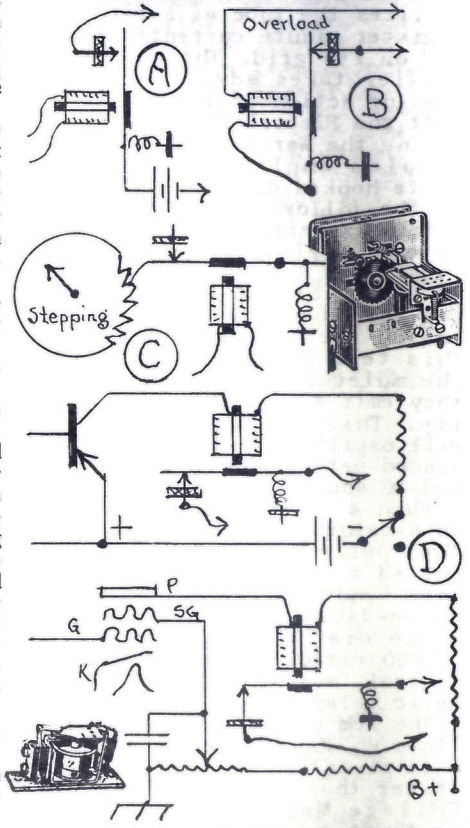
These old parts, when they can be found, usually get into museums. Many Radio Antique clubs are operating around the country now. They have meetings and discuss their Good Ole Days!

RELAYS

We never gave much thought to this branch of Electronics until one of our customers wrote in about them.

Probably the first relays were used when a feeble current came over a telegraph (A). This entered a coil of fine wire, with an iron core center. The core pulled the armature, to make a contact in order to operate a loud sounder, and be copied without difficulty. It was necessary to pull the relay armature but a few thousandths of an inch.

Later, heavy relays, in the form of circuit breakers (B) were used. Instead of blowing a



33. Some Relay Circuits.

fuse, this overload relay would break the circuit for an instant and throw it back on again. This would save valuable apparatus.

The Radio tube is one of the most developed type of relays. A very feeble current, on the grid will be magnified many times on the plate. DeForest found, that by adding a screen grid, the operator could trigger the action of the relay, by regulating the current applied to this new grid element.

A magnetic relay may be placed in the plate circuit and triggered by light affecting a photo electric cell in the grid.

The vacuum-tube voltmeter is another useful instrument that utilizes the tube as a relay, to register minute currents impressed on its grid. The common amplifier takes advantage of the step-up action of the tube.

At the Electrical Products Co. during the War, we used a direct coupled amplifier, with the plate hooked direct to the grid of the following tube. Amplification is terrific. We hooked it across a vise with insulated jaws. They squeezed a large pc. of quartz crystal. This squeezing showed a considerable reading on the plate output meter, This test is to show that when the molecules are re-arranged, they emit a current of electricity. This proves the crystal will oscillate when smoothed and placed between two metal plates, and AC applied.

When a relay magnet pulls on an armature, and actuates a pawl that pulls a ratchet - this is called a counting relay (C). We have hundreds of uses for these now-a-days. When you spin your phone dial - you actuate some 10,000 circuits at the telephone central, mostly by means of magnetic relays and tubes.

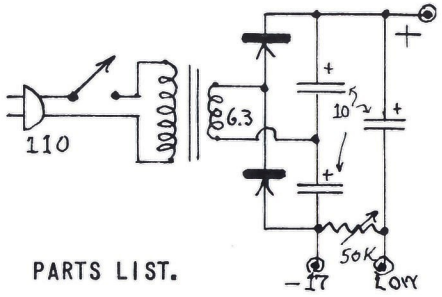
The IBM electric brain can now store up 400,000 digits and does multiplication over 60,000 times faster than a human. (No wonder College Majors are lousy in arithmetic - they don't need it any more!) Hi.

Another familiar counting relay works at intersections as cars are counted in both directions. If you approach a red light from the side street, and no cars coming on the highway, you immediately get the green light. If traffic is heavy, you will wait until a certain number of cars have been counted. If you have an Auto Radio, you'll probably hear the relay circuit click as you hit the plate with your tires.

(D) shows relay connections to Transistor and tube outputs. You can now buy hundreds of different types of relays. Look into some relay catalog and see.

From a rig, to keep out chicken thieves - to electric brain - the principle is the same.

2 GOOD LOW POWER SUPPLIES

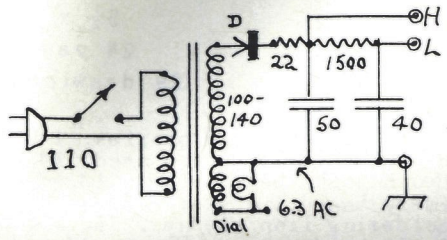


PARTS LIST.

1 6.3 v. filament transformer.
1 50K volume control and switch.
2 Silicon rectifier diodes.
3 10 mfd. x 25 v. condensers.
1 3x3 compo. base.
1 Vol. control mounting bracket.
3 Binding posts.
1 110 plug and cord.

34. Doubler Power Supply for Transistor use.

Here is a good circuit (34) for low-power rigs, as Transistors, Carborundum, etc. Not recommended for larger rigs that draw much current. This is a good doubler circuit that doubles 6.3 v. AC into 17 v. DC.



PARTS LIST.

1 Isolation transformer.
1 SPST toggle switch.
1 Silicon rectifier diode or 65 to 100 m.a. Selenium rect.
1 50 x 150 v. filter condenser.
1 40 x 150 same.
1 6.3 v. dial lamp and socket.
1 Base, about 4x4 compo.
1 22 to 56 ohm x ½ watt resistor.
1 1500 ohm x ½ watt.
3 Binding posts.

35. Heavier Duty Supply for 1-3 Tube Rigs.

You may use 1N34 crystal diodes, but Silicon rectifier diodes seem to give more output. They are also more reliable as they can stand a higher current. Be sure to get polarities right.

Volume control may be other than 50K - but this should lower voltage a lot for tests. Run the 17 v. to the last TRX stage. Run the LOW to other stages. Connect switch on volume control so you can cut off 110 when not used.

Filter condensers may be 10 mfd. - or larger if desired.

You may also use the 6.3 v. AC on tube filaments at the same time you use the power supply for B. Be sure to get grounds (-) on the same side.

For real heavy-duty rigs, we prefer the layout in our DP-49 - using tube rectifier. However, this circuit (35) works very well with our 1-2-3 tube rigs. It has very little hum - not enough to bother.

It uses an isolation transformer. This keeps you from getting shocked if the chassis is grounded like line cord sets.

You may use a 65 to 100 ma. Selenium rectifier unit on this rig. Or, you may use a Silicon rectifier diode as desired.

Resistors are ½ watt. Formula for the 22 ohm protective resistor is from 22 to 56 ohms. This helps save the rectifier in case of high voltage surges. Drain is very low on small rigs. Note we replaced the audio choke with a 1500 ohm resistor.

You may use 150 v. filters, but 450 will be safer but will occupy more space. Note the (H) runs to the last power stage of your set. (L) runs to the other stages where more filtering is required. We use this supply on our 2-tube (DP-31) and it works swell - with very little hum unless phones are used. If you desire less hum - add another 1500 ohm and 20x150 v. filter cond.

Selenium rectifiers have been used for a long time on meters, sets, etc. Some operate up to 5K volts at 20 amps. Others operate at hi-amps and low-voltage for battery chargers. Standard for most sets is 100 ma. Our Sears' TV set uses (2) 350 ma. in a doubler circuit that doubles 110 up to 270 v. DC. Altho the same principle as a crystal, they will not work as detectors in a receiver.

More on Silicon rectifier diodes in MRL HB-10.

INTERMITTENT FILAMENTS.

Hours add up, on a job, when U get an intermittent set. Often it takes days to right it. A good kink, that will work on series strings for bad tubes is as follows: Clip a 1/25th watt Neon lamp across each filament and put the set on. If a filament goes out - the Neon will light on the bad tube. This is just one more hurdle you've made.

BERYLLIUM

used in Fluorescent tubes is dangerous to inhale or to get in an open sore or it may not heal. Break them under water. Handle them with newspaper or gloves. They say the light is not harmful to the eyes.

another MRL Handbook...

HB-12. "Radio Workbench Tips."

$5\frac{1}{2}$ x $8\frac{1}{2}$
24 pages
29 drawings

CONTENTS

A FEW of the QUESTIONS ANSWERED in HANDBOOK 12. Pages given.

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Can it lead to inventions? 3.
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This is one of our most popular Handbooks. The title may be a little misleading, as it covers a lot more than the workbench itself - as you can see from the above contents.

It gives tips on starting a Radio repair shop on a small scale and working up to a full-sized establishment. If you have a fairly good knowledge of Radio you can do it. This is the easiest way to make money in Radio - College can come later.

All the Handbook is result of many years of practical experiences - no dreamy stuff! Much has cost the writer a lot. As you know - most of us do everything wrong the first time!

Bench equipment, etc. can be used for years, no matter how much Radio and TV change. It is designed far ahead of present.

The average handyman will find many practical things of interest to him in his work and his many hobbies.