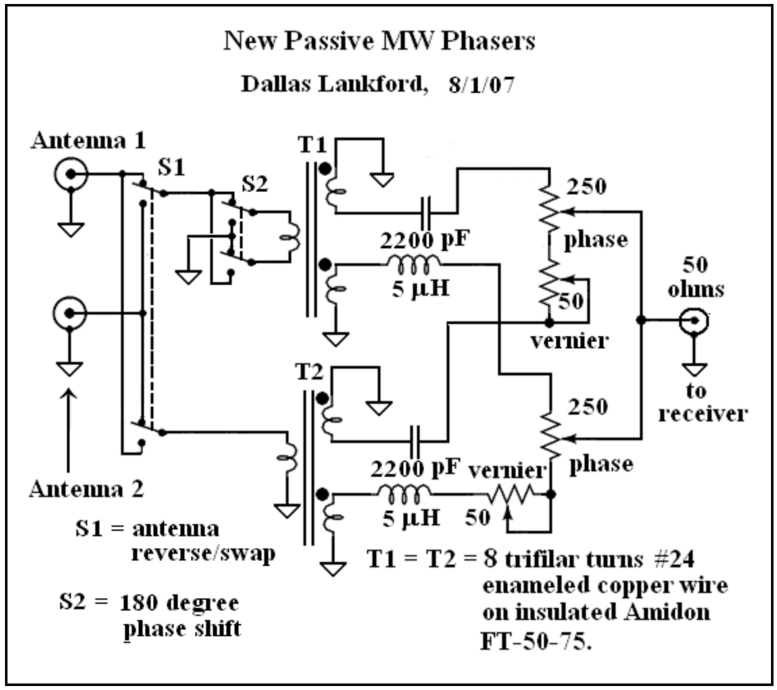
New Passive Phasers

Dallas Lankford, 8/2/07, rev. 8/6/07



I have never been entirely satisfied with the family of New High Performance Phasers which which I designed in October 2006. It always seemed to me to be more difficult to generate nulls with the new high performance phasers than with my modified Misek phasers, such as MW Phaser #2, and in some cases the nulls of the new phasers did not seem to be as deep as the nulls of MW Phaser #2. After testing many variants of those new phasers, I believe that I have finally found one for which null generation is as easy as, if not easier than, MW Phaser #2 in most, if not all, cases. At right is a schematic of a MW only version of these new phasers. ***Note that this schematic and the schematics below are not the same as earlier schematics in (previous) drafts of this article.*** For many daytime groundwave signals and most nighttime skywave signals the vernier controls are not absolutely necessary, but they are often useful even when not necessary. As with previous designs of mine, the vernier controls should be set to mid range before beginning to null a signal or noise. Like my previous high performance phasers, no amplifier is necessary for these new passive phasers. All of the phasers I have modified or designed, including these newly designed passive MW phasers, should be used with identical antennas spaced 0.1 λ apart at the lowest frequency which is used. If used with other antennas or other spacings, nulls may not be as deep as potentially possible, and in some cases nonexistent. The simpler version above is configured for coax input. A more complex version below is configured for switchable coax or twin lead input.

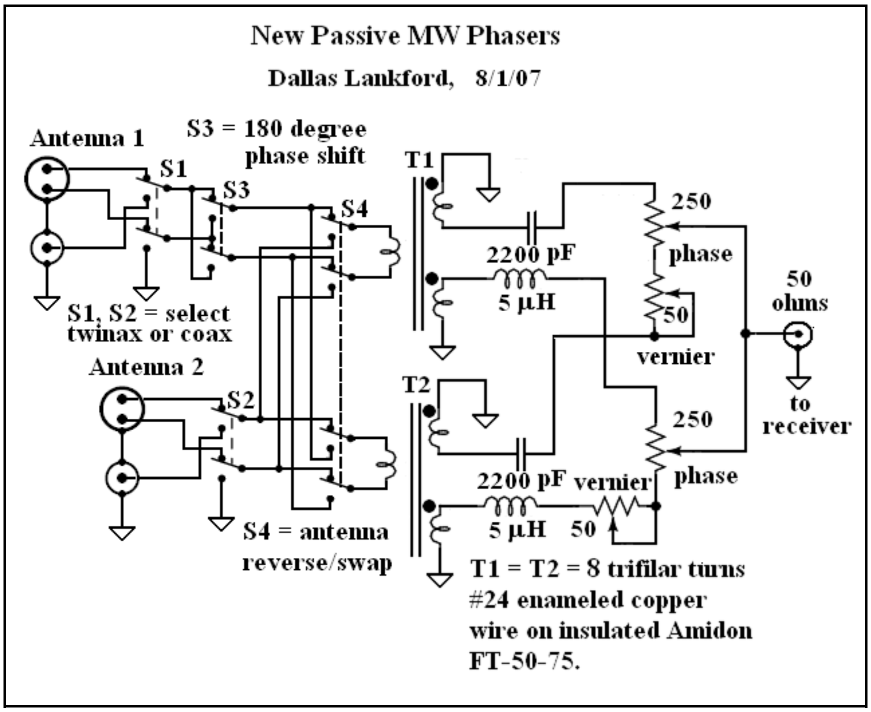
Brandon Jordan has called my (previous) new high performance phasers passive phasers, which is a good name because they do not need an amplifier to work correctly or for adequate signal levels. An amplifier (or 2 or 3) may be beneficial if you use these passive phasers with short antennas, such as 15' noise reducing antennas. You may use two unamplified noise reducing antennas with an amplifier at the output of the phaser, or two amplified 15' noise reducing antennas with or without an amplifier at the output of the phaser. These antennas are discussed in detail in articles in The Dallas Files.

The New Passive MW Phaser above has been tested throughout the MW band with a pair of unamplified 15' noise reducing verticals, a pair of amplified 15' noise reducing verticals, and a pair of (unamplified) 45' noise reducing verticals. It works as well as my modified Misek phasers, such as MW Phaser #2, in the MW band.

The main supplier, Newark InOne, of the 200 ohm and 50 ohm pots which I normally use has recently raised the price of their 200 ohm Type J pots (now manufactured by Honeywell, formerly Clarostat, formerly Allen Bradley) to about $50 each, and discontinued their 50 ohm Type J pots. They have a few (34 as of today, 7/21/07) 50 ohm Type J pots for about $20 each (buy them while you can). Surplus Sales Of Nebraska currently has 250 ohm Allen Bradley Type J pots (NOS = new old stock) for $6 each. I have been using the 250 Ω AB Type J pots for several weeks in a new high performance phaser and in this new passive MW phaser, and they seem to be suitable substitutes for the specified 200 ohm Type J pots. Time will tell. NTE may also have suitable 50 ohm pots, NTE number 501-0001, Mouser 526-501-0001 for $12.50 each, but I have not tested any of those pots yet.

While these circuits are still prototypes, I have decided to circulate them anyway because of the simplicity of the simpler versions, their generally lower cost and complexity than my modified Misek phasers, and their excellent nulling performance which has been verified to be equal to MW Phaser #2 and its variants in the MW band. These new circuits were motivated by Misek's original design and by my New High Performance Phasers which will be retired after less than a year in The Dallas Files. Not only was Misek's phase shifter not symmetric, but the signal from the inductive phase shifted component was routed to the capacitive phase shifted component. I believe this accounts for the smooth control of null depths exhibited by Misek phasers. The new passive MW phasers described here are also not symmetric, and also route an inductance (and capacitance) phase component(s) to the other branch, though not in the same way as Misek's phase shifter.

At right is a more elaborate version of the new phaser for switched twinax or coax input.

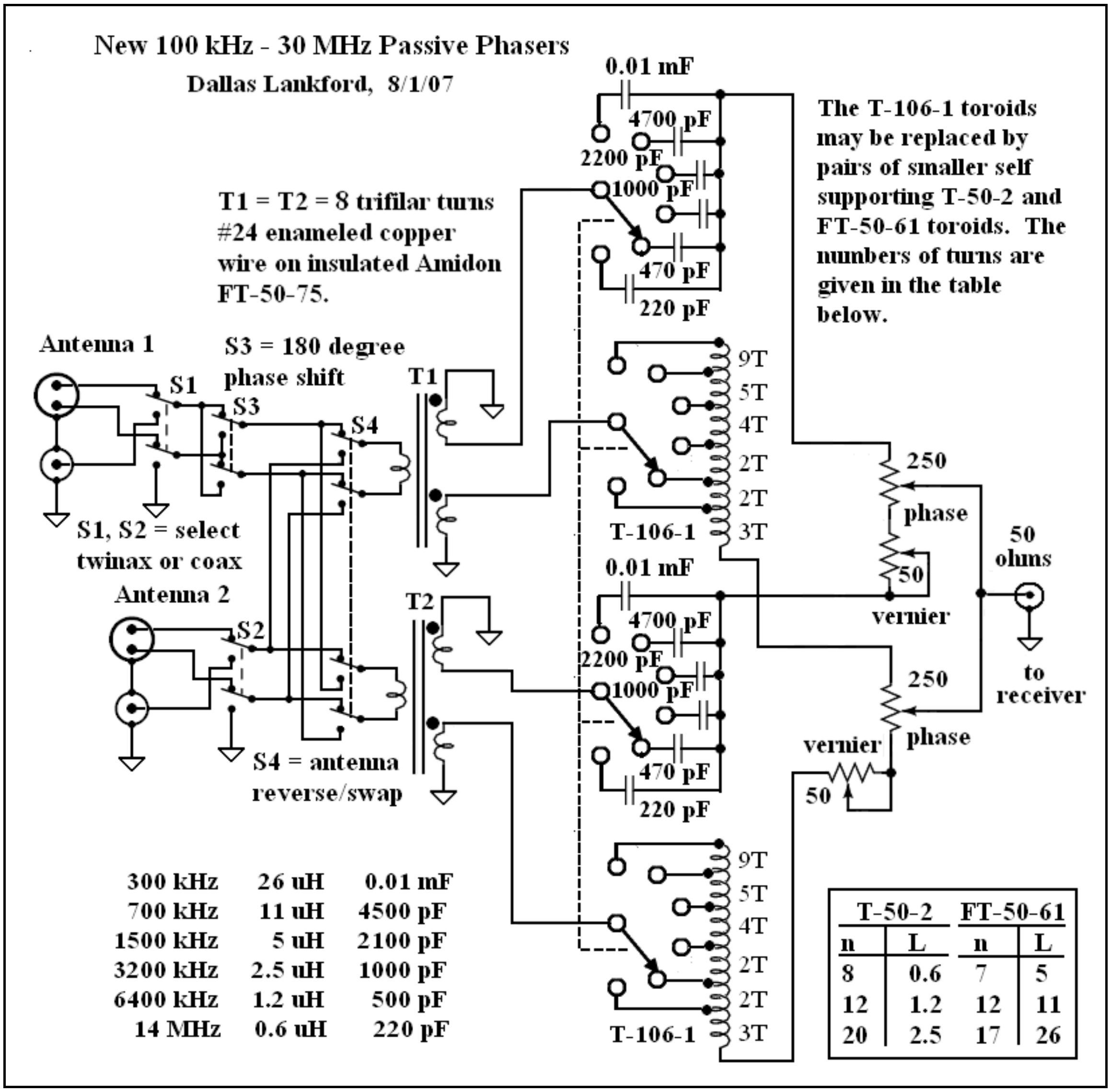


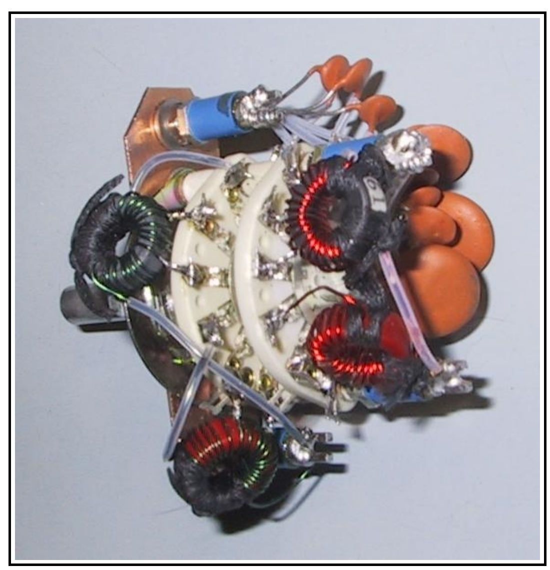
A schematic of a 100 kHz – 30 MHz bandswitched version is given below. Instead of T-106-1 toroids specified on the schematic, two pairs of smaller self supporting toroids were used, namely T-50-2 and FT-50-61 toroids. The numbers of turns for the required inductances are given in the table with the schematic.

The bandswitched version below is not intended for general construction. It is an experimental version to determine if this approach works well at VLF and if it is useful for nulling noise at SW frequencies. At present I do not know of an off the shelf rotary switch for the bandswitched version. I custom built one using parts from other rotary switches. As an experiment, instead of 50 ohm pots for the vernier controls, I used two 100 ohm pots which I had on hand with fixed 100 ohm resistors in parallel with the pots. These modified 100 ohm pots are not quite as linear as 50 ohm linear pots, but they are close enough.

Accidental or deliberate changes in the wiring of the passive phasers described above and below should be avoided. If the circuits are not true copies, they may not perform as well as described; the nulls may not be as easy to generate as they should be, and null depths may not be as deep as they should be. For example, changing a vernier control from one side of a phase pot to the other can and probably will degrade performance, such as making null generation more difficult.

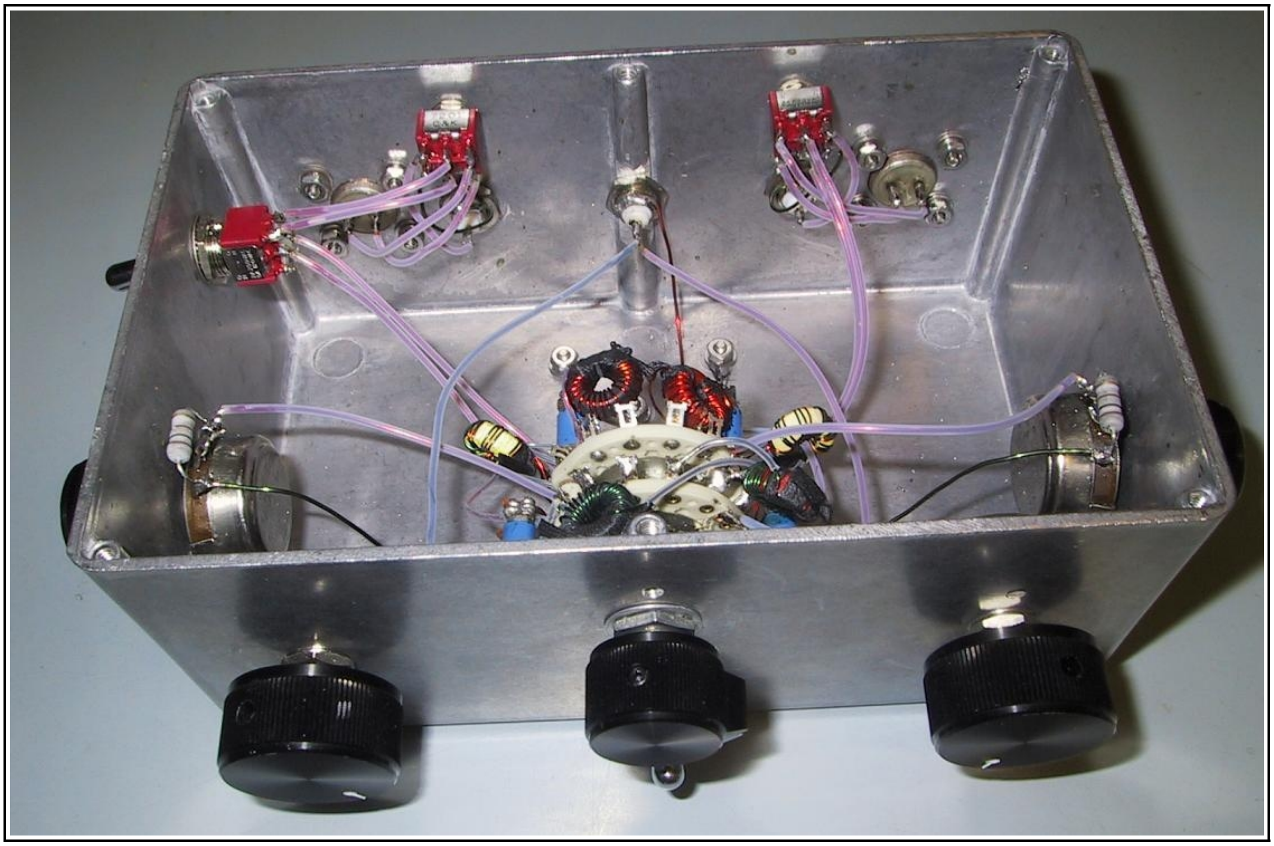
Based on preliminary testing the bandswitched version (below) generates excellent steered cardioid nulls in the MW band when used with an ALA-100 loop antenna (60' circumference loop head) and an amplified 15' noise reducing vertical antenna spaced about 20' apart. Good performance with other non-standard antennas or for other frequencies is not guaranteed. For example, in the NDB band (~ 250 kHz) a variable attenuator at one of the antenna inputs was required to obtain deep nulls with the loop and vertical spaced 20' apart.

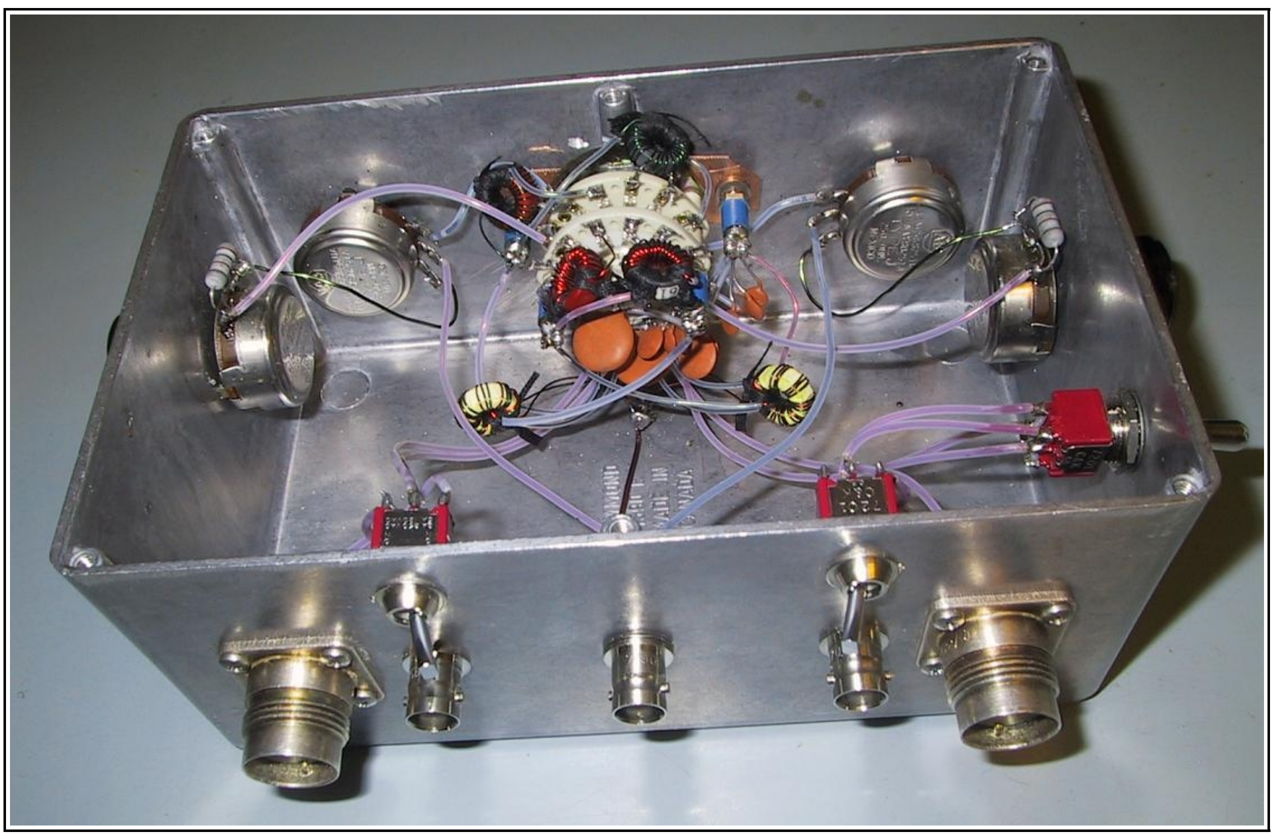




The photo at right shows the bandswitch assembly using four small toroids. The rotary switch was modified with four insulated standoffs and two small hand made brackets mounted to the rotary switch assembly using the two wafer mounting screws which permitted all inductors and capacitors to be mounted directly to the switch assembly.

My bandswitched New 100 kHz – 30 MHz High Performance Phaser which was built in October 2006 has been upgraded to a bandswitched New 100 kHz – 30 MHz Passive Phaser by replacing the old bandswitch assembly with the new bandswitch assembly at right. Below are interior photos of the completed bandswitched 100 kHz – 30 MHz Passive Phaser. Preliminary testing indicates my new passive phaser also nulls noise at SW frequencies as well as the 100 kHz – 30 MHz versions of MW Phaser #2 (and #3 and #4).





Like my modified Misek phasers, MW Phaser #2, #3, and #4, which are described in detail in The Dallas Files, my new passive phasers basically have two controls, the phase controls, as I call them (not counting the two additional vernier phase controls and the 180 degree phase shift switch). So operation of my new passive phasers is almost identical to operation of my modified Misek phasers. As Misek said about his phaser, page 74, ***The Beverage Antenna Handbook***, Second Edition, " One of the signal channels is split into two branches... resulting in a net phase shift of 90 degrees between potentiometers P1 and P2 [which I have called the phase controls in previous articles]. ... Because these two outputs [the outputs of P1 and P2] are connected in series, the resulting vectorial combinations can produce any phase shift at zero to maximum amplitude." Consequently no amplitude control (or controls) is (are) required for a Misek type phaser when identical antennas spaced 0.1 λ apart at the lowest frequency are used. As Misek stated, the two "phase" controls simultaneously vary both the phase and amplitude of one of the signal paths, the path which contains the phasing circuit and the amplifier. There is, however, a minor problem with this approach, namely the signal levels must be "corrected" to obtain full 360 degree nulling. In my modified Misek phasers this was done with toggle switched standard resistive pi attenuators in the unamplified signal path. Alternately, one could put a variable amplitude control in the unamplified signal path, but that does not seem to me to be a good idea because it would make generating nulls more difficult in some cases. My new phasers phasers vary amplitude and phase similar to although somewhat different from the Misek phasers. Because the signal paths of my new phasers are symmetric (ignoring that some path contains inductors and other paths contains capacitors), no amplitude "correction" is needed for one path. ***One of the things that makes Misek's phasers and my new passive phasers so much better than other phasers is that they do not have and generally do not need variable amplitude controls provided you use reasonable antennas.*** The exception is if you use modified Misek phasers or new passive phasers with nonstandard antennas (antennas which are not identical or which are not spaced 0.1 λ apart at the lowest operating frequency). As I have said repeatedly over the years, if you use the phasers I have developed with nonstandard antennas, then I do not guarantee their performance. Proceed at your own risk. For example, to get the deepest nulls possible in the NDB band with an amplified 15' noise reducing antenna and a 60' loop head circumference ALA-100 an external 1 dB per step rotary attenuator path was required in one signal path for both for my bandswitched modified Misek phasers and my bandswitched new passive phaser. From many hours of hands on experiences with other kinds of phasers, all of which used variable gain (amplitude) controls in both signal paths, even if you do use them with identical antennas spaced 0.1 λ apart, you will still have to use their amplitude controls and that makes generating nulls more difficult, and in some cases impossible. Also, phasers with variable amplitude controls which I have used generally have poorer long term null stability compared to my modified Misek phasers and my new passive phasers.

The simplest passive phaser above has only coax input. The others have switches to select coax input or twinax input. The 180 degree phase shift switch is common to all of the passive phasers above; it is necessary for full 360 degree null steering with overlap. If you get mostly shallow nulls, put the 180 degree phase shift switch in the other position. Deepest nulls for most signals will be obtained with the antenna reverse/swap switch in only one of the two positions, but for a few signals the other position will be needed for deepest nulls. In some cases there may be little or no difference in maximum null depth between the two positions of the antennas reverse/swap switch.

Before beginning to null a signal, first set the vernier controls to mid range. Next use the phase controls to begin nulling a signal. Adjust one phase control until a dip of the receiver S-meter is observed. It may be helpful to set both phase controls to mid range before adjusting them. An analog S-meter is desirable because some of the null deepening steps may not be indicated by a digital S-meter. If no dip is observed when one phase control is adjusted, then adjust the other phase control until a dip is observed. Alternately adjust the phase controls, first one and then the other, to deepen the null. When the null cannot be deepened further, use the vernier controls to try to deepen the null further. At some point during the nulling process a weaker signal (or tow or three) should be come audible, or if there are no other signals on that frequency, then background noise should become stronger as the signal is nulled. The deepest part of the null can only be adjusted "by ear," not by using the S-meter, and headphones are necessary in many cases to null the stronger signal mostly or completely into the background of the weaker signal(s). The entire process above can be repeated with the antenna reverse/swap switch in its other position to determine if a deeper null is possible. If the maximum null depth is shallow, put the 180 degree phase shift switch in its other position and repeat the entire process above. Except for nearby 50 kW MW signals, you should be able to null any of your daytime groundwave MW signals completely below man made noise at your location. The nulls of daytime groundwave MW signals should have good long term stability except during sunrise and sunset transition. Daytime groundwave nulls of 70 dB or more should be common. For nighttime skywave MW signals use the same procedure as above to null signals. The nulls generated by the phase controls for nighttime skywave MW signals are generally broader than for daytime groundwave signals, making it easier to generate nighttime skywave nulls unless there are numerous weaker signals beneath the signal being nulled. In that case it is difficult to tell when you have nulled the stronger signal as much as possible. Headphones are usually necessary for obtaining the deepest possible nulls for nighttime skywave signals, especially when there are multiple weaker signals underneath the stronger signal, which is often the case. Many nighttime skywave nulls are quite stable, some are not. The skywaves of strong nearby MW transmitters generally have less stable nulls than the skywaves of more distant transmitters. For example, 820 WBAP Ft. Worth, TX has a less stable null at my location in Ruston, LA than 750 WSB Atlanta, GA. And 1510 WLAC Nashville, TN has a less stable null than 1530 WSAI Cincinnate, OH. Virtually all MW skywave nulls are moderately to severely unstable during sunset and sunrise transitions, and when ionospheric propagation is unstable. When MW skywave propagation is stable, stable skywave nulls of 50 dB or more are not uncommon.