ERRATA -

All page, topic, and chapter references relate to "Recollections of a Radio Receiver" 2009.

Readers have reported the following corrigenda, hereby corrected. Errors are shown in *italic font*, corrections in ***bold italic font.***

This Errata version contains some **entire pages that have been revised, added or both,** as described in following paragraphs. These pages are in addition to individual word and number changes to existing pages, also as described herein.

- Errata identified with **suffix R replace existing** pages. For example, page 1:5.28R replaces in its entirety existing page 1:5.28.
- Errata identified with **suffix A add a new page**. For example, page 1:5.29A adds a single new page behind existing page 1:5.29, resulting in page 1:5.29A being between pages 1:5.29 and 1:5.30.
- Errata identified with an **alphanumeric suffix add multiple new pages**. For example, pages 1:5.29A1 and 1:5.29A2 adds two consecutive new pages behind existing page 1:5.29, resulting in pages 1:5.29A1 and 1:5.29B being placed between pages 1.5.29 and 1:5.30.

Version 2- 1 May 2010

This erratum appears as a file in e-books produced subsequent to 15 April, and this erratum includes the entirety of Version 1- 22 November 2009.

Book Part 1

Page NTE 2.1 — **Change** Gerry O'Hara's call sign from *VE6GUH* to ***VE7GUH.***

Page 1:3.3 — **Change** in second paragraph, HBR 14 RF tube type from *6AU6* to ***6BA6***

Page 1:3.7 — **Change** in last line of first bulleted paragraph "6CR *diode*" to "6CR ***triode***."

Page 1:3.15 — **Change** in second major paragraph, second line, "Ted *providedideas"* to "Ted ***provided ideas***.

Page 1:5.3 — **Change,** in first sentence immediately below major *topic "Physical Aspects of the Coils"* sentence ". . . Amphenol 24-5P polystyrene coil form . . . . and having a *wall thickness of 0.130- in"* to ***0.063*-in**. The coil O.D. is 1.250-in and I.D. is 1.125-in, the difference being 0.125-in, hence the wall thickness being half that or 0.063-in. Both OD and wall thicknesses are coil form parameters that affect inductance.

Page 1:5.10 — **Change**, in first sentence *"polycarbonate"* to "***polystyrene"***

Page 1:5.20 — **Remove** entire page and **replace** with ***revised page 1:5.20R***, attached. **Add** behind replacement page 1:5.20R ***additional page 1:5.20A***, attached.

Page 1:5.21 — **Remove** entire page and **replace** with ***revised page 1:5.21R***, attached.

Page 1:5.27 — **Delete** the last three lines at the bottom of the page. **Change** in first paragraph immediately below major topic "*The quandary of present-day coil form substitutes",* sentence commencing "As you have read in preceding sections . . . they will be wound on a 1.25-in diameter form having a 0.130 in *wall thickness"* to ***0.063-in.*** Same explanation as for Page 1:5.3, above.

Page 1:5.27A1 — **Add behind Page 1:5.27** new ***Page 1:5.27A1,*** following.

Page 1:5.28 — **Replace** existing Page 1:5.28 with ***Page 1:5.28R***, following.

Page 1:5.29 **Replace** existing Page 1:5.39 with new ***Page 1:5.29R***, following.

Page 1:5.29A1 **Add behind Page 1:5.29R** new ***Page 1:5.29A1***, following

Page 1:5.29A2 **Add behind Page 1:5.29A1** new ***Page 1:5.29A2,*** following

Page 1:5.29A3 **Add behind Page 1:5.29A2** new ***Page 1:5. 29A3,*** following

Page 1:5.41 **Change caption** from *"A 3/4-in length* …." to read ***"A short length …"***

Page 1:5.42 **Add to second caption** the words -

"Note wide stop ring supporting APC inside PVC connector body"

Add third caption having the words -

"Note in both views the nylon screw clamping the APC to the inner connector wall"

Page 1:5.46 **Delete in photo caption** behind abbreviation "NMT section" the words "*Top photo t****".***

Add to photo caption behind abbreviation "NMT section: the following -

"NMT shown has PVC measured wall thickness of 0.060-in, and is manufactured and marketed by J.M. Eagle as "PVC duct, 1-in diameter, power and communication duct for direct burial applications, TC6 and TC8, Type DB 120"

Add to photo caption the following -

"***The PVC pipe caps shown are manufactured by Genova; note flat bottom surface."***

Page 1:5.47 **Add to photo caption** the following -

"NMT shown has PVC measured wall thickness of 0.060-in, and is manufactured and marketed by J.M. Eagle as "PVC duct, 1-in diameter, power and communication duct for direct burial applications, TC6 and TC8, Type DB120"

Page 1:5.49 **Change photo caption** to read ***"Left view shows …"*** and ***"Right view shows …"***

Add new photo caption as follows -

"Note that the APC capacitor in the left view is not supported on the NMT edge by the tubing trimmed as in the right view. This is typical of an excessively deep rotor plate cut. For physical stability needed to achieve the "stay put" condition, this NMT section should be re-cut to provide APC support at both top corners, as well as clear the rotor plates when fully extended."

Add to existing photo caption the following -

"NMT shown has PVC measured wall thickness of 0.060-in, and is manufactured and marketed by J.M. Eagle as "PAVC duct, 1-in diameter, power and communication duct for direct burial applications, TC6 and TC8, Type DB 120."

Page 1.5:50 **Add to photo caption** the following -

"NMT shown has PVC measured with wall thickness of 0.060-in, and is manufactured and marketed by J.M. Eagle as "PVC duct, 1-in diameter, power and communication duct for direct burial applications, TC6 and TC8, Type DB 120. Glue was Duco cement, chosen to allow removal or replacement of NMT section."

Page 1:6.19 **Delete**, in last paragraph, the single word sentence **'Century',** appearing as an editorial "orphan". It has no relevant meaning to the text, and its presence resulted from computerized editing.

Page 1:7.12 **Change**, in first paragraph, sentence reading "His pragmatic use of a *2000 ohms/volt* …" to read ***20,000 ohms/volt***.

Page 1:8.3 **<u>Change</u>**, in first paragraph, sentence reading "The purpose of the Antenna Trimmer (*15 mFd* variable capacitor C-11 …" to read ***15 pFd***.

Page 1:8.10 **<u>Change</u>**, in fourth paragraph sentence reading "… focused on Eddystone receivers sold in the *1970 - 1990 decades* …" to read ***late 1940 - 1970 decades***.

Page Elg.15 **<u>Change</u>**, in fifth paragraph, sentence reading "… packed up *in 1958* …" to read ***in 1968***.

Book Part 2

Page 2:3xxx **<u>Delete</u>**, in second paragraph "… *their former employees have formed an organization* … " and annotate to read ***Ted Moore G6AIR/G3EUG in the early 1990's formed an organization***… It was the author's belief that G3EUG was a former Eddystone employee, but such was not the case.

harmonic mixing frequency would have had to cover a 29610/30610 kHz figure. Obviously, in this second instance, due to the fact that the Polar 1st oscillator tuning capacitance range will provide a GREATER FREQUENCY COVERAGE at the HIGHER 29610/276390kHz band of frequencies than it will at the LOWER 26390/27390 kHz portion of the spectrum, now easy enough to understand why it was that if by chance you had ended up with your 3 ½ turn/150 pFd padder 10 meter L3 coil set in such fashion that you were using the HIGH SIDE 2nd harmonic as the mixing frequency, the frequency coverage was precisely 1050 kHz you claimed you came up with, rather than the 1000 kHz spread you would have secured from this particular combination, had you been using the LOWER SIDE instead. It is my opinion therefor that it was this Nr 2 set of circumstances and conditions which you ended up with in the 3 ½ turn coil you constructed, and which you subsequently discarded, due to the fact it was covering 1050 kHz rather than the 650/750 kHz you had expected to get.

"Which finally brings us to this 2 ½ turn 10-meter L3 coil of your own design. Obviously, impossible for me to make even a wild guess as to what frequency you ended up with; inasmuch as you gave me neither the overall winding length of this coil, nor the value of the fixed padder you used across the coil. But again, did I have to make a guess at the value of the padder, I would be willing to give odds that again you used 150 pFd. If that be true, it would be my further guess that in this instance you ended up with an L3 coil that ***missed the very important 2nd harmonic mixing frequency classification*** *entirely, and* ***ended up with a coil which is operational at its FUNDAMENTAL instead.*** *Quite certain that even though you had made this coil "close wound", its effective inductance still much too small ever to have got it down to the relatively LOW FREQUENCIES required for 2nd harmonic type use. If you are attempting to use this coil at its fundamental frequency, this in itself goes far to explain its unsatisfactory performance as you describe it. And, if we then take the consideration the fact that with such a coil, it is practically impossible to arrange for* ***anything near to the much to be desired 35% location of the cathode tap point.*** *We come up with a further reason for your present difficulties and gripes. For* ***unless the 1st oscillator feedback be almost precisely correct, as I've told you many times, you can look for a type of 1st oscillator instability which will literally drive you nuts."***

*(**Bold italic** emphasis by W6HHT)*

Let us list here the salient points of Ted's critique -

- Ted had memorized the harmonic frequencies of the 3500 kHz marker and the 1710 2nd (crystal) oscillators, as well as the positive/negative 1st IF offset. I certainly had not, nor do I believe did very many of the HBR builders. Before even putting the L1 or L2 coil in place, it is appropriate to create a written record of all the harmonic signals you might encounter in "finding the band".

- You can set the 1st Oscillator either 1610 kHz (or whatever other IF frequency you are using) **above or below** the desired signal **and still generate the correct 1st IF frequency**. In his coil specifications Ted identifies whether the 1st oscillator should be above or below the desired signal, and he designed the 1st mixer specifically for that "high" or "low" oscillator signal. His reasons included avoiding images and achieving best frequency stability. **If you somehow manage to set the oscillator on the wrong side, the mixer will not perform as it should.**

- Three oscillators (tunable Hartley 1st, crystal-controlled 1710 kHz 2nd, and crystal-controlled 3500 kHz lower band edge marker), all running simultaneously inside the crowded interior of your HBR, **creates an environment rich in harmonics and beat frequencies**. The fundamental and 2nd harmonic of those signals will be the strongest, and it is these signals (**and not any others**) you will be looking for when commencing your "find the band" exercise.

- The HBR receiver design has enormous overall gain. By advancing the RF gain and retarding the mixer gain you can attenuate the many signals you do not wish to consider, thereby making it easier to find the correct frequencies. **Specific front panel gain settings are specified** elsewhere in this chapter to carry out this maneuver.

- The comparison chart following gives a basic picture of the environment, but does not include **any of the many beat signals generated by heterodyne action** between the oscillator signals**.**

HARTLEY OSCILLATOR FREQUENCY & HARMONICS COMPARISON TABLE
Based on 1610 kHz 1st IF and 100 kHz 2nd IF frequencies w/1710 kHz 2nd (xtal) oscillator

Band	1st Osc low-end output required	1st Mix input	2nd Osc output	Marker Osc
			1710 kHz (F)	
			3420 (2)	
80m	(3500 + 1610) = 5110 (F)	**5110** kHz (F)		***3500*** *kHz (F)*
			5130 (3)	
40m	(7000 - 1610) = 5390 (F)	**5390** kHz (F)		***7000*** (2)
			6840 (4)	
			8550 (5)	
			10260 (6)	
				10500 (3)
			11970 (7)	
20m	(14000 - 1610) x 1/2 = 6195 (F)	**12390** kHz (2)		***14000*** (4)
			13680 (8)	
			15390 (9)	
			17100 (10)	
				17500 (5)
			18810 (11)	
15 m	(21000 - 1610) x 1/2 = 9695 (F)	**19390** kHz (2)		***21000*** (6)
			20520 (12)	
			22230 (13)	
			23940 (14)	
				24500 (7)
			25650 (15)	
10 m	(28000 - 1610) x 1/2 = 13195 (F)	**26390** kHz (2)		***28000*** (8)
			27360 (16)	
			•	
			47880 (28)	
6 m	(50000 - 1610) x 1/2 = 24195 (F)	**48390** kHz (2)		[8350 kHz mkr xtal]
			49590 (29)	***50100*** (6)

- The **boldface** frequencies in the 1st Mixer input column are those needed for optimum 1st mixer operation. The frequencies in the 2nd Oscillator column are additional harmonics present in the HBR during alignment. Even more sum and difference beat frequencies are also present, caused by heterodyne action between the frequencies shown here.

- Only the 80-meter 1st oscillator operates above the lower band limit frequency. All other Hartley 1st oscillators operate below the lower band limit frequency, Only the 80 and 40 meter mixers use the Hartley 1st Oscillator fundamental frequencies. All other mixers use the 1st Oscillator second harmonic frequency.

- If your Hartley 1st IF is some frequency other than 1610 kHz, and/or your 2nd IF is some frequency other than 100 kHz, re-compute the 1st Oscillator output, 1st Mixer input, and 2nd Oscillator output columns.

- An 8350 kHz marker oscillator crystal must replace the 3500 kHz kHz marker crystal for the 6-meter band alignment.

So, after you wound your Hartley L3 coil, following Ted's specifications as closely as you could, and plugged it into the L3 socket, your next step was to "find the band". This is done by turning the APC capacitor in the top of the coil to acquire the marker oscillator frequency at a low dial setting of 10.0. As your Hartley oscillator generates its mixing signal, if you happened to acquire one of the 2^{nd} oscillator's harmonic signals instead of the appropriate crystal oscillator, a real "Rosetta Stone" puzzle was yours to solve.

Way-back-then those of us who owned a precision signal generator (such as a war surplus LM or BC-221) and who were concerned about "finding the band" instead of "finding a harmonic", used it to cross check our selection. We coupled the generator into the HBR's antenna connector, then carefully tuned it through the low band limit frequency with the integral crystal marker signal OFF. If we heard the generator signal at 10.0 +/- on our dial, then we could be satisfied we had in fact initially "found-the-band". Having verified our signal selection, we then disconnected the generator and returned to the integral HBR 3.5 mHz marker generator for the remainder of our alignment.

In the 21st Century, digital frequency counters are relatively common, and they too can be used to measure the frequency being generated by the 1st Oscillator, and verifying it as matching that shown in the table. Care must be taken not to "pull" the 1st oscillator frequency by the probe or pickup used to couple the input into the counter.

Way-back-then this simple "find the band, not the harmonic" exercise was not always understood, and in too many cases ignored as "not being needed", with the **result that a perfectly fine HBR failed to produce anticipated results on one or more bands**. Not having understood the reasoning behind (and necessity for) careful work, the builder was left with a strong sense of dis-satisfaction. The simple mistake of using the wrong 1st Oscillator harmonic (i.e. higher frequency instead of the specified lower frequency), thereby upsetting Ted's fine tuning of the following mixer stage also falls into this category. Hopefully, 21st Century builders, availing themselves of information on these pages, will be able to avoid that way-back-then problem.

In March, 1968, responding to growing requests for Hartley oscillator data, Ted wrote and distributed a 9-page document he refers to in his letters as the “Hartley Dope Sheet”. In it he summarized much of the detail in this publication (to simplify things for those select few who would copy his Hartley circuitry), and included in it results of his temperature experiments using the Hartley oscillator on his own receiver. I have extracted from that source, as well as a letter dated 26 June 68 (Archive 48) and a postcard dated 19 April 68 (Archive 38), the various corrections and clarifications he subsequently made to “The Dope Sheet”. In short, all Hartley corrections and clarifications I am aware of from any source are included right here in this chapter.

I have included a copy of Ted’s original “Dope Sheet” with my annotated corrections in Part 1 Chapter 3 References, mainly for historical background.

Ted, cognizant of the “find-the-band problem, and (like all the rest of us) not able to afford a frequency counter (and too stubborn to admit he really needed one!) fell back on a relatively simple arrangement as extracted from his “Dope Sheet” below -

W6TC Hartley Dope Sheet 29 March 1968

“The 80 meter Hartley L3 coil is designed to operate on the high side of the incoming signal, while all of the remaining L3 coils are designed for low side operation. With both the 80 and 40 meter L3 coils, the circumstances and conditions electronically are such that if the low end of these bands is located, automatically the 80 meter L3 coil will be operational on the high side of the incoming signal; on the low side on 40 meters”. Unfortunately, this is not true for the 10, 15 and 20 meter L3 coils, where it is quite possible for this L3 inductance value to be off sufficiently the coil can be APC bandset tuned to the high side of the desired signal rather than the required reverse. In which event, not only will the subsequent frequency coverage of the L3 coil be overly great, but incapable of as great a degree of stability as when the low side frequency of operation is present.

“Fortunately there is available to us a method of determining positively that the initial turns spacings adjustment of the 10, 15 and 20 meter L3 inductance has placed the 1st oscillator on the necessary low side of the incoming signal frequency. Once the 80 meter coil is functioning correctly, we can be certain that the 1st oscillator is now operational on the high side of the incoming signal frequency. Now make a note of which way off its center passband frequency positioning (i.e., half-capacitance) point of the BFO pitch control C-12 has been moved in order to place the null of an off-the air CW signal on a certain side of the vernier dial markings of the Eddystone 898 dial; on the right or left side of these vertical markings? Obviously, to maintain this identical positioning of the null with any one of the L3 coils designed for low side operation, the positioning of C12 will of necessity have to be the reverse of what was required for the 80 meter high side L3 coil. In other words, the C12 control knob must be moved to the opposite side of its half-capacitance position when any correctly functioning low side L3 coil is in use, as compared to its positioning

Alternative coil form dimensional issues

Paragraphs following that deal with alternative coil forms discuss dimensional limits for various plastic tubing and injection molded plastic pipe fittings. Certain of these dimensions are suffixed with "spec" to indicate a value **specified** by a manufacturer or by a technical standard. Other dimensions are suffixed with "meas" to indicate a value **measured** by the author on a sample; this generally appears where a product is no longer manufactured and we have little or no idea what the specified value might have been. Still other dimensions carrying no suffix are understood to be **nominal** values, generally used as trade designations or when several different manufacturers make a near-identical product. For example, we may write about "1-in plastic conduit" which is the trade designation for a pipe actually having an outside diameter (o.d) of about 1.32 inches. This is all confusing, and whether the measured value is "spec", "meas" or "nominal" in many cases is not very clear.

If this were not enough, all pipes having a round cross section when built, will inevitably exhibit a somewhat elliptical cross section as a result of aging, ultra-violet light, high temperature, outdoor storage, or weight placed on them during transportation or storage. For example, a 1.250-in diameter pipe may well measure anywhere from 1.260 to 1.240 depending on exactly where on the pipe you made the measurement. The thinner the tube wall, the worse this is. Although this morphing from circular to elliptical cross section creates complexity in measurements, its extent is usually meaningless to performance or to the mating of pipe with fittings; the tapered interior cavity of the fitting takes care of these variations.

The builder who creates his own coil forms (or modifies an existing form, such as the Meissner) needs the help of a dial caliper accurate to 0.001-inch. These are available in the $25 - $30 range at places such as Harbor Freight; mine is a Model 5658 by CenTech (China). When shopping or scavenging for plastic parts, take the dial caliper with you so you can measure wall thickness, o.d. and i.d.

Methodology of mating plastic tubing and molded fittings

Since alternative coil forms frequently involve use of plastic water pipe, plastic conduit, and molded pipe fittings, it is important to understand how the designers of such products visualize their method of mating pipe and fittings. When a section of pipe/plastic conduit is inserted into a molded plastic fitting, the mating surfaces permit sliding the two parts together until a 60 to 75% insertion takes place. This is deliberately designed into the plastic fittings by providing a slight taper of their interior walls. When the mating surfaces are primed, coated with appropriate pipe cement, then pushed to their "bottomed out" position, a chemical welding occurs over the point of former interference fit. Such a welded joint is needed for the assembled pipe/fitting to be water- or gas-tight.

What does this have to do with HBR coils? As we use various combinations of plastic pipe and plastic pipe fittings in a "dry fit" environment, there does not exist a stable connection between the two mating surfaces, and Ted's infamous "wiggle-wobble" is very likely to happen. We probably don't want to use plastic pipe glue, or perhaps cannot use it because one of the mating surfaces is something other than plastic (e.g., the insulated front of an APC capacitor). In creating alternate forms that use plastic fittings designed for pressure-tight piping service, we must either mechanically secure the two surfaces together, or use a general-purpose adhesive. My personal favorite for this is Duco, despite some contemporary opinion to the contrary. Way-back-then Duco was the adhesive of choice to stake down the windings on the Amphenol fittings; it has survived nearly 50-years on my personal coils, and it works well for me at making a reasonably strong bond between two adjacent parts, one of them being plastic. I want a glue that will keep two surfaces together when gently handled, but will release its bond when subjected to pocket knife pressure; I like to have ability to salvage the coil form (or whatever else the Duco may be fastening).

This also points out that some sanding of pipe ends may be needed, since adhesives such as Duco do not have the chemical welding properties of plastic pipe cement.

It should also be kept in mind that pipe and fitting manufacturers from time to time change their designs so the particular part that worked so well for you a few years ago may now have different dimensions or shape.

The Baker forms

Larry Baker K5OFD (larrybaker@suddenlink.com), both an amateur and a machinist, has copied the Amphenol polyethylene coil forms (built using injection molding equipment) to achieve a close replication using polycarbonate tubing (machined on his lathe). He can make the form any desired length up to a 5-inch maximum, and it is my personal opinion that his 3-in long form is of optimum size for HBR applications. Using the Amphenol form as our baseline reference we see the following differences -

Attribute	Amphenol	Baker
Material dielectric constant	2.4 to 2.6	2.9 to 3.0
Coil length available	2.5-in max	3.0-in (5-in max)
Outside form diameter	1.250	1.250 spec
Inside form diameter	1.126	1.000 spec
Wall thickness	**0.062-in**	**0. 125-in** meas

The significant negative differences in the Baker form are the higher dielectric constant and greater wall thickness. The positive differences are the greater coil length supported, and consequently the greater separation between innards and the coil's flux field. I judge the later as an offset to the greater wall thickness, lacking any present test data to quantify that judgment.

Larry must keep his cost for materials fairly low if he is to avoid being stuck with inventory he cannot sell. He also must counter-bore the coil for approximately 1-inch at the top to permit 180-degree rotation of the APCs; the amount of counter-bore is a function of the specific APC used, and may vary from one form order to the next; APCs from different manufacturers have different mounting plate dimensions, and this impacts how the coil is created so as to best support them. All of these facts, plus the amount of lathe work needed, makes his forms labor intensive.

The higher dielectric constant for the Baker coils does not overly bother me; both PVC and Bakelite have higher values.

From the builder's standpoint, the polycarbonate material's relatively low melting point makes it sensitive to soldering iron temperatures, and the same degree of care must be used with soldering on these forms as on the Amphenol forms.

All things considered, and presently absent any comparative test results, I conclude the Baker form is a very satisfactory "equal-to" substitution for the original Amphenol form.

The original Meissner forms

These Bakelite forms, produced by injection molding, were built in the years 1930 - 1950 for service in the Meissner Signal Shifter, a 3-tube 4-watt tunable exciter. The 5-pin form is pin-compatible with the requirements of the HBR, and are available from John Brewer K5MO (johnk5mo@gmail.com).

Attribute	Amphenol	Meissner
Material dielectric constant	**2.2 to 2.4** spec	**3.5 - 5.0** spec
Coil length available	2.5-in max meas	2.5-in max
Outside form diameter	1.250 meas	1.250 meas
Inside form diameter	1.126 meas	1.125 meas
Wall thickness	0.063-in	0.062-in

From this we can see that the negative differences in the Meissner form are the substantially higher dielectric constant (about double), and the absence at the coil top of a ring providing a firm mounting for the APC variable capacitor, fixed capacitor and temperature compensating capacitor, all part of the innards. The positive differences are in the high heat tolerance of the Bakelite material, making the soldering task on these coils much easier than on the Amphenol or Baker forms, both of which have a tendency to soften (and even melt) if your soldering iron lingers a bit too long.

There is one other special aspect of these coils. The original stock of Meissner 5-pin forms was about 500; today that stock level is something less than 100. On-going use of the Meissner forms for HBR (and other radio) coils will decrease this inventory to zero within the next several years. Once that occurs, HBR builders could shift to the 6-pin Meissner coil form for all their coils, and change their L1, L2 and L3 coil sockets from 5- to 6-pin. Lee Craner WB6SSW has an HBR-16 built with 6-pin sockets and finds they work fine. Obviously, any individual HBR must be either 5-pin or 6-pin. A start-of-project decision relative to plug-in socket configuration then seems appropriate, as does an early acquisition of sufficient forms to cover all the spectrum of interest to the builder.

All things considered, and presently absent any comparative test results, I conclude the Meissner form is a satisfactory substitution for the Amphenol form. I also conclude, for my set of judgment values and available data, that I would rank the original Meissner forms lower than the modified Meissner forms or the Baker forms; others may not agree.

The modified Meissner forms

The original Meissner forms can be easily modified so as to permit better mounting of the APC capacitor and the innards components by a simple addition to the coil height. To do this, a short section of PVC electrical conduit (formerly known as non-metallic tubing, or NMT) having a thin (0.060 - 0.072-in) nominal wall thickness) serves to mate a standard Schedule 40 1-in PVC connector to the Bakelite coil body. This arrangement is shown on Page 1:5.41.

First, to explain the plastic components used in this modification, the reader should be aware that the somewhat archaic NMT designation was first used to differentiate a plastic electrical conduit from the traditional steel GRC (galvanized rigid conduit) or EMT (electrical metal tubing, known in the electrical trades as "thin-wall" and made from steel). NMT was particularly useful where corrosion and exposure to chemicals was present. The success of NMT in the marketplace soon morphed the product to suit a number of special applications (i.e., plenums, concrete slabs, flexible and liquid-tight situations), all resulting in additional acronyms, manufacturer's designations, and industry standards

The particular NMT product used with the Meissner coils is intended for direct burial for protection of electrical and communication cables; it is manufactured and marketed nation-wide by J. M. Eagle, and is compliant with NEMA TC6 and 8, TYPE DB129. Many retail hardware stores and most electrical supply houses carry this or an equivalent product, such as www.harvel.com (160 psi Sch 26 0.060-in wall thickness, or 200 psi Sch 21 0.063 wall thickness), all available in 10-foot lengths.

One end of a short section cut from this particular thin wall PVC conduit will fit into the top ring of the Meissner form, and the other end extend inside a standard Schedule 40 1-in PVC pipe connector. This allows mounting of the APC and the other innards components in the top half of the connector, well away from the flux field. All PVC pipe connectors have an internal ring at their mid-point, providing a positive stop for the two plastic pipes being connected by special glue in their usual application. The inside diameter of that stop ring (i.e., how far the stop ring extends inside the connector) will dictate how you next proceed. Keep in mind that the APC needs a minimum opening of about 1.125-in i.d. for the its rotor to turn a full 360-degrees. The stop ring may or may not provide such an opening, and at the same time project far enough into the connector that it supports the APC itself.

- Where the connector's stop ring does project sufficiently into the cavity (and simultaneously allows full APC rotor movement), the APC and innards assembly can be supported directly by the connector. Duco can be applied to the upper face of the stop ring, as well as on the lower face of the APC mounting plate, then held in place with finger pressure until reasonably dry. Alternatively, drill and tap the side of the connector to support a nylon screw which will engage the APC insulating block on its top surface, and as this screw is tightened, force the APC against the opposing wall to make a secure fastening. Duco can then be applied to further secure the innards assembly. In this situation an NMT section 3/4-in long will serve to mate the PVC connector to the Meissner coil top. This is shown on pages 1.541 and 1:542.

- Where the stop ring does not project sufficiently into the cavity for APC support, a short section of NMT can be placed on the upper end of the stop ring, providing sufficient support for the APC.

- Prior to gluing the NMT section to the Meissner coil form, drill and tap the side of the connector to support a nylon screw; it will be this screw pressure that gives the major support for the APC and innards assembly. If the APC rotor dimensions are such that an interference with connector interior wall is a concern, drill and tap for two nylon screws 180-degrees apart. By judicious advancing and retarding the two screws, the APC can be "nudged" across the opening to best obtain the compromise of secure mounting and free rotor turning.

- In difficult cases, cut a very thin Schedule 80 pipe section sufficient to fit between the front stator plate and the rear of the capacitor's mounting plate. This section, when cemented to the stop ring below it, will both support the APC as well as ensure clearance from the connector wall.

This PVC connector extension keeps the innards components (and the PVC plastic material) reasonably well clear of the coil flux field; see Fig 1:5.42 for a comparison with an original Meissner form. To do the job properly, it may be necessary to visit a number of retail hardware, irrigation, and plumbing stores to find the NMT with the correct wall thickness, or the PVC connectors with the larger stop rings. Both products, as I have described them here, bear UPC codes normally applied by manufacturers only when they anticipate sales at a retail (as contrasted with contractor or industrial) level.

By now the reader is wondering how he cuts plastic tubing accurately and in such short dimensions without loss of fingers! There are several answers to this -

- A radial arm saw with a plywood or other fine-tooth veneer blade gives excellent results; this is my favorite method (and I still have all my fingers), but I have run radial arm saws for decades, and am well experienced in supporting the material to be cut, and how to stay well clear of the shining spinning blade. Simply hold the long end of the tubing or fitting, be sure you are clear of all rotating parts, pull the blade through, turn off the saw, wait for spin-down and then remove your cut pieces. You can do a very smooth and accurate cut with this technique.

- A bench saw similarly fitted with a plywood or other fine-tooth veneer blade will give equally good results, but you also need to make a cutting jig to hold the plastic since pipe you are cutting conceals the point of cut underneath, and fingers are at greater risk.

- Buy a low-cost miter box with a fine-tooth back saw, and cut your PVC conduit and parts manually and at zero risk to your fingers. Ace Hardware offers for $10 a very nice 14-in plastic miter box + back saw kit, Part Nr. 28589.

I have also found Duco cement works well both for gluing the Bakelite and NMT parts together, as well as gluing NMT to NMT. Duco is an adhesive that gives a relatively weak bond, and does not chemically weld two surfaces together. For that reason, the modified Meissner forms as described here can be easily taken apart should their builder wish to re-use the Bakelite body on another coil, or for some other purpose. I have deliberately dropped sample modified Meissner forms on a cement floor from a height of 2.5- and 4-feet, simulating fall from a tabletop and being dropped by a standing person. The test consisted of 5 drops from 2.5 feet followed by 5 drops from 4-feet with an unwound coil form, the Duco having dried a minimum of 24 hours. Other than some scuffmarks on the Bakelite and PVC, I could detect no failure.

Providing the innards above the Bakelite form supplies a full 2.75-in winding length, completely free of flux-field interference by innards. This benefit should reduce the "twitchy" nature of APC adjustments I have encountered when innards are seated inside the Meissner coil itself. It also helps substantially with achieving temperature stabilization.

In all other respects, there should be no performance differences between the original and modified Meissner forms.

I would personally rank the modified form below the Baker form, but above the original Meissner form.

The PVC homebrew forms (a work still very much in progress)

In 2007 I began thinking how nice it would be to have a coil form that could conceivably be substantially homebrew constructed, that using standard PVC pipe/conduit and other standard PVC irrigation parts. Keeping sourcing in mind, I found satisfactory end caps and connectors manufactured and marketed by Genova at retail hardware stores such as Ace. The end caps (which serve to mount the connecting pins) have a flat surface (somewhat unique among all other end cap manufacturers, thereby eliminating the need for lathe work otherwise needed to flatten the curved faces of "normal" end caps. The Genova connectors also have a centerline internal ring of dimensions needed to support the APC and innards components.

With the help of Larry Baker, a set of Genova end caps were constructed and equipped with pins as shown on page 1:5.46. Some further mechanical experiments were undertaken using the J. M. Eagle thin-wall NMT and Genova PVC connectors. The coil would be wound over 3.5-inches of 0.075-in thick NMT connecting the base (cap) to the 1-in connector. Note that a cutout is needed at the top of the NMT section to allow full rotation of the APC rotor, as was the case in the modified Meissner forms. Various views are provided on page 1:5.49.

The question of connecting pins in the end cap arose in late 2009. Pins, as we remember them from times past on the bottom of vacuum tubes, are designed for solder connections at their tips, as we do with the Amphenol, Baker and Meissner forms. Pin manufacturers no longer have interest in small orders (minimum order sizes quoted are 10,000 to 15,000), nor are they readily available from Newark or other mail order stores. This then suggests that pins for any homebrew construction coil form probably need to be of the solid type (so they can be turned using lathe tooling, and this then means that rear wiring connections will be required if form longevity is to be achieved. Making wiring connections on the rear of pins then translates to a winding activity running in connection with a coil assembly activity. If that were not enough, the coil bottom must be of a material that handles solder heat better than does polycarbonate or similar plastics.

Winding the coils on a PVC form, albeit one of small wall thickness (0.060-in) is a subject that will be alarming to some. If we repeat our comparison of materials using the Amphenol material as our baseline, we see the following -

Attribute	Amphenol	Homebrew PVC
Material dielectric constant	**2.2 to 2.4** spec	**3.4 - 4.0** spec
Coil length available	2.5-in max meas	3.5-in meas
Outside form diameter	1.250 meas	1.315 spec
Inside form diameter	1.126 meas	1.210 meas
Wall thickness	**0.063-in**	**0.053-in**

What soon became obvious was that an entirely new protocol for coil winding on forms of the type described would be needed. I had originally believed that the only real problem with an all-PVC coil form would be the difference in coil diameters (1.300 vis-à-vis 1.250-in, or approximately 4%) and the higher dielectric index of PVC itself, but when all the issues were explored, a whole bunch of problems emerged from their hiding place. As a result, this coil form as described here remains something slightly more than conceptual, but still very much a work in progress. Once we can resolve the issue of solid pins and how best to wire the coil as we assemble it, it will be necessary to wind a few coils and compare them against the original Amphenol coils. It is (in my mind, anyway) debatable as to whether the PVC form itself will have substantive negative impact on coil performance (other than in the RF Amplifier stage). On the other hand, the coefficient of thermal expansion for PVC is such that I have concern about the material in the 1st Oscillator from the standpoint of both stay-put as well as time from startup to reach frequency stability. These are all aspects that require further design effort and experimental confirmation.

Also keep in mind that APC capacitors installed in the coil form do not always have the same mounting plate footprint or dimensions. These vary from manufacturer to manufacturer, and between different APC models from the same manufacturer. The coil builder **needs to understand these dimensional differences before he winds his coils**; See **caption on Page 1:5.49** for details and further explanation**.**

Future 2010 work planned and some expectations

One portion of the 2010 HBR-XX work (potentially leading to HBR Enhancement Notes) will cover unresolved coil issues as described in this Chapter. To my knowledge, there has never been a performance comparison between an HBR equipped with Amphenol coils and the same HBR equipped with some other coil type. I plan to make such a comparative test with the Baker coil, the Meissner coil, and the modified Meissner coil, all on 40 meters. To that end, I plan to wind a complete 3-coil set for each coil form so I can test the set as a whole, as well as individual "alternate coils" when mixed in with the Amphenol coils. The object of these tests is to establish which coils work best vis-à-vis not so well.

With the comparative test data, it is my hope builders can make their own decisions as to the risk/benefit ratio of building the alternate coils. I would not be surprised, for example, to see the Amphenol coil take first place in the 1st RF application, the Baker coil take first place in the 1st Oscillator application, and the Meissner original coil take last place in the 1st Oscillator application. I do not plan to make this comparison over all bands; I picked 40 meters because it is the easiest coil set to wind, and my goal is to verify that comparative test yields usable results. Others can do the comparative testing on different bands.

The perfect hindsight view

Looking back on these matters from the perfect hindsight of nearly half a century, it seems clear that the HBR activity in the late 1960's was probably what kept the Amphenol 5-pin coil in the marketplace. I have encountered allegorical accounts that Amphenol had planned to abandon the 5P-24 form in the early 1960's, but instead sold their product and production equipment to Allied Radio. If this story is factual, there is little wonder that the 5-pin coils were on their way out of the market at the very peak of the HBR adventure, and they disappeared sometime in the mid 70's after Ted's death. I have correspondence about Millen form configurations to replace the Amphenol product dated in the early 1970's.

Since the 5-pin plug-in high-performance coils were essential to the HBR front end, and hence to the entire receiver performance, it is unfortunate that Ted left the planet before there was need to find a replacement coil form that would work well with his regenerative front end, and with his high-performance Hartley oscillator. Looking back on these matters from a perspective of 50 years, I wonder how many who wound their Amphenol coils or converted from tickler to Hartley oscillator really understood their essential nature, then took the time to fine-tune the coil windings. I know I certainly did not have a full comprehension in 1969 of how important those coils were.

The Hartley L3 coil was of particular importance to receiver performance, and was also the most sensitive to small fabrication errors. It was very important to follow all the details Ted had developed, and I wonder how many really did so. What was both obvious and easy to Ted, even when made available to experienced builders who recognized Ted's brilliance, in many cases was probably put aside as one of his many eccentricities, or perhaps just too much fuss and bother. Since the Hartley was never a published design change, there never existed in one single place all of the relevant information needed to comprehend the need for details to carry out, the L3 fine-tuning. The existing Hartley documentation appears to exist in bits and pieces without "glue" of a published article to pull everything together. Had I not had the good fortune to have a face-to-face discussion and tutorial with Ted on these matters, undoubtedly I, too, would have fallen into the category of the "uninformed".

I suspect, had Ted's health not begun to fail, he might well have offered to build for sale Hartley L3 coils for 20, 15 and 10 meters, all fine tuned in his HBR-20 or HBR012/13. In 1967 he had begun to sell his schematics and notes, (first with Alex and then myself providing him unlimited "bootleg copies" courtesy of the copy machines at our places of employment!). He seemed to much enjoy contemplating the fact he had "just made $25 by selling 10 copies of (you name it) at $2.50 each". Although Ted and "Mom" lived very simply in their tiny "retiree home", Ted never seemed to be critically short of cash. Somehow I think he just enjoyed seeing a tangible monetary "reward: for the knowledge he so carefully put down on paper. For those of us serious about HBR performance, that advice was priceless.

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