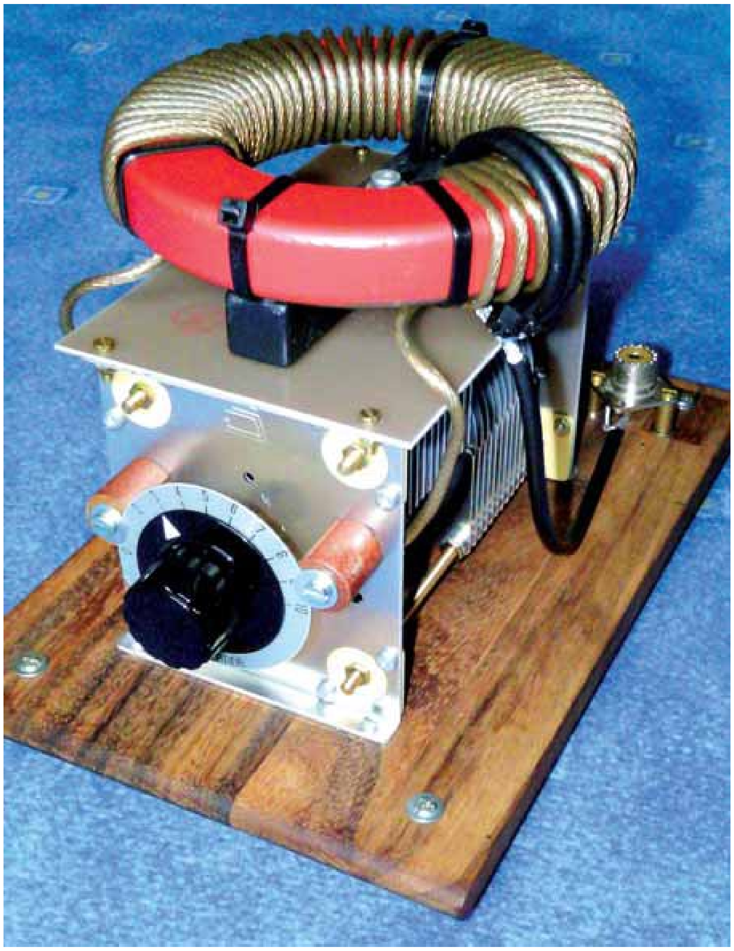
Parallel Circuit Coupler for 160 m, by Alfred Klüß, DF2BC

(Originally Published in the German Magazine "CQ DL", issue May, 2011, pages 332-333.)

Almost all commercially available antenna couplers are inadequate for extremely short doublets fed by open wire line. A home-brew coupler, purpose-designed specifically for 160 m, does the "job" even with a doublet of only 2 × 7 m length!



Conventional coupler circuits often have two problems on short antennas: the low antenna impedances are outside the matching range, and the devices are often under-sized for the high voltages and currents that occur. Matching cannot be achieved at all - and even if it can, then there are extremely high voltages on the capacitors and high losses in the coils; and forget about trying to maintain balance using a balun transformer, no matter what type of construction.

Requirements Profile

In order to be able to handle 100 W of transmitting power under these conditions, we need components that at first glance appear considerably oversized: variable capacitors free of moving contacts with a large plate spacing to provide high voltage capability of several kilovolts, and coils with a large-gauge wire. Air coils of thick solid wire or thin copper tubing are certainly the electrical optimum. Unfortunately, for a 160-meter band application, they are very large physically, which requires a lot of space and makes an open-chassis construction unavoidable.

Solution Approach

The coupler circuit should have as few components as possible and be simple and easy to operate, i.e. one-knob tuning. The L-network is less suitable here because it would be hard to achieve the needed L- and C-values. Therefore, the favored circuit is the parallel circuit presented here.

Translated by Marlin Brown, KC0O and Rick Westerman, DJ0IP

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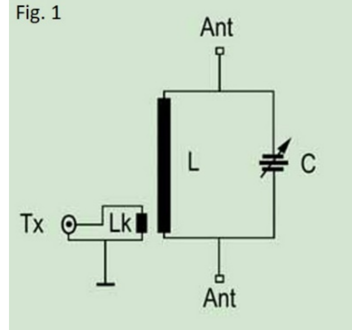
Toroid core coils are generally frowned upon for this application, but they are more practical than conventional [air] coils whose sizes become unmanageably large. In addition, they can be easily and quickly manufactured when using a very large diameter Toroid. Furthermore, they enable a compact design and, in addition, produce virtually no external field.

A simple LC circuit **(Fig. 1)** with a link-coupled coil formed the basis for all further experiments. This was followed by weeks of experiments with iron powder toroid cores of different sizes, winding with different inductance and various coupling, that is, via coil taps or via electrically-isolated coupling windings.

Fig. 1



The Amidon toroid "T-520-2" **[1]**, shown in **Fig. 2**, with an outer diameter of 132.1 mm is absolutely necessary for 100 W of power! Apart from the fact that on smaller toroid cores the required inductance can only be achieved with significantly smaller wire gauges, toroidal cores of the sizes T-400, T-300 and smaller are not large enough for thermal dissipation and rapidly enter the saturation range.

Results and Structure

The toroid core T-520-2 is wound with 47 turns of insulated stranded antenna wire **[2]**, 7×7×0.25mm dia. 'Litz', with 2.48 mm^2 cross-section. {about AWG-10} Both ends are secured with wire-ties. The inductance measured with an LC meter LDM-2 (Hamware) is 53 µH. For a variable capacitor, a split-stator with 2 × 300 pF and 2 mm plate spacing **[3]** has proven itself.

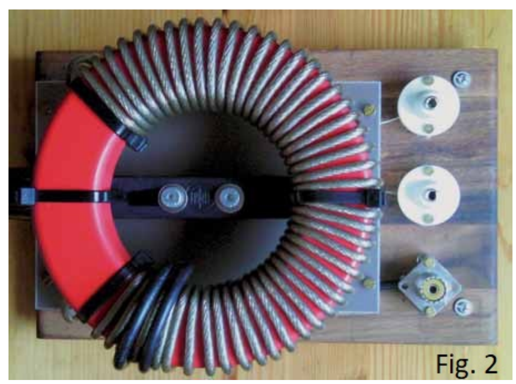


Fig. 2

If the coil is connected across the two stator sections with the rotor not externally connected, a final capacitance of approximately 150 pF is achieved. The voltage maximum thus doubles by the 2 × 2 mm plate-spacing to a total of 4 kV. Two kV is not enough!

The split-stator also avoids losses of a moving contact, and eliminates the "hand-effect" which is extremely troublesome when using a single section capacitor. It was not necessary to connect the center point (rotor) to ground. This measure had no influence on SWR or antenna current. At these points, no current flow towards the ground could be detected with the RF ammeter.

{Note: "hand-effect" is when an un-insulated shaft of the capacitor is sensitive to the operator touching the knob. The capacitance changes when the knob is touched.}

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An inductive link-coupling with two windings has proven to be optimal. It avoids tapping the coil winding and is easy to handle for adjusting the optimum amount of coupling by sliding it on the main coil.

The full galvanic separation to the antenna is characterized by significantly quieter reception and drastically reduced levels of omnipresent man-made noise. In order to get the most out of this, the unwanted capacitive coupling between the coupling and the main coil can also be eliminated by using a shielded coupling coil of coaxial cable **(Fig. 3)**. Since this article is not a doctoral thesis, I will only refer to **[4]**, where more information on the magnetically shielded coupling coil can be read.

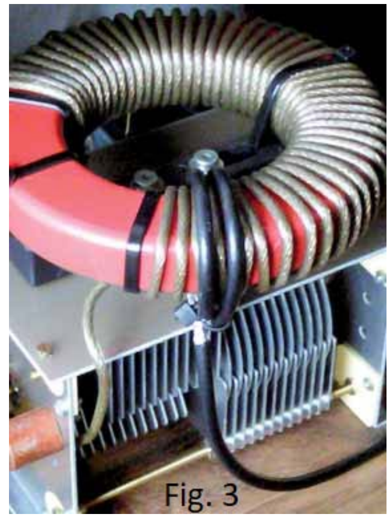

Fig. 3

One end of the RG-58, preferably double shielded with foil, is stripped to approx. 3 cm. The braid shielding and foil are completely removed and the outer insulating jacket is pushed slightly over it.

Two (2) cm of the center conductor is stripped and tinned. For testing, the cable end is placed with two turns around the toroidal coil and the location is determined where approximately 1 to 2 cm of the outer insulating jacket has to be carefully removed without damaging the braid shielding.

After rewinding onto the toroidal coil - only so tight that you can still slide the coupling coil - the center conductor is placed around the exposed braid shielding and soldered. The purely magnetically-coupled coupling coil is finished!

{Note: exact details on constructing L1 are shown in **[6]**}

I have mounted the toroidal coil on a wooden [maple] board of appropriate size. I mounted a plate of epoxy-board {FR4} on top of the variable capacitor.

The centrically-fastened Fritzel end insulator **[5]** serves as a carrier for the toroidal core coil. The coupling coil remains movable through the space between the circuit board and the toroid coil {L2}. The rest - the connection leads from the two hot ends of the LC circuit to the connections of the parallel feedline and the cable to the coaxial socket - is shown in **Fig. 4.** These connection elements are placed directly on the board

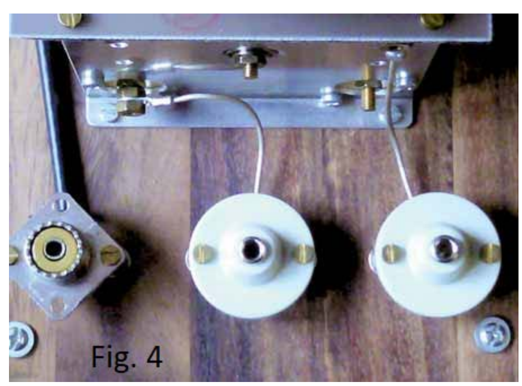

Fig. 4

with spacer cylinders and screws. The scale was fixed with spacers in the existing holes of the cover plate of the variable capacitor. With the mounting of four rubber feet on the bottom, the 160 m breadboard tuner was ready!

The only handwork you have to do here is wire winding, insolating, soldering, marking, hole-drilling and bolting. It doesn't get any easier, and when using new components, a design looks better than a snappy box with a rotary knob and a few jacks.

Operating Practices

Together with the 2 × 7 m short doublet from CQ DL 3/11, page 189-191, the coupler can be tuned at an SWR of 1 between 1.8 and 2 MHz. The total capacitance required for the operating frequency is composed of the capacitive reactance portion of the antenna and the capacitance value set at the rotary encoder. The nearly symmetrical antenna current in both conductors of the parallel feedline reaches 4 A.

In the near field, the ground wave often reaches 599+10 dB with 50 to 40 Watts of transmitting power (decreasing from 1.8 to 1.9 MHz). As soon as the sky wave is added, the reports vary between 559 and 599 depending on the conditions. The station ground is completely rf-free!

{Thanks to the link coupling} The local noise level is greatly reduced, and the improved preselection is another significant feature.

Fig. 1: The LC parallel circuit with coupling coil

Fig. 2: View of the toroidal coil with an Amidon T-520-2, and connections on the right

Fig. 3: The capacitively shielded coupling coil

Fig. 4: The connection elements mounted on the back of the breadboard

Literature and Component Sourcing:

[1] www.amidon.de

[2] www.kabel-kusch.de

[3] www.schubert-gehaeuse.de

[4] Karl Rothammel, Y21BK: Antennenbuch, 10 Edition 1991, Cap. 30.2, Maßnahmen zur Funkentstörung, Die abgeschirmte Koppelspule, P. 589

[5] www.hofi.de

[6] Ham Radio Site - Short 160m Antenna

About the Author

• Alfred Klüß {Kluess}, DF2BC

Born in 1957, Amateur Radio License in 1975.

{in 2011} Industrial Manager, and Freelance author and editor for 11 years.

Special interests: the operating mode telegraphy, everything to do with wire antennas and the 160 m band, despite limited antenna possibilities.

Other hobbies: long-distance cycling tours and "a six-year-old daughter and her mother."

About the DARC

The Deutsche Amateur Radio Club (DARC) e.V. is the largest association of radio amateurs in Germany and Europe.

The DARC is divided into 24 districts and approx. 960 local associations nationwide. The club's tasks are to promote amateur radio and to create suitable conditions for the amateur radio service. It is internationally active as a member of the International Amateur Radio Union (IARU).

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[END]

I wish the thank Alfred, DF2BC for permission to translate his article into English as well as the DARC Verlag GmbH for giving me permission to use the original photos, and to publish the article in English and German on my web site.

I also want to thank Marlin, NC0O for doing the initial bulk translation into English, enabling me to focus on translation of the technical terminology and layout of the English version.

73, de Rick, DJ0IP (NJ0IP)

P.S. Don't forget to visit my web page on this antenna tuner for a Short 160m Dipole. Here you will find additional drawings and tips for building the tuner:

https://www.dj0ip.de/open-wire-fed-ant/short-antennas/short-160m-antenna/