# Johnson Matchbox Renaissance

*A flea market winner! Or, build one yourself.*

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A recent article in *QST* which evaluated a number of different antenna-matching devices caught my attention. The venerable Johnson Matchbox got high marks for efficiency and degree of balance. It was proven to compensate for a fair amount of reactance from an antenna operated off-resonance.

I had always wanted a Matchbox in order to feed my large balanced-fed loop antenna with 50 ohm coax on all bands, but I'd never found a Matchbox at ham radio flea markets for the right price. I built a copy of one instead. It was an uncertain affair because I had only a small photo of the innards of a Matchbox to guide me. Matchboxes are somewhat hard to find (they haven't been made for about 35 years) so I think that others might want to build accurate copies. Mine is the version of the Matchbox that is conservatively rated at 275 watts (a kilowatt-rated model was also manufactured).

***"The Real McCoy" may be hard to find but dedicated hams can build accurate working copies."***

## Main Coil

The construction of the main coil (L1) is unusual; the two ends of the coil are wound with a smaller turn spacing than the middle section. The coil is symmetrical in construction as it is intended to be connected to a balanced line. The pitch of the two end sections is 8.5 turns per inch. This is equal to a center-to-center wire spacing, between adjacent turns, of about 0.12 inch. Each end of the coil contains 14.75 turns.

The pitch of the center section changes to 4.3 turns per inch in about one-quarter turn (90°) of the coil. This gives a center-to-center wire spacing between adjacent turns of about 0.23 inch. The center portion contains 5 turns.

The length of the entire coil (two end sections plus center section) is 4.5 inches; its outside diameter is 2.7 inches. The entire coil is air wound on

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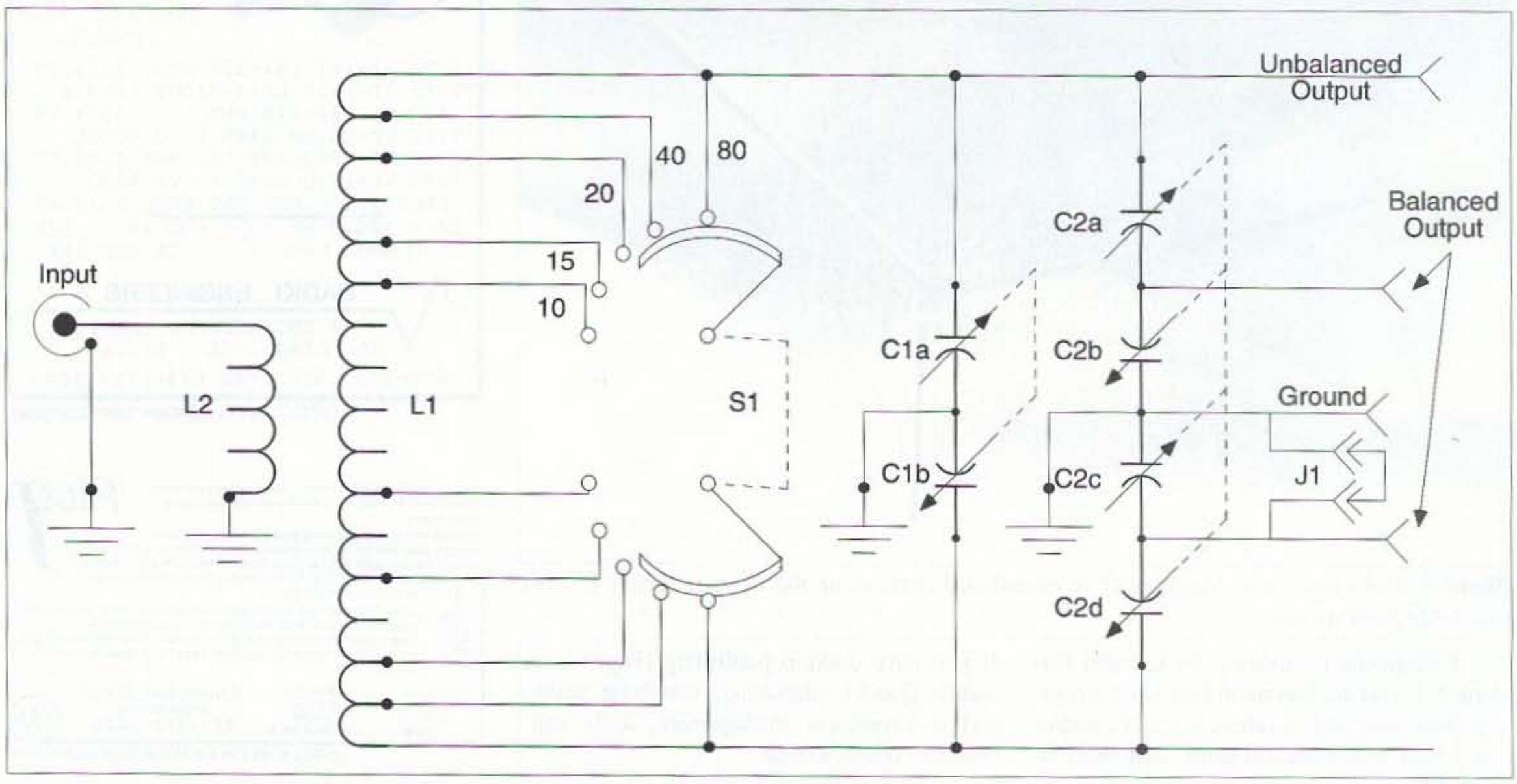

## Johnson Matchbox

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four narrow plastic spreaders which run the whole length of the coil. They are located every 90° around the circumference of the coil.

The main coil is tapped at approximately 0, 8.8, 12.7, 14.6 and 15.5 turns from each end; the tap at 0 turns means that the entire coil is used. This gives 80 through 10 meter coverage, respectively. 17 and 12 meters are covered but not 30 meters. 30 meter coverage could be provided by an additional tap between the 40 and 20 meter taps.

### Link Coil

Wound over the center section of the main coil is an unbalanced input link coil (L2).

The link is wound with the just about same pitch as the center section of the main coil. However, its outside diameter is larger, 3.0 inches. It contains four turns.

The link coil is positioned coaxially with and over the center portion of the main coil. It has an adjustable tap—about 1.25 turns up from ground gives around 50 ohms output impedance. Using all the turns of the link gives in excess of 300 ohms impedance.

Both coils and all the wiring is made from 12-gauge, tinned, solid-copper wire.

### Switch

The switch (S1) for selecting coil taps is a rotary unit. It has two poles with five positions (Johnson No. 22.884). It is a successively shorting design, although I'm not sure if this is strictly necessary. The switch is not large—it's about 1.75 inches in diameter. The two switch sections are located on opposite sides of 3/16-inch thick ceramic insulation. In my home-brew version, I just used alligator clips to tap the coil.

### Capacitors

There are two variable capacitors. They are both rated at 3 kV peak using 0.075 inch plate spacing and ceramic insulation.

The first one (C1) is an ordinary dual gang unit, with 10 to 100 pF of capacitance per section (Johnson Part No. 154-505-4 [100ED30]).

The other capacitor (C2) is set up as a two gang, dual differential variable, also 10 to 100 pF per section (Johnson Part No.169-25 (100EDA30)). Adjusting a dual differential capacitor causes one section to increase in capacitance while the other section decreases. For example, as the capacitance of section C2a is increased, that of section C2b will decrease (ditto for sections C2d and C2c, respectively). For this circuit, the rotor of this capacitor needs to be insulated from the chassis.

My home-brew version of the Matchbox was built on a metal plate resting on a wooden chassis. The manufactured version comes in a 10 x 10 x 8-inch high metal box.

### Tuning Up

Tune up is simple. Install an SWR bridge between the transmitter and the matchbox with short pieces of coaxial cable. Select the correct coil tap for the band to be used. Using the lowest possible power input to get an SWR indication, juggle both variable capacitors for the lowest SWR. There is interaction between the capacitor adjustments.

Or, to be more considerate of others on the air, connect an antenna noise bridge to a receiver. Set the noise bridge to 50 ohms resistive, then adjust the tuner for a dip in noise in the receiver.

### Performance

Using my particular antenna (a 275-foot long closed loop, roughly triangular in shape, approximately parallel to and about 25 feet above the earth, fed with 25 feet of home made 600 ohm open-wire line), I'm able to achieve very nearly a 1:1 SWR on all bands. Current balance, as indicated by an RF ammeter in each leg of feed line to the tuner, is excellent though my loop is not symmetrical. The Matchbox circuit provides at least 15 dB of harmonic attenuation as it is a resonance circuit. It gives some preselection for the receiver as well. You'll realize this when you have to retune every several hundred kHz or so on 80 and 40 meters if you want to keep the SWR low. I don't find this a serious inconvenience, since I made up a calibration chart giving frequency vs. dial setting.

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## A Simple One-Hour

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The few components can be mounted on a terminal strip. R1 is best attached to either the rear of the meter case or the interior of the enclosure, using epoxy, superglue or hot glue.

**Calibration**

Look at your meter scale. With luck there will be four main divisions. If not, carefully take the meter apart and divide the meter scale into four equal, 10-volt divisions, using a fine tip felt pen. Mark these points 90, 100, 110, 120, 130, starting at the zero end of the scale as follows: The space between 90 and 100 is one division; between 100 and 110 is division two; between 110 and 120 is the third division; and the final division is between 120 and 130 at full scale. Reassemble the meter and mount it in its enclosure.

If you are unfamiliar with disassembling meters, please see my article, "Use Those Surplus Meters," *73 Amateur Radio Today*, January 1992, page 42.

With your meter scale properly calibrated and all parts mounted in the enclosure, adjust R1 to maximum resistance. Using an accurate AC meter—a digital multimeter is preferred for accuracy, but a V-O-M can be used—measure the AC voltage at the nearest outlet, and note this value.

Plug in the Line Voltage Monitor. Being very careful not to touch any points carrying voltage, adjust R1 so the meter indicates the same voltage you measured previously. This completes calibration.

Operation is automatic. When this instrument is plugged into a live 117 VAC outlet it will continually monitor the level of voltage supplied by the power company.

**Notes**

Be sure the meter you use has a moving coil (D'Arsonval) movement. Do not use an iron vane meter. If you can't tell the difference at a glance, a good rule of thumb is: If it looks expensive, it probably is a D'Arsonval meter. If it is round or square and has a cheap-looking black painted metal case held together with bent metal tabs, it is probably an iron vane meter.

There are similar-looking line voltage meters commercially available costing about $20. Some of these appear to use an iron vane meter. You can build a better monitor for a lot less money.

A major disadvantage of using an iron vane meter to which a voltage is applied continuously is that they lose accuracy as the movement becomes magnetized. You'll find that, if you unplug one after a year in use, the needle will not return to the left end of the scale. Instead, it will indicate some level of voltage even though none is being applied.

An excellent and inexpensive source of surplus name-brand meters with D'Arsonval movements is Fair Radio Sales, Box 1105, Lima, OH 45802. A selection of five meters (their choice, not yours), Catalog No. 47-84, costs $10. Mostly basic 0-1-mA movements will be in each selection. Usually there will be one, possibly two meters with 100-µA movements. Some may have internal shunts, multiplier resistors, or rectifiers, but these are easy to eliminate, leaving you with the desired basic meter movement. This gets you your meter for only $2, and you still have four more nice meters for future projects! 73

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**Further Reading**

1. Witt, F. (AI1H), "How to Evaluate Your Antenna Tuner- Part 2," *QST* May 1995

2. Magnusson, John E. (W0AGD), "How's Your Antenna," *CQ* January 1962, p. 27. Picture is of the kilowatt version of the Johnson Matchbox.

3. Marriner, E. (W6XM), "Another Antenna Tuner," *Ham Radio*, May 1983. Describes building a dual differential variable capacitor. Shows construction of one-half of the Matchbox circuit for use with a balun or unbalanced loads.

**References:**

1. Mitchell, J.D. (K4IHV), "MatchBox Plus Two," *Ham Radio*, July 1979. Describes a modification of the Johnson Matchbox.

2. Maxwell, M.W. (W2DU), "Reflections," The American Radio League, 1990, p. 13-14. Comments on the theory of operation of the Matchbox circuit. 73

## Debunking Some Myths

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## HAM TO HAM

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item from the original equipment manufacturer's specifications. No responsibility is implied by the moderator or 73 for any equipment damage or malfunction resulting from information supplied in this column.

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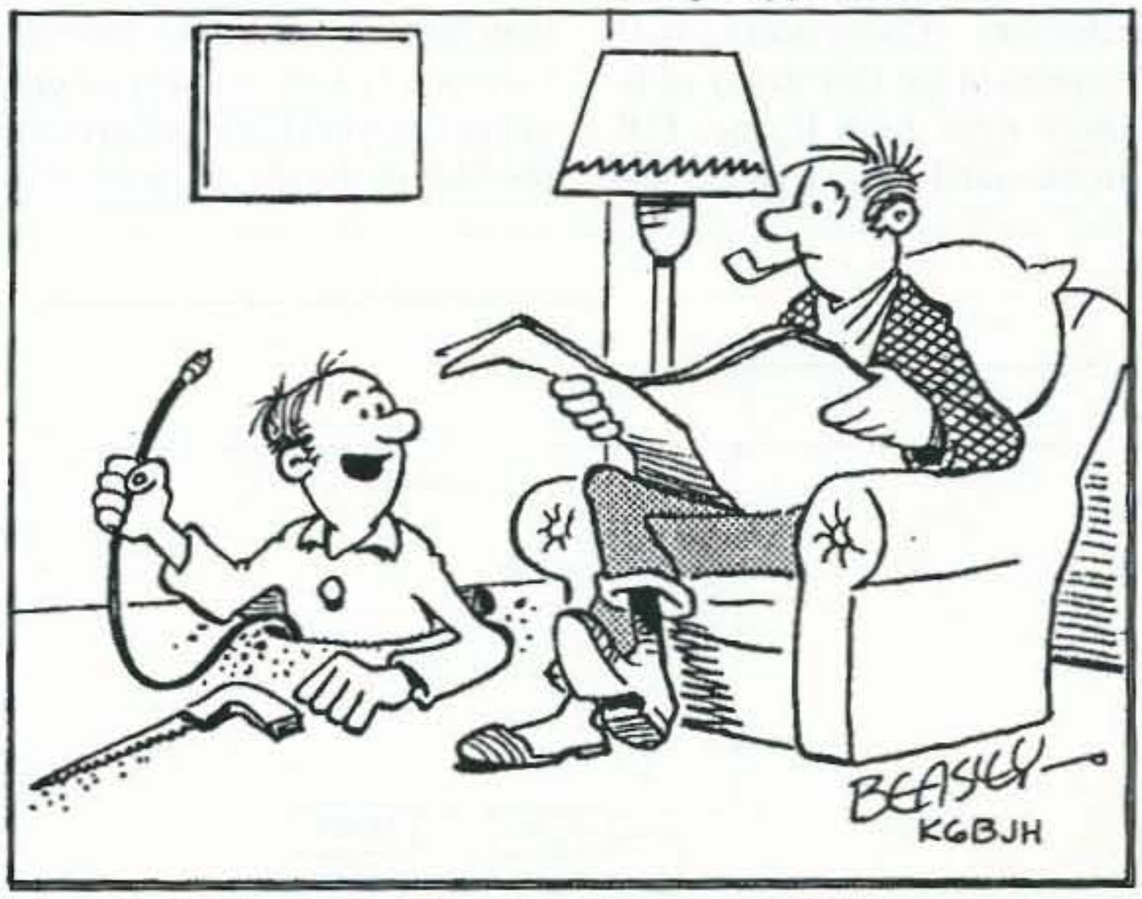
## Calling Young Hams!

Carole Perry WB2MGP is looking for youngsters under the age of 18 who are enthusiastic about amateur radio to contact her about appearing at the DAYTON 96 HAMVENTION this year. Kids should have good speaking skills and be at ease in front of an audience.

Please write or phone at PO Box 131646, Staten Island NY 10313-0006; (718) 983-1416 **ASAP**. Have some fun, network with other hams, and wouldn't this look good on your college applicationss?




***Toon 2:*** *Hi, I'm the ham from downstairs—mind if I run my coax through here to the roof?*

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